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SDMS DocID 000214269

Total Environmental Restoration Contract

New England Division

USACE Contract No. DACW33-94-D-0002

FOSTER WHEELER ENVIRONMENTAL CORPORATION

USACE CONTRACT NO. DACW33-94-D-0002
TASK ORDER NO. 0017
TOTAL ENVIRONMENTAL RESTORATION CONTRACT

FINAL BASIS OF DESIGN/ DESIGN ANALYSIS REPORT (100%) 700 TO 2,000 GPM WATER TREATMENT SYSTEM NEW BEDFORD HARBOR SUPERFUND SITE New Bedford, Massachusetts

Volume II – Appendix F
Technical Specifications

June 2002

Prepared for

U.S. Army Corps of Engineers
New England District
Concord, Massachusetts

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SECTION 01110

SUMMARY OF WORK

PART 1 GENERAL

1.1 SUMMARY

The work of this contract is described in the following documents:

a. Statement of Work (SOW) titled, "SOW for Remedial Design of Operable Unit #1".

b. Specifications titled, "Operable Unit #1 Water Treatment System, New Bedford Harbor Superfund Site, New Bedford, Massachusetts".

c. Contract Drawings titled, "Operable Unit #1 Water Treatment System, New Bedford Harbor Superfund Site, New Bedford, Massachusetts".

1.1.1 Order of Precedence of Contract Documents

The order of precedence for contract documents for this project are as follows:

1. Contract Terms and Conditions;

2. Statement of Work;

3. SOW Attachments (Specifications, Health and Safety Requirements, Quality Assurance Plan, Drawings, and other documents specific to the project);

4. Other Contract Requirements (Project Provisions, etc.).

In the event of conflict between the technical documents, the following order of precedence shall apply: Statement of Work (inclusive of attachments or exhibits), Specifications (inclusive of attachments or exhibits), and Drawings. Figured dimensions shall have priority over scale or configuration.

1.2 PROJECT DECRIPTION

The work includes constructing a new water treatment plant adjacent to the existing facility as described in the Basis of Design/Design Analysis (BD/DA) Report. The new water treatment plant will be installed within a prefabricated building and will include chemical addition, clarification, sand filtration, polishing filtration, and liquid phase granular activated carbon. Functionality of the plant will comply in accordance with action standards set by the Environmental Protection Agency.

1.3 LOCATION

The work shall be located at the New Bedford Harbor Superfund Site in New Bedford, Massachusetts. More specifically, the new water treatment plant shall be located at the Sawyer Street facility along the shore of the

Acushnet River. The exact location is as shown on the design drawings.

1.4 EXISTING WORK

In addition to "FAR 52.236-9, Protection of Existing Vegetation, Structures, Equipment, Utilities, and Improvements":

a. Remove or alter existing work in such a manner as to prevent injury or damage to any portions of the existing work which remain.

b. Repair or replace portions of existing work which have been altered during construction operations to match existing or adjoining work, as approved by the Contracting Officer. At the completion of operations, existing work shall be in a condition equal to or better than that which existed before new work started.

1.5 LOCATION OF UNDERGROUND FACILITIES

Obtain necessary digging permits prior to start of excavation. Verify the elevations of existing piping, utilities, and any type of underground obstruction not indicated or specified to be removed but indicated in locations to be traversed by piping, ducts, and other work to be installed. Verify elevations before installing new work closer than nearest manhole or other structure at which an adjustment in grade can be made.

1.5.1 Notification Prior to Excavation

For all excavation work in Massachusetts call Dig Safe at 1-888-344-7233. Notification of excavation work to the Contracting Officer as well as Dig Safe shall not be earlier than 30 days prior, nor later than 3 days prior, to the planned excavation.

1.6 CONTRACTOR USE OF SITE

1.6.1 Storage Areas

Area within the project limits is available for use by the Contractor, for work, storage of equipment, materials and trailers during the life of this contract. The Contractor shall confine his storage areas to the limits as designated or approved by the Contracting Officer. The Contractor shall be responsible for the security of storage areas outside of the Sawyer Street Site Support Zone. Upon completion of the contract, the Contractor shall remove all equipment and materials, except as otherwise specified, and restore the site to its original condition as approved by the Contracting Officer at no additional cost to the Government.

1.6.2 Work Limits

Work shall be restricted to the areas shown on the contract drawings in addition to any access locations and additional storage areas assigned to the Contractor.

1.6.3 Contractor Receipt of Supplies

The Contractor shall be responsible for all arrangements for the receipt and inspection of materials and supplies at the job site. The Contracting Officer's Representative is not permitted to receive or sign for items delivered to the site.

1.6.4 Delivery Schedule

Notify the Contracting Officer in writing at least 5 calendar days in advance of the date on which the materials and equipment are required. Pick up materials and equipment no later than 30 calendar days after such date.

1.6.5 Delivery Location

The materials and equipment will be delivered to the Sawyer Street Site with approval of the Contracting Officer. All deliveries will be the responsibility of the Contractor.

1.7 WORK SEQUENCE

1.7.1 General

There are certain essential criteria relative to the preparation of a work sequence and time schedule which the Contractor will be required to implement and follow during the prosecution of the work. Minor variations in the sequence of the items of work as specified may be made by the Contractor, provided such variations do not conflict with critical elements of the schedule. Variations shall be approved by the Contracting Officer prior to implementation.

1.7.2 Hours of Operation

Normal work hours are from 7:00 am through 5:30 pm, Monday through Friday. The Contractor will not be permitted to work on Sunday or legal holidays unless otherwise authorized by the Contracting Officer. The exclusion of work on Sunday and legal holidays has been considered in computing the performance time of this contract. The following legal holidays will be observed:

New Year's Day - 01 January 2002
President's Day - 18 February 2002
Memorial Day - 27 May 2002
Independence Day - 04 July 2002
Labor Day - 02 September 2002
Thanksgiving - 28 November 2002
Thanksgiving - 29 November 2002
Christmas - 25 December 2002

When one of the above designated legal holidays falls on a Sunday, the following Monday will be the observed legal holiday. When a legal holiday falls on a Saturday, the preceding Friday is observed as a holiday. Requests to perform work at other times shall be made in writing to the Contracting Officer. Every effort will be made to accommodate such requests.

1.8 PROJECT/SITE CONDITIONS

1.8.1 Site Conditions

Contractor shall video tape site prior to construction and replace any destroyed or damaged property when construction is complete.

1.8.2 Security

Within the Sawyer Street Support Zone, security will be provided. The Contractor shall provide any supplemental security measures necessary to perform the work specified herein.

1.8.3 Operational Restrictions

The Contractor shall not interrupt water, sewer, or supplied power service.

1.9 ORGANIZATION AT THE SITE

1.9.1 General

The Contractor shall employ ample personnel and sufficient equipment to accomplish the work of this contract in the least amount of time, within the prosecution period specified in the Contract Terms and Conditions.

1.9.2 Rate of Progress

Should the Contractor fail to maintain a satisfactory rate of progress, the Contracting Officer may require that additional personnel and equipment be placed on the project and weekend and overtime work be performed, in order that the work be brought up to schedule and maintained.

1.10 REGULATORY REQUIREMENT

1.10.1 Compliance With Site Regulations

All activities of the Contractor and his employees while on the site shall be conducted in strict accordance with all applicable Federal, State and City Regulations.

1.10.2 Identification of Employees

The Contractor shall be responsible for requiring each employee engaged in the work to sign in and out at the Security Guard shack. The Contractor shall acquaint himself with all site regulations in advance. Compliance with the provisions of this paragraph by the Contractor's subcontractors and their employees shall be the responsibility of the Contractor.

1.11 PRECONSTRUCTION CONFERENCE

The Contracting Officer shall conduct a preconstruction conference to inform the Contractor concerning the labor standards and clauses, safety and other conditions of the contract. It is mandatory that this preconstruction conference be attended by the Contractor or his representative and his on-site construction manager prior to beginning any work on the contract.

PART 2 PRODUCTS

All materials will be new unless otherwise specified by the Owner or Engineer.

PART 3 EXECUTION

Execution of work shall be as stated in the technical specifications of this text.

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SECTION 01320

PROJECT SCHEDULE

PART 1 GENERAL

1.1 QUALIFICATIONS

The Contractor shall designate an authorized representative who shall be responsible for the preparation of all required project schedule reports.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

A Project Schedule as described below shall be prepared. The scheduling of construction shall be the responsibility of the Contractor. Contractor management personnel shall actively participate in its development. Subcontractors and suppliers working on the project shall also contribute in developing and maintaining an accurate Project Schedule. The approved Project Schedule shall be used to measure the progress of the work, to aid in evaluating time extensions, and to provide the basis of all progress payments.

3.2 BASIS FOR PAYMENT

The schedule shall be the basis for measuring Contractor progress. Lack of an approved schedule or scheduling personnel will result in an inability of the Contracting Officer to evaluate Contractor's progress for the purpose of payment. Failure of the Contractor to provide all information, as specified below, shall result in the disapproval of the entire Project Schedule submission and the inability of the Contracting Officer to evaluate Contractor progress for payment purposes. In the case where Project Schedule revisions have been directed by the Contracting Officer and those revisions have not been included in the Project Schedule, the Contracting Officer may hold retainage up to the maximum allowed by contract, each payment period, until revisions to the Project Schedule have been made.

3.3 PROJECT SCHEDULE

The computer software system utilized by the Contractor to produce the Project Schedule shall be capable of providing all requirements of this specification. Failure of the Contractor to meet the requirements of this specification shall result in the disapproval of the schedule. Manual methods used to produce any required information shall require approval by the Contracting Officer.

3.3.1 Use of the Critical Path Method

The Critical Path Method (CPM) of network calculation shall be used to generate the Project Schedule. The Contractor shall provide the Project Schedule in the Precedence Diagram Method (PDM).

3.3.2 Level of Detail Required

The Project Schedule shall include an appropriate level of detail. Failure to develop or update the Project Schedule or provide data to the Contracting Officer at the appropriate level of detail, as specified by the Contracting Officer, shall result in the disapproval of the schedule.

3.3.2.1 Activity Durations

Contractor submissions shall follow the direction of the Contracting Officer regarding reasonable activity durations. Reasonable durations are those that allow the progress of activities to be accurately determined between payment periods less than 20 days.

3.3.2.2 Procurement Activities

Tasks related to the procurement of long lead materials or equipment shall be included as separate activities in the project schedule. Long lead materials and equipment are those materials that have a procurement cycle of over 90 days. Examples of procurement process activities include, but are not limited to: submittals, approvals, procurement, fabrication, and delivery.

3.3.2.3 Contracting Officer Activities

Contracting Officer and other agency activities that could impact progress shall be shown. These activities include, but are not limited to: approvals, inspections, and Notice to Proceed (NTP).

3.3.2.4 Modification or Claim Number

Any activity that is added or changed by contract modification or used to justify claimed time shall be identified by a mod or claim code that changed the activity. Activities shall not belong to more than one modification or claim item. The modification or claim number of each activity shall be identified by the Mod or Claim Number. Whenever possible, changes shall be added to the schedule by adding new activities. Existing activities shall not normally be changed to reflect modifications.

3.3.3 Scheduled Project Completion

The schedule interval shall extend from NTP to the contract completion date.

3.3.3.1 Project Start Date

The schedule shall start no earlier than the date on which the NTP was acknowledged. The Contractor shall include as the first activity in the project schedule an activity called "Start Project". The "Start Project" activity shall have an "ES" constraint date equal to the date that the NTP was acknowledged, and a zero day duration.

3.3.3.2 Early Project Completion

In the event the project schedule shows completion of the project prior to the contract completion date, the Contractor shall identify those activities that have been accelerated and/or those activities that are scheduled in parallel to support the Contractor's "early" completion. Contractor shall specifically address each of the activities noted in the

narrative report at every project schedule update period to assist the Contracting Officer in evaluating the Contractor's ability to actually complete prior to the contract period.

3.4 PROJECT SCHEDULE SUBMISSIONS

The Contractor shall provide the submissions as described below. The data disk, reports, and network diagrams required for each submission are contained in paragraph SUBMISSION REQUIREMENTS.

3.4.1 Initial Project Schedule Submission

The Initial Project Schedule shall be submitted for approval within 10 calendar days after NTP. The schedule shall provide a reasonable sequence of activities which represent work through the entire project and shall be at a reasonable level of detail.

3.4.2 Monthly Schedule Updates

Based on the result of progress meetings, specified in "Monthly Progress Meetings," the Contractor shall submit monthly schedule updates. These submissions shall enable the Contracting Officer to assess Contractor's progress. If the Contractor fails or refuses to furnish the information and project schedule data, which in the judgement of the Contracting Officer or authorized representative is necessary for verifying the Contractor's progress, the Contractor shall be deemed not to have provided an estimate upon which progress payment may be made.

3.5 SUBMISSION REQUIREMENTS

The following items shall be submitted by the Contractor for the preliminary submission, initial submission, and every monthly project schedule update throughout the life of the project:

3.5.1 Data Disks

Two data disks containing the project schedule shall be provided.

3.5.1.1 File Medium

Required data shall be submitted on 3.5 disks, formatted to hold 1.44 MB of data, under the MS-DOS Version 6.x, unless otherwise approved by the Contracting Officer.

3.5.1.2 Disk Label

A permanent exterior label shall be affixed to each disk submitted. The label shall indicate the type of schedule (Preliminary, Initial, Update, or Change), full contract number, project name, project location, data date, name and telephone number of person responsible for the schedule, and the MS-DOS version used to format the disk.

3.5.1.3 File Name

Each file submitted shall have a name related to either the schedule data date, project name, or contract number. The Contractor shall develop a naming convention that will ensure that the names of the files submitted are unique. The Contractor shall submit the file naming convention to the Contracting Officer for approval.

3.5.2 Approved Changes Verification

Only project schedule changes that have been previously approved by the Contracting Officer shall be included in the schedule submission. The Narrative Report shall specifically reference, on an activity by activity basis, all changes made since the previous period and relate each change to documented, approved schedule changes.

3.5.3 Schedule Reports

The format for each activity for the schedule reports listed below shall contain: Activity Numbers, Activity Description, Original Duration, Remaining Duration, Early Start Date, Early Finish Date, Late Start Date, Late Finish Date, Total Float. Actual Start and Actual Finish Dates shall be printed for those activities in progress or completed.

3.5.3.1 Activity Report

A list of all activities sorted according to activity number.

3.5.4 Network Diagram

The network diagram shall be required on the initial schedule submission and on monthly schedule update submissions. The network diagram shall depict and display the order and interdependence of activities and the sequence in which the work is to be accomplished. The Contracting Officer will use, but is not limited to, the following conditions to review compliance with this paragraph:

3.5.4.1 Continuous Flow

Diagrams shall show a continuous flow from left to right with no arrows from right to left. The activity number, description, and duration shall be shown on the diagram.

3.5.4.2 Project Milestone Dates

Dates shall be shown on the diagram for start of project, any contract required interim completion dates, and contract completion dates.

3.5.4.3 Critical Path

The critical path shall be clearly shown.

3.6 MONTHLY PROGRESS MEETINGS

Progress meetings to discuss payment shall include a monthly on-site meeting or other regular intervals mutually agreed to at the preconstruction conference. During this meeting the Contractor shall describe, on an activity by activity basis, all proposed revisions and adjustments to the project schedule required to reflect the current status of the project. The Contracting Officer will approve activity progress, proposed revisions, and adjustments as appropriate.

3.6.1 Meeting Attendance

The Contractor's Project Manager and Schedule shall attend the regular progress meeting.

3.6.2 Update Submission Following Progress Meeting

A complete update of the project schedule containing all approved progress, revisions, and adjustments, based on the regular progress meeting, shall be submitted not later than 4 working days after the monthly progress meeting.

3.6.3 Progress Meeting Contents

Update information, including Actual Start Dates, Actual Finish Dates, Remaining Durations, and Cost-to-Date shall be subject to the approval of the Contracting Officer. As a minimum, the Contractor shall address the following items on an activity by activity basis during each progress meeting.

3.6.3.1 Start and Finish Dates

The Actual Start and Actual Finish dates for each activity currently in-progress or completed.

3.6.3.2 Time Completion

The estimated Remaining Duration for each activity in-progress. Time-based progress calculations shall be based on Remaining Duration for each activity.

3.6.3.3 Cost Completion

The earnings for each activity started. Payment will be based on earnings for each in-progress or completed activity. Payment for individual activities will not be made for work that contains quality defects. A portion of the overall project amount may be retained based on delays of activities.

3.6.3.4 Logic Changes

All logic changes pertaining to NTP on change orders, change orders to be incorporated into the schedule, Contractor proposed changes in work sequence, corrections to schedule logic for out-of-sequence progress, lag durations, and other changes that have been made pursuant to contract provisions shall be specifically identified and discussed.

3.6.3.5 Other Changes

Other changes required due to delays in completion of any activity or group of activities include: 1) delays beyond the Contractor's control, such as strikes and unusual weather. 2) delays encountered due to submittals, Government Activities, deliveries or work stoppages which make re-planning the work necessary. 3) Changes required to correct a schedule which does not represent the actual or planned prosecution and progress of the work.

3.7 REQUESTS FOR TIME EXTENSIONS

In the event the Contractor requests an extension of the contract completion date, or any interim milestone date, the Contractor shall furnish the following for a determination as to whether or not the Contractor is entitled to an extension of time under the provisions of the contract: justification, project schedule data, and supporting evidence as the Contracting Officer may deem necessary. Submission of proof of delay,

based on revised activity logic, duration, and costs (updated to the specific date that the delay occurred) is obligatory to any approvals.

3.7.1 Justification of Delay

The project schedule shall clearly display that the Contractor has used, in full, all the float time available for the work involved with this request. The Contracting Officer's determination as to the number of allowable days of contract extension shall be based upon the project schedule updates in effect for the time period in question, and other factual information. Actual delays that are found to be caused by the Contractor's own actions, which result in the extension of the schedule, will not be a cause for a time extension to the contract completion date.

3.7.2 Submission Requirements

The Contractor shall submit a justification for each request for a change in the contract completion date of under 2 weeks based upon the most recent schedule update at the time of the NTP or constructive direction issued for the change. Such a request shall be in accordance with the requirements of other appropriate Contract Clauses and shall include, as a minimum:

a. A list of affected activities, with their associated project schedule activity number.

b. A brief explanation of the causes of the change.

c. An analysis of the overall impact of the changes proposed.

d. A sub-network of the affected area.

Activities impacted in each justification for change shall be identified by a unique activity code contained in the required data file.

3.7.3 Additional Submission Requirements

For any requested time extension of over 2 weeks, the Contracting Officer may request an interim update with revised activities for a specific change request. The Contractor shall provide this disk within 4 days of the Contracting Officer's request.

3.8 DIRECTED CHANGES

If the NTP is issued for changes prior to settlement of price and/or time, the Contractor shall submit proposed schedule revisions to the Contracting Officer within 2 weeks of the NTP being issued. The proposed revisions to the schedule will be approved by the Contracting Officer prior to inclusion of those changes within the project schedule. If the Contractor fails to submit the proposed revisions, the Contracting Officer may furnish the Contractor with suggested revisions to the project schedule. The Contractor shall include these revisions in the project schedule until revisions are submitted, and final changes and impacts have been negotiated. If the Contractor has any objections to the revisions furnished by the Contracting Officer, the Contractor shall advise the Contracting Officer within 2 weeks of receipt of the revisions. Regardless of the objections, the Contractor shall continue to update the schedule with the Contracting Officer's revisions until a mutual agreement in the revisions is reached. If the Contractor fails to submit alternative revisions within 2 weeks of receipt of the Contracting Officer's proposed

revisions, the Contractor will be deemed to have concurred with the Contracting Officer's proposed revisions. The proposed revisions will then be the basis for an equitable adjustment for performance of the work.

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SECTION 01330

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SUBMITTAL IDENTIFICATION

Submittals required are identified by SD numbers and titles as follows:

SD-01 Preconstruction Submittals

SD-02 Shop Drawings

SD-03 Product Data

SD-04 Samples

SD-05 Design Data

SD-06 Test Reports

SD-07 Certificates

SD-08 Manufacturer's Instructions

SD-09 Manufacturer's Field Reports

SD-10 Operation and Maintenance Data

SD-11 Closeout Submittals

1.2 SUBMITTAL CLASSIFICATION

Submittals are classified as follows:

1.2.1 Government Approved - GA

Governmental approval is required for extensions of design, critical materials, deviations, equipment whose compatibility with the entire system must be checked, and other items as designated by the Contracting Officer. Within the terms of the Contract Clause entitled "Specifications and Drawings for Construction," they are considered to be "shop drawings."

1.2.2 For Information Only - FIO

All submittals not requiring Government approval will be for information only. They are not considered to be "shop drawings" within the terms of the Contract Clause referred to above.

1.3 APPROVED SUBMITTALS

The Contracting Officer's approval of submittals shall not be construed as a complete check, but will indicate only that the general method of construction, materials, detailing and other information are satisfactory.

Approval will not relieve the Contractor of the responsibility for any error which may exist. The Contractor under the Contractor Quality Control (CQC) requirements of this contract is responsible for dimensions, the design of adequate connections and details, and the satisfactory construction of all work. After submittals have been approved by the Contracting Officer, no resubmittal for the purpose of substituting materials or equipment will be considered unless accompanied by an explanation of why a substitution is necessary. The Contractor shall be required to participate in Quality Control activities outlined in the Construction Quality Control Plan for the project. The Contractor shall abide by the requirements of this plan as well as any direction given, with regard to QC, by the Contracting Officer's QC System Manager.

1.4 DISAPPROVED SUBMITTALS

The Contractor shall make all corrections required by the Contracting Officer and promptly furnish a corrected submittal in the form and number of copies specified for the initial submittal. If the Contractor considers any correction indicated on the submittals to constitute a change to the contract, a notice in accordance with the Contract Clause "Changes" shall be given promptly to the Contracting Officer.

1.5 WITHHOLDING OF PAYMENT

Payment for materials incorporated in the work will not be made if required approvals have not been obtained.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 GENERAL

The Contractor shall make submittals as required by the specifications. The Contracting Officer may request submittals in addition to those specified when deemed necessary to adequately describe the work covered in the respective sections. Units of weights and measures used on all submittals shall be the same as those used in the contract drawings. Each submittal shall be complete and in sufficient detail to allow ready determination of compliance with contract requirements. Prior to submittal, all items shall be checked and approved by the Contractor's Quality Control (CQC) Representative. Proposed deviations from the contract requirements shall be clearly identified. Submittals shall include items such as: Contractor's, manufacturer's, or fabricator's drawings; descriptive literature including (but not limited to) catalog cuts, diagrams, operating charts or curves; test reports; test cylinders; samples; O&M manuals (including parts list); certifications; warranties; and other such required submittals. Submittals requiring Government approval shall be scheduled and made prior to the acquisition of the material or equipment covered thereby. Samples remaining upon completion of the work shall be picked up and disposed of in accordance with manufacturer's Material Safety Data Sheets (MSDS) and in compliance with existing laws and regulations.

3.2 SUBMITTAL REGISTER (ENG FORM 4288)

At the end of this section is one set of ENG Form 4288 listing items of equipment and materials for which submittals are required by the specifications; this list may not be all inclusive and additional

submittals may be required. The Contractor will also be given the submittal register files, containing the computerized ENG Form 4288 and instructions on the use of the files. These submittal register files will be furnished on a separate diskette. Columns "d" through "r" have been completed by the Contracting Officer; the Contractor shall complete columns "a" and "s" through "u" and submit the forms (hard copy plus associated electronic file) to the Contracting Officer for approval within 10 calendar days after Notice to Proceed. The Contractor shall keep this diskette up-to-date and shall submit it to the Contracting Officer together with the monthly payment request. The approved submittal register will become the scheduling document and will be used to control submittals throughout the life of the contract. The submittal register and the progress schedules shall be coordinated.

3.3 SCHEDULING

Submittals covering component items forming a system or items that are interrelated shall be scheduled to be coordinated and submitted concurrently. Certifications to be submitted with the pertinent drawings shall be so scheduled. Adequate time (a minimum of 10 calendar days exclusive of mailing time) shall be allowed and shown on the register for review and approval. No delay damages or time extensions will be allowed for time lost in late submittals.

3.4 TRANSMITTAL FORM (ENG FORM 4025)

The sample transmittal form (ENG Form 4025) attached to this section shall be used for submitting both Government approved and information only submittals in accordance with the instructions on the reverse side of the form. This form shall be properly completed by filling out all the heading blank spaces and identifying each item submitted. Special care shall be exercised to ensure proper listing of the specification paragraph and/or sheet number of the contract drawings pertinent to the data submitted for each item.

3.5 SUBMITTAL PROCEDURE

Submittals shall be made as follows:

3.5.1 Procedures

The Contractor shall submit 5 copies of each submittal unless otherwise directed by the Contracting Officer.

3.5.2 Deviations

For submittals which include proposed deviations requested by the Contractor, the column "variation" of ENG Form 4025 shall be checked. The Contractor shall set forth in writing the reason for any deviations and annotate such deviations on the submittal. The Contracting Officer reserves the right to rescind inadvertent approval of submittals containing unnoted deviations. When a variation is submitted on a For Information Only (FIO) submittal, the Contractor will make a special note of this fact either via a cover letter or verbally at the time the submittal is transferred to the Contracting Officer.

3.6 CONTROL OF SUBMITTALS

The Contractor shall carefully control his procurement operations to ensure

that each individual submittal is made on or before the Contractor scheduled submittal date shown on the approved "Submittal Register."

3.7 GOVERNMENT APPROVED SUBMITTALS

Upon completion of review of submittals requiring Government approval, the submittals will be identified as having received approval by being so stamped and dated. Three (3) copies of the submittal will be retained by the Contracting Officer and 2 copies of the submittal will be returned to the Contractor.

3.8 INFORMATION ONLY SUBMITTALS

Normally submittals for information only will not be returned. Approval of the Contracting Officer is not required on information only submittals. The Government and/or Contracting Officer reserves the right to require the Contractor to resubmit any item found not to comply with the contract. This does not relieve the Contractor from the obligation to furnish material conforming to the plans and specifications; will not prevent the Contracting Officer from requiring removal and replacement of nonconforming material incorporated in the work; and does not relieve the Contractor of the requirement to furnish samples for testing by a Contracting Officer laboratory or for check testing by the Contracting Officer in those instances where the technical specifications so prescribe.

3.9 STAMPS

The Contractor shall certify, in the space provided on the transmittal form, that the submittal meets contract requirements. Additionally, where specified or appropriate, the submittal document(s) shall be stamped and certified by a registered professional engineer and/or land surveyor.

-- End of Section --

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CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAG# RAPH	CLASSIFICATION	GOVT OR A/E REVWR	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION			APPROVING AUTHORITY					REMARKS
							SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION	MAILED TO CONTR/ DATE RCD FRM APPR AUTH	
(a)	(b)	(c)	(d)	(e)	(f)		(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		01356	SD-04 Samples															
			Turbidity Curtain															
			GA															
			Filter Fabric Mill Certificates															
			FIO															
		01410	SD-01 Preconstruction Submittals															
			Environmental Protection Plan	1.2.2														
			GA															
		01451	SD-01 Preconstruction Submittals															
			Contractor Quality Control Plan															
			GA															
		01720	SD-07 Certificates															
			Surveyor and Professional															
			Engineer Qualifications															
			FIO															
		01780	SD-11 Closeout Submittals															
			Record Drawings	1.2.1														
			GA															
			Record of Equipment and															
			Materials															
			Warranty Management Plan	1.3.1														
			Pre-Final Inspection Punch-List															
			FIO															
		02315	SD-06 Test Reports															
			Field Density Tests															
			GA															

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		02315	Testing of Fill Materials															
			SD-07 Certificates															
			Testing Laboratory Qualifications															
			GA															
			Certified Clean Materials															
		02316	SD-06 Test Reports															
			Field Density Tests	3.4.3														
			GA															
			Testing of Backfill Materials	3.4.2														
			SD-07 Certificates															
			Testing Laboratory Qualifications															
			GA															
			Certified Clean Materials															
		02531	SD-03 Product Data															
			Product(s)															
			GA															
			SD-07 Certificates															
			Portland Cement	2.7.1														
			GA															
			Pipeline Leakage Tests															
			Pipeline Deflection Tests															
			SD-08 Manufacturer's Instructions															
			Placing Pipe															
			FIO															
		02556	SD-02 Shop Drawings															

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		02556	Pipe, Fittings, and Associated	2.1														
			Materials															
			GA															
			SD-03 Product Data															
			Materials and Equipment	1.3.3														
			GA															
			Spare Parts Data															
			Connections to Existing Lines	3.12														
			Welding Steel Piping	1.3.1														
			Jointing Polyethylene and	1.3.2														
			Fiberglass Piping															
			Connection and Abandonment															
			Plan															
			SD-06 Test Reports															
			Pressure and Leak Tests	3.14.2														
			GA															
			SD-07 Certificates															
			Utility Work	3.12.1														
			GA															
			Training	1.3.2														
			SD-10 Operation and Maintenance															
			Data															
			Gas Distribution System	3.6														
			GA															
		03100	SD-02 Shop Drawings															
			Formwork															

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		03100	GA															
			Cast-in-Place Foundation															
			SD-03 Product Data															
			Design	1.3														
			GA															
			Form Materials	2.1														
			FIO															
			Form Releasing Agents	2.1.7														
		03150	SD-02 Shop Drawings															
			Waterstops	2.4														
			GA															
			SD-03 Product Data															
			Preformed Expansion Joint Filler	2.2														
			GA															
			Sealant	2.3														
			Waterstops	2.4														
			SD-04 Samples															
			Lubricant for Preformed	2.3.2														
			Compression Seals															
			GA															
			Field-Molded Type	2.3.4														
			Non-metallic Materials	2.4.3														
			SD-07 Certificates															
			Preformed Expansion Joint Filler	2.2														
			GA															
			Sealant	2.3														

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		03150	Waterstops	2.4														
		03200	SD-02 Shop Drawings															
			Concrete Reinforcement System															
			GA															
			SD-07 Certificates															
			Reinforcing Steel	2.3														
			GA															
		03300	SD-03 Product Data															
			Mixture Proportions	1.9														
			GA															
			SD-04 Samples															
			Surface Retarder	2.3.5														
			GA,															
			SD-06 Test Reports															
			Testing and Inspection for	3.17														
			Contractor Quality Control															
			GA															
			SD-07 Certificates															
			Qualifications	1.5														
			GA															
		04200	SD-02 Shop Drawings															
			Masonry Work															
			GA															
			SD-03 Product Data															
			Cold Weather Installation	3.1.2														
			GA															

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		04200	SD-06 Test Reports															
			Field Testing of Mortar	3.26.1														
			GA															
			Field Testing of Grout	3.26.2														
			Fire-rated CMU	2.4.3														
			SD-07 Certificates															
			Concrete Masonry Units (CMU)	2.4														
			FIO															
			Anchors, Ties, and Bar	2.12														
			Positioners															
			Expansion-Joint Materials	2.16														
			Joint Reinforcement	2.13														
			Reinforcing Steel Bars and Rods	2.14														
			Masonry Cement															
			Precast Concrete Items	2.8														
			Mortar Admixtures															
			Grout Admixtures															
		05120	SD-02 Shop Drawings															
			Structural Steel System															
			GA.															
			Structural Connections	3.2.1														
			SD-03 Product Data															
			Erection	3.2														
			GA															
			Welding	3.3														
			GA.															

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		05120	SD-07 Certificates															
			Mill Test Reports															
			GA.															
			Welder Qualifications															
			Welding Inspector	1.5														
			Fabrication	3.1														
		05500	SD-02 Shop Drawings															
			Miscellaneous Metal Items	1.6														
			GA															
			SD-06 Test Reports															
			Mill Test Reports															
			FIO															
			SD-07 Certificates															
			Welder Qualifications															
			FIO															
			Structural Steel Erector															
			Qualiications															
			Fabrication															
			GA															
			SD-08 Manufacturer's Instructions															
			Erection															
			FIO															
		07840	SD-02 Shop Drawings															
			Firestopping Materials	2.1														
			GA															
			SD-07 Certificates															

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		07840	Firestopping Materials	2.1														
			GA															
			Installer Qualifications	1.5														
			Inspection	3.3														
		07900	SD-03 Product Data															
			Backing	2.1														
			GA															
			Bond-Breaker	2.2														
			Sealant	2.5														
			SD-07 Certificates															
			Sealant	2.5														
			FIO															
		08110	SD-02 Shop Drawings															
			Doors and Frames	2.1														
			GA															
			SD-07 Certificates															
			Thermal Insulated Doors															
			FIO															
		08330	SD-02 Shop Drawings															
			Overhead Rolling Door Unit															
			GA															
			SD-03 Product Data															
			Overhead Rolling Door Unit															
			GA															
			SD-10 Operation and Maintenance															
			Data															

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		08330	Operation Manual															
			GA															
			Maintenance and Repair Manual															
			FIO															
		08510	SD-02 Shop Drawings															
			Steel Windows	1.4														
			GA															
			Insect Screens	2.5														
			FIO															
			SD-03 Product Data															
			Steel Windows	1.4														
			FIO															
			SD-04 Samples															
			Steel Windows	1.4														
			FIO															
			SD-07 Certificates															
			Steel Windows	1.4														
			FIO															
			SD-10 Operation and Maintenance															
			Data															
			Steel Windows	1.4														
			FIO															
		08700	SD-03 Product Data															
			Exit Device Accessories	2.5														
			GA															
			Hardware Schedule	1.3														

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		08700	Keying	2.6														
			SD-07 Certificates															
			Hardware and Accessories															
			GA															
		08810	SD-02 Shop Drawings															
			Installation	3.2														
			GA															
			SD-03 Product Data															
			Insulating Glass															
			GA															
			Glazing Accessories															
			SD-04 Samples															
			Insulating Glass															
			GA															
			SD-07 Certificates															
			Insulating Glass															
			GA															
			Glazing Accessories															
		09250	SD-02 Shop Drawings															
			Steel Framing	2.6.2														
			FIO															
			Control Joints	3.3.6														
			Fire-Resistant Assemblies	3.8														
			SD-07 Certificates															
			Gypsum Wallboard	2.5.1														
			Gypsum Wallboard	3.8														

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		09250	FIO															
			Water-Resistant															
			Steel-Framing	2.6.2														
			Fire-Rated Gypsum Board	2.4.2														
			Cemetitious Backer Units															
		09510	SD-02 Shop Drawings															
			Approved Detail Drawings	1.3														
			GA															
			SD-03 Product Data															
			Acoustical Ceiling Systems	2.5														
			FIO															
			SD-06 Test Reports															
			Fire Resistive Ceilings	2.5														
			FIO															
			Ceiling Attenuation Class and															
			Test															
			SD-07 Certificates															
			Acoustical Units	2.1														
			FIO															
		09650	SD-03 Product Data															
			Resilient Flooring and															
			Accessories															
			FIO															
			SD-04 Samples															
			Flooring	3.2														
			FIO															

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		09650	SD-06 Test Reports															
			Moisture Test	3.3														
			FIO															
		09900	SD-03 Product Data															
			Paint	2.1														
			GA															
			SD-04 Samples															
			Moisture-Curing Polyurethane															
			FIO															
			Paint	2.1														
			SD-06 Test Reports															
			Paint	2.1														
			FIO															
			SD-07 Certificates															
			Lead	2.1.3														
			FIO															
			Mildewcide and Insecticide	2.1.2														
			Volatile Organic Compound	2.1.5														
			(VOC) Content															
			SD-08 Manufacturer's Instructions															
			Mixing and Thinning	3.3														
			FIO															
			Application	3.4														
		09910	SD-03 Product Data															
			High Solids Thin Film Epoxy															
			Flooring System															

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		09910	GA															
			Material Safety Data Sheets															
			(MSDSs)															
			FIO															
			Cleaning and Thinner Solutions															
			SD-04 Samples															
			High Solids Thin Film Epoxy															
			Flooring System															
			GA															
			SD-07 Certificates															
			Qualifications of Applicator															
			GA															
		09930	SD-03 Product Data															
			Protective Coating System															
			GA															
			Material Safety Data Sheets															
			(MSDSs)															
			FIO															
			Cleaning and Thinner Solutions															
			SD-04 Samples															
			Protective Coating System															
			GA															
			SD-07 Certificates															
			Qualifications of Applicator															
			GA															
		10201	SD-02 Shop Drawings															

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		10201	Wall Louvers	2.2														
			GA															
			SD-04 Samples															
			Wall Louvers	2.2														
			GA															
		10430	SD-01 Preconstruction Submittals															
			Exterior Signs															
			FIO															
			SD-02 Shop Drawings															
			Exterior Signs															
			FIO															
			SD-03 Product Data															
			Exterior Signs															
			FIO															
			SD-04 Samples															
			Exterior Signs															
			FIO															
			SD-08 Manufacturer's Instructions															
			Exterior Signs															
			FIO															
		10440	SD-02 Shop Drawings															
			Interior Signage															
			GA															
			SD-03 Product Data															
			Interior Signage															
			GA															

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		10440	SD-04 Samples															
			Interior Signage															
			GA															
		10800	SD-03 Product Data															
			Finishes	2.1.2														
			GA															
			Accessory Items	2.2														
		11240	SD-02 Shop Drawings															
			Adsorption Battery Components	2.2														
			GA															
			SD-03 Product Data															
			Activated Carbon Adsorption Units															
			GA															
			Activated Carbon	2.1.1														
			Material Safety Data Sheet															
			FIO															
			Adsorption Battery Components	2.2														
			Posting Framed Instructions	3.9														
			Delivery, Storage, and Handling	1.8														
			SD-07 Certificates															
			Activated Carbon	2.1.1														
			GA															
			Equipment	3.7.1														
			SD-10 Operation and Maintenance															
			Data															

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		11240	Complete Activated Carbon															
			Adsorption System															
			GA															
		11242	SD-01 Preconstruction Submittals															
			Chemical Feed Systems	2.1														
			GA															
			SD-02 Shop Drawings															
			Chemical Feed Systems	2.1														
			GA															
			SD-03 Product Data															
			Chemical Feed Systems	2.1														
			GA															
			SD-06 Test Reports															
			Testing	3.3														
			GA															
			SD-08 Manufacturer's Instructions															
			Chemical Feed Systems	2.1														
			SD-10 Operation and Maintenance															
			Data															
			Chemical Feed Systems	2.1														
			GA															
		11310	SD-02 Shop Drawings															
			Equipment Installation	3.1														
			GA															
			SD-03 Product Data															
			Pump System															

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		11310	GA															
			Spare Parts															
			FIO															
			Pump System Instructions															
			SD-06 Test Reports															
			Field Testing and Adjusting	3.3														
			Equipment															
			GA															
			SD-10 Operation and Maintenance															
			Data															
			Pump System															
			GA															
		11394	SD-02 Shop Drawings															
			Shop Drawings	3.5														
			GA															
			SD-03 Product Data															
			Posting Framed Instructions	3.10														
			FIO															
			Qualifications	1.4														
			GA															
			Media	2.3														
			Materials and Equipment	2.1														
			Control System	2.2.4														
			Spare Parts	2.13														
			SD-06 Test Reports															
			Acceptance Testing	3.11.3														

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		11394	GA															
			Factory Tests															
			SD-07 Certificates															
			Materials and Equipment	2.1														
			GA															
			SD-10 Operation and Maintenance															
			Data															
			Field Training	3.12														
			FIO															
		11395	SD-02 Shop Drawings															
			Shop Drawings															
			GA															
			SD-03 Product Data															
			Posting Framed Instructions															
			FIO															
			Qualifications	1.4														
			GA															
			Media															
			Materials and Equipment	2.1														
			Spare Parts	2.13														
			SD-07 Certificates															
			Materials and Equipment	2.1														
			GA															
			SD-10 Operation and Maintenance															
			Data															
			Field Training	3.12														

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		11395	FIO															
		11540	SD-03 Product Data															
			Clarifier Design															
			GA															
			SD-10 Operation and Maintenance															
			Data															
			Operation and Maintenance															
			(O&M) Manuals															
			GA,															
		13120	SD-02 Shop Drawings															
			Drawings															
			GA															
			SD-03 Product Data															
			Design Analysis	1.5														
			GA															
			Instruction Manuals															
			Erection	3.1														
			Qualifications	1.3.2														
			SD-04 Samples															
			Accessories	2.3.6														
			FIO															
			Roofing and Siding	2.3														
			Fasteners	2.4														
			Insulation	2.9														
			Gaskets and Insulating	2.11														
			Compounds															

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		13120	Sealant	2.10														
			Wall Liners															
			SD-07 Certificates															
			Metal Building Systems															
			GA															
		13405	SD-02 Shop Drawings															
			Installation	3.1.1														
			GA															
			Wiring	3.1.1														
			SD-03 Product Data															
			Instrumentation and Control	3.7														
			System															
			GA															
			Meters and Sensors															
			Training Manual	3.8														
			Performance Verification Test	3.5.2														
			(PVT)															
			SD-06 Test Reports															
			Testing, Adjusting and	3.5.1														
			Commissioning															
			GA															
			Performance Verification	3.5.2														
			Test(PVT)															
			SD-07 Certificates															
			Sensor and Control Wiring	3.3.2.2														
			GA															

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		13405	SD-10 Operation and Maintenance															
			Data															
			Instrumentation and Control	3.7														
			System															
			GA															
		13850	SD-02 Shop Drawings															
			Fire Alarm Reporting System	1.4.1														
			GA															
			SD-03 Product Data															
			Storage Batteries	2.2														
			GA															
			Voltage Drop															
			FIO															
			Spare Parts	2.8.4														
			Technical Data and Computer	1.5														
			Software															
			Training	3.6														
			Testing	3.5														
			SD-06 Test Reports															
			Testing	3.5														
			GA															
			SD-07 Certificates															
			Equipment															
			GA															
			Qualifications	1.3.7														

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		13850	SD-10 Operation and Maintenance															
			Data															
			Technical Data and Computer	1.5														
			Software															
			GA															
		15080	SD-04 Samples															
			Thermal Insulation Materials															
			GA															
		15190	SD-02 Shop Drawings															
			Gas Piping System	3.2														
			GA															
			SD-03 Product Data															
			Qualifications															
			GA															
			SD-06 Test Reports															
			Testing															
			GA															
			Pressure Tests	3.16.1														
			Test With Gas	3.16.3														
		15200	SD-02 Shop Drawings															
			Pipe and Equipment	3.1.1														
			GA															
			SD-03 Product Data															
			Qualifications	1.4														
			GA															
			Welders	1.4.2														

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		15200	Assistance and Training															
			Delivery, Storage and Handling	1.6														
			Materials and Equipment															
			FIO															
			Installation	1.9.2														
			Pipe Schedule	1.5														
			Valve Schedule															
			Operator Schedule															
			SD-06 Test Reports															
			Pipe Leakage Tests	3.13.2														
			GA															
			Hydrostatic Tests	3.13.1														
			Pneumatic Tests															
			Valve Testing	3.13.4														
			SD-07 Certificates															
			Plastic Piping System	2.2														
			GA															
			Contractor's Installation															
			SD-10 Operation and Maintenance															
			Data															
			Piping and Appurtenances	3.2														
			FIO															
		15400	SD-02 Shop Drawings															
			Plumbing System	3.9.1														
			GA															
			Electrical Schematics															

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		15400	SD-03 Product Data															
			Welding	1.3.1														
			GA															
			Plumbing Fixture Schedule	3.10														
			Vibration-Absorbing Features	3.4														
			SD-06 Test Reports															
			Tests, Flushing and Disinfection	3.9														
			GA															
			Backflow Prevention Assembly															
			Tests															
			SD-07 Certificates															
			Materials and Equipment															
			FIO															
			Bolts	2.1.1														
			SD-10 Operation and Maintenance															
			Data															
			Plumbing System	3.9.1														
			FIO															
		15565	SD-02 Shop Drawings															
			Heating System															
			GA.															
			Installation	3.1														
			SD-03 Product Data															
			Heating System															
			FIO.															
			SD-06 Test Reports															

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		15565	Testing, Adjusting, and Balancing	3.2														
			FIO.															
			SD-10 Operation and Maintenance															
			Data															
			Instructions	3.3														
			FIO.															
		15700	SD-02 Shop Drawings															
			Drawings															
			GA															
			SD-03 Product Data															
			Unitary Equipment	2.4														
			GA															
			Spare Parts Data															
			Posted Instructions	3.5														
			Verification of Dimensions	1.5.1														
			SD-07 Certificates															
			Unitary Equipment	2.4														
			GA															
			Service Organization	2.1														
			SD-10 Operation and Maintenance															
			Data															
			Operation Manuals															
			GA															
			Maintenance Manuals	3.5														
		15760	SD-03 Product Data															
			Unit heaters	2.1														

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		15760	GA															
			Infrared heaters	2.2														
			SD-10 Operation and Maintenance															
			Data															
			Unit heaters	2.1														
			GA															
			Infrared heaters	2.2														
		15895	SD-02 Shop Drawings															
			Drawings	3.1.9														
			GA															
			Installation	3.1														
			SD-03 Product Data															
			Components and Equipment	2.1														
			GA															
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TRANSMITTAL OF SHOP DRAWINGS, EQUIPMENT DATA, MATERIAL SAMPLES, OR MANUFACTURER'S CERTIFICATES OF COMPLIANCE *(Read instructions on reverse side prior to initiating this form)*	DATE	TRANSMITTAL NO:

SECTION I - REQUEST FOR APPROVAL OF THE FOLLOWING ITEMS (This section will be initiated by the Contractor)

TO:	FROM:	CONTRACT NO:	CHECK ONE:
			__ THIS IS A NEW TRANSMITTAL THIS IS A RESUBMITTAL OF TRANSMITTAL _____

SPECIFICATION SECTION NO: (Cover only one section with each transmittal) NA	PROJECT TITLE AND LOCATION: New Bedford Harbor Superfund Site OU#1 and OU#2 Remedial Design and Remedial Action

ITEM NO. a.	DESCRIPTION OF ITEM SUBMITTED (Type, size, model number, etc.) b.	MFG. OR CONTR. CAT. CURVE DRAWING OR BROCHURE NO. (See instruction No. 8) c.	NO. OF COPIES d.	CONTRACT REFERENCE DOCUMENT SPEC. PARA. NO. e.	DRAWING SHEET NO. f.	FOR CONTRACTOR USE CODE g.	VARIATION (See instruction No. 6) h.	FOR CE USE CODE i.

REMARKS	I certify that the above submitted items have been reviewed in detail and correct and in strict conformance with the contract drawings and specifications except as otherwise stated.
	NAME AND SIGNATURE OF CONTRACTOR

SECTION II - APPROVAL ACTION

ENCLOSURES RETURNED (List by Item No.)	NAME, TITLE AND SIGNATURE OF APPROVING AUTHORITY	DATE

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SECTION 01356

STORMWATER POLLUTION PREVENTION MEASURES

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 4439	(1997) Standard Terminology for Geosynthetics
ASTM D 4491	(1996) Water Permeability of Geotextiles by Permittivity
ASTM D 4533	(1991; R 1996) Trapezoid Tearing Strength of Geotextiles
ASTM D 4632	(1991; R 1996)) Grab Breaking Load and Elongation of Geotextiles
ASTM D 4751	(1995) Determining Apparent Opening Size of a Geotextile
ASTM D 4873	(1995) Identification, Storage, and Handling of Geosynthetic Rolls

1.2 GENERAL

The Contractor shall implement the stormwater pollution prevention measures specified in this section in a manner which will meet the requirements of Section 01410 ENVIRONMENT PROTECTION.

1.3 EROSION AND SEDIMENT CONTROLS

The Contractor shall implement an Erosion and Sedimentation Control and Stormwater Management Plan as described in Section 01410 ENVIRONMENT PROTECTION. This plan may include, but not be limited to the use of the controls and measures described below.

1.3.1 Soil Stabilization Practices

The stabilization practices to be implemented shall include temporary seeding, mulching, erosion control mats. Stabilization practices shall be implemented when construction activities temporarily or permanently cease on a portion of the site. Except as provided in paragraphs UNSUITABLE CONDITIONS and NO ACTIVITY FOR LESS THAN 21 DAYS, stabilization practices shall be initiated as soon as practicable, but no more than 14 days, in any portion of the site where construction activities have temporarily or permanently ceased.

1.3.1.1 Unsuitable Conditions

Where the initiation of stabilization measures by the fourteenth day after construction activity temporarily or permanently ceases is precluded by unsuitable conditions caused by the weather, stabilization practices shall be initiated as soon as practicable after conditions become suitable.

1.3.1.2 No Activity for Less Than 21 Days

Where construction activity will resume on a portion of the site within 21 days from when activities ceased (e.g., the total time period that construction activity is temporarily ceased is less than 21 days), then stabilization practices do not have to be initiated on that portion of the site by the fourteenth day after construction activity temporarily ceased.

1.3.2 Structural Practices

Structural practices shall be implemented to divert flows from exposed soils, temporarily store flows, or otherwise limit runoff and the discharge of pollutants from exposed areas of the site. Structural practices shall be implemented in a timely manner during the construction process to minimize erosion and sediment runoff. Location and installation shall be in accordance with the project Construction Stormwater Pollution Prevention Plan, as indicated in the contract documents, or as determined necessary by the Contracting Officer. Structural practices shall include the following devices.

1.3.2.1 Silt Fence

The Contractor shall provide silt fence as a temporary structural practice to minimize erosion and sediment runoff. Silt fence shall be properly installed in accordance with paragraph INSTALLATION OF SILT FENCE to effectively retain sediment immediately after completing each phase of work where erosion would occur in the form of sheet and rill erosion (e.g. clearing and grubbing, excavation, embankment, and grading). Final removal of silt fence barriers shall be upon approval by the Contracting Officer.

1.3.2.2 Straw Bales

The Contractor shall provide bales of straw as a temporary structural practice to minimize erosion and sediment runoff. Bales shall be properly placed in accordance with paragraph INSTALLATION OF STRAW BALES to effectively retain sediment immediately after completing each phase of work (e.g., clearing and grubbing, excavation, embankment, and grading) in each independent runoff area (e.g., after clearing and grubbing in an area between a ridge and drain, bales shall be placed as work progresses, bales shall be removed/replaced/relocated as needed for work to progress in the drainage area). Final removal of straw bale barriers shall be upon approval by the Contracting Officer. Rows of bales of straw at a minimum shall be provided as follows:

a. Along the downhill perimeter edge of all areas disturbed.

b. Along the top of the slope or top bank of drainage ditches, channels and swales that traverse disturbed areas.

c. Along the toe of all cut slopes and fill slopes of the construction areas.

d. Perpendicular to the flow in the bottom of existing drainage ditches,

channels and swales that traverse disturbed areas or carry runoff from disturbed areas.

e. Perpendicular to the flow in the bottom of new drainage ditches, channels, and swales.

f. At the entrance to culverts that receive runoff from disturbed areas.

1.3.2.3 Turbidity Curtain

The Contractor shall provide turbidity curtains along the shoreline of the Acushnet River as a temporary structural practice to minimize migration of sediment and debris to the river. Turbidity curtain shall be of sufficient height and properly installed to effectively retain sediment before beginning any phase of work where erosion could occur (e.g. clearing and grubbing, excavation, embankment, and grading) adjacent to the Acushnet River. Monitoring of turbidity of the Acushnet River shall be the responsibility of the Contractor. Final removal of turbidity curtain barriers shall be upon approval by the Contracting Officer.

1.4 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Turbidity Curtain; GA

Detail Drawings shall be submitted for approval for turbidity curtain components.

SD-13 Certificates

Filter Fabric Mill Certificates; FIO

The Contractor shall submit a mill certificate or affidavit signed by a legally authorized official from the company manufacturing the filter fabric in accordance with paragraph MILL CERTIFICATE OR AFFIDAVIT.

PART 2 PRODUCTS

2.1 COMPONENTS FOR SILT FENCES

2.1.1 Filter Fabric

The geotextile shall comply with the requirements of ASTM D 4439, and shall consist of polymeric filaments which are formed into a stable network such that filaments retain their relative positions. The filament shall consist of a long-chain synthetic polymer composed of at least 85 percent by weight of ester, propylene, or amide, and shall contain stabilizers and/or inhibitors added to the base plastic to make the filaments resistant to deterioration due to ultraviolet and heat exposure. Synthetic filter fabric shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of 0 to 120 degrees F. The filter fabric shall meet the

following requirements:

FILTER FABRIC FOR SILT SCREEN FENCE

PHYSICAL PROPERTY	TEST PROCEDURE	STRENGTH REQUIREMENT
Grab Tensile	ASTM D 4632	100 lbs. min.
Elongation (%)		30 % max.
Trapezoid Tear	ASTM D 4533	55 lbs. min.
Permittivity	ASTM D 4491	0.2 sec-1
AOS (U.S. Std Sieve)	ASTM D 4751	20-100

2.1.2 Silt Fence Stakes and Posts

The Contractor may use either wooden stakes or steel posts for fence construction. Wooden stakes utilized for silt fence construction, shall have a minimum cross section of 1 inch by 1 inch when oak is used and 2 inches by 2 inches when pine is used, and shall have a minimum length of 5 feet. Steel posts (standard "U" or "T" section) utilized for silt fence construction, shall have a minimum weight of 1.33 pounds per linear foot and a minimum length of 5 feet.

2.1.3 Mill Certificate or Affidavit

A mill certificate or affidavit shall be provided attesting that the fabric and factory seams meet chemical, physical, and manufacturing requirements specified above. The mill certificate or affidavit shall specify the actual Minimum Average Roll Values and shall identify the fabric supplied by roll identification numbers.

2.1.4 Identification Storage and Handling

Filter fabric shall be identified, stored and handled in accordance with ASTM D 4873.

2.2 *COMPONENTS FOR STRAW BALES*

The straw in the bales shall be stalks from oats, wheat, rye, barley, rice, or from grasses such as byhalia, bermuda, etc., furnished in air dry condition. The bales shall have a standard cross section of 14 inches by 18 inches. All bales shall be either wire-bound or string-tied. The Contractor may use either wooden stakes or steel posts to secure the straw bales to the ground. Wooden stakes utilized for this purpose, shall have a minimum dimensions of 2 inches x 2 inches in cross section and shall have a minimum length of 3 feet. Steel posts (standard "U" or "T" section) utilized for securing straw bales, shall have a minimum weight of 1.33 pounds per linear foot and a minimum length of 3 feet.

2.3 COMPONENTS FOR TURBIDITY CURTAIN

2.3.1 Filter Fabric

The base material shall be fabricated with upper and lower pockets to ballast and flotation billets. Ends shall be doubled over for reinforcement with the addition of grommets for connecting additional sections of turbidity curtain. The geotextile shall comply with the

requirements of ASTM D 4439, and shall consist of polymeric filaments which are formed into a stable network such that filaments retain their relative positions. The filament shall consist of a long-chain synthetic polymer composed of at least 85 percent by weight of ester, propylene, or amide, and shall contain stabilizers and/or inhibitors added to the base plastic to make the filaments resistance to deterioration due to ultraviolet and heat exposure. Synthetic filter fabric shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of 0 to 120 degrees F. The filter fabric shall meet the following requirements:

FILTER FABRIC FOR TURBIDITY CURTAIN

PHYSICAL PROPERTY	TEST PROCEDURE	STRENGTH REQUIREMENT
Grab Tensile	ASTM D 4632	250 lbs./inch min.
Elongation (%)		34 % max.
Trapezoid Tear	ASTM D 4533	65 lbs/inch. min.
Permittivity	ASTM D 4491	0.04 sec-1
AOS (U.S. Std Sieve)	ASTM D 4751	70-100

2.3.2 Mill Certificate or Affidavit

A mill certificate or affidavit shall be provided attesting that the fabric and factory seams meet chemical, physical, and manufacturing requirements specified above. The mill certificate or affidavit shall specify the actual Minimum Average Roll Values and shall identify the fabric supplied by roll identification numbers.

2.3.3 Floatation

Floatation shall consist of segmented closed cell polyethylene foam tubing enclosed in the upper pocket and machine enclosed. No polystyrene foam products shall be used for floatation. A grommet shall be installed between each billet pocket to allow the attachment of external floatation stabilizers. The tubing shall be a minimum 4 inches in diameter. The turbidity curtain floatation shall have a floatation ratio of not less than 5:1.

2.3.4 Ballast

Ballast shall consist of either galvanized or bright steel chain of 5/16 inch diameter installed at the factory or on-site. The manufacturer shall provide a draw cord in all units with chain not installed at the factory.

2.3.5 Connections

Adjacent sections of turbidity curtain shall be attached by the use of grommet clips, lacing with rope through the end grommets or as directed by the Contracting Officer. Grommets shall be provided in end sections at a spacing of 12 inches on center vertically at both ends of each unit.

2.3.6 Reinforcement

A reinforcement belt of polyester webbing shall be installed at the top of the curtain to provide additional tensile reinforcement and dimensional

stability.

PART 3 EXECUTION

3.1 INSTALLATION OF SILT FENCES

Silt fences shall extend a minimum of 16 inches above the ground surface and shall not exceed 34 inches above the ground surface. Filter fabric shall be from a continuous roll cut to the length of the barrier to avoid the use of joints. When joints are unavoidable, filter fabric shall be spliced together at a support post, with a minimum 6 inch overlap, and securely sealed. A trench shall be excavated approximately 4 inches wide and 4 inches deep on the side of the location of the silt fence, and the silt fence shall be embedded in this trench to a depth of 4 inches. The 4-inch by 4-inch trench shall be backfilled and the soil compacted over the filter fabric. Silt fences shall be removed upon approval by the Contracting Officer.

3.2 INSTALLATION OF STRAW BALES

Straw bales shall be placed in a single row, lengthwise on the contour, with ends of adjacent bales tightly abutting one another. Straw bales shall be installed so that bindings are oriented around the sides rather than along the tops and bottoms of the bales in order to prevent deterioration of the bindings. The barrier shall be entrenched and backfilled. A trench shall be excavated the width of a bale and the length of the proposed barrier to a minimum depth of 4 inches. After the bales are staked and chinked (gaps filled by wedging with straw), the excavated soil shall be backfilled against the barrier. Backfill soil shall conform to the ground level on the downhill side and shall be built up to 4 inches against the uphill side of the barrier. Loose straw shall be scattered over the area immediately uphill from a straw bale barrier to increase barrier efficiency. Each bale shall be securely anchored by at least two stakes driven through the bale. The first stake or steel post in each bale shall be driven toward the previously laid bale to force the bales together. Stakes or steel pickets shall be driven a minimum 18 inches deep into the ground to securely anchor the bales.

3.3 INSTALLATION OF TURBIDITY CURTAIN

Turbidity curtain will be installed perpendicular to the flow of the Acushnet River, except when protecting a shoreline area, when it will be installed parallel to the flow of the River. Curtain shall extend to a minimum of 2 feet above mean high water. Each end of the entire turbidity curtain length shall be securely attached. Stakes or steel pickets used to tie off ends shall be driven a minimum 18 inches deep into the ground to securely anchor the curtain. Adjacent sections of turbidity curtain shall be attached by the use of grommet clips, lacing with rope through the end grommets, or as directed by the Contracting Officer. Ballast shall be used to hold bottom edge of curtain to the River Bottom.

3.4 MAINTENANCE

The Contractor shall maintain the temporary and permanent vegetation, erosion and sediment control measures, and other protective measures in good and effective operating condition by performing routine inspections to determine condition and effectiveness, by restoration of destroyed vegetative cover, and by repair of erosion and sediment control measures and other protective measures. The following procedures shall be followed

to maintain the protective measures.

3.4.1 Silt Fence Maintenance

Silt fences shall be inspected in accordance with paragraph INSPECTIONS. Any required repairs shall be made promptly. Close attention shall be paid to the repair of damaged silt fence resulting from end runs and undercutting. Should the fabric on a silt fence decompose or become ineffective, and the barrier is still necessary, the fabric shall be replaced promptly. Sediment deposits shall be removed when deposits reach one-third of the height of the barrier. When a silt fence is no longer required, it shall be removed. The immediate area occupied by the fence and any sediment deposits shall be shaped to an acceptable grade and stabilized.

3.4.2 Straw Bale Maintenance

Straw bale barriers shall be inspected in accordance with paragraph INSPECTIONS. Close attention shall be paid to the repair of damaged bales, end runs and undercutting beneath bales. Necessary repairs to barriers or replacement of bales shall be accomplished promptly. Sediment deposits shall be removed when deposits reach one-half of the height of the barrier. Bale rows used to retain sediment shall be turned uphill at each end of each row. When a straw bale barrier is no longer required, it shall be removed. The immediate area occupied by the bales and any sediment deposits shall be shaped to an acceptable grade and stabilized.

3.4.3 Turbidity Curtain Maintenance

Turbidity curtains shall be inspected in accordance with paragraph INSPECTIONS. Any required repairs shall be made promptly. Should the fabric on a curtain decompose or become ineffective, and the barrier is still necessary, the curtain shall be replaced promptly. When a turbidity curtain is no longer required, it shall be removed.

3.5 INSPECTIONS

3.5.1 General

The Contractor shall inspect disturbed areas of the construction site, areas used for storage of materials that are exposed to precipitation that have not been finally stabilized, stabilization practices, structural practices, other controls, and area where vehicles exit the site at least once every seven (7) calendar days and within 24 hours of the end of any storm that produces 0.5 inches or more rainfall at the site. Where sites have been finally stabilized, such inspection shall be conducted at least once every month.

3.5.2 Inspection Details

Disturbed areas and areas used for material storage that are exposed to precipitation shall be inspected for evidence of, or the potential for, pollutants entering the drainage system. Erosion and sediment control measures identified in the Construction Pollution Prevention Plan shall be observed to ensure that they are operating correctly. Discharge locations or points shall be inspected to ascertain whether erosion control measures are effective in preventing significant impacts to receiving waters. Locations where vehicles exit the site shall be inspected for evidence of offsite sediment tracking.

3.5.3 Inspection Reports

For each inspection conducted, the Contractor shall prepare a report summarizing the scope of the inspection, name(s) and qualifications of personnel making the inspection, the date(s) of the inspection, major observations relating to the implementation of the Construction Pollution Prevention Plan, maintenance performed, and actions taken. The report shall be furnished to the Contracting Officer within 24 hours of the inspection as a part of the Contractor's daily CQC REPORT. A copy of the inspection report shall be maintained on the job site.

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SECTION 01410

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PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

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SECTION 01410

ENVIRONMENT PROTECTION

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

FOSTER WHEELER ENVIRONMENTAL CORPORATION (Foster Wheeler)

SSHP	(2001) Foster Wheeler Site-Specific Safety and Health Plan

NOBIS ENGINEERING, INC. (NOBIS)

CSPPP	(2000) Construction Stormwater Pollution Prevention Plan

1.2 GENERAL REQUIREMENTS

The Contractor shall perform the work minimizing environmental pollution and damage as the result of construction operations. Environmental pollution and damage is the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to humankind; or degrade the utility of the environment for aesthetic, cultural and/or historical purposes. The control of environmental pollution and damage requires consideration of land, water, and air, and includes management of visual aesthetics, noise, solid waste, as well as other pollutants. The environmental resources within the project boundaries and those affected outside the limits of permanent work shall be protected during the entire duration of this contract.

1.2.1 Subcontractors

The Contractor shall ensure compliance with this section by his/her subcontractors.

1.2.2 Environmental Protection Plan

The Contractor shall submit an environmental protection plan within 10 days after receipt of the notice to proceed. Approval of the Contractor's plan will not relieve the Contractor of responsibility for adequate and continuing control of pollutants and other environmental protection measures. The environmental protection plan shall include, but shall not be limited to, the following:

a. Procedures to be implemented to provide the required environmental protection, to comply with the applicable laws and regulations, and to correct pollution due to accident, natural causes, or failure to follow the procedures of the environmental protection

plan.

b. Drawings showing locations of any proposed temporary excavations or embankments for haul roads, stream crossings, material (including fuel and chemical) storage areas, structures, sanitary facilities, and stockpiles of excess or spoil materials.

c. Traffic control plan including measures to reduce erosion of temporary roadbeds by construction traffic, especially during wet weather, and the amount of mud transported onto paved public roads by vehicles or runoff.

d. Methods of protecting surface and ground water during construction activities.

e. Plan showing the proposed activity in each portion of the work area and identifying the areas of limited use or nonuse. Plan should include measures for marking the limits of use areas.

f. A recycling and waste prevention plan with a list of measures to reduce consumption of energy and natural resources; for example: the possibility to shred fallen trees and use them as mulch shall be considered as an alternative to burning or burial.

g. Pollution Prevention Training for Contractor's personnel during the construction period.

1.2.3 Construction Stormwater Pollution Prevention Plan

The Contractor shall be responsible for implementing the project Construction Stormwater Pollution Prevention Plan (CSPPP).

1.2.4 Permits

The Contractor will not be required to obtain any site specific permits or licenses unless specifically called for in the contract documents.

1.2.5 Preconstruction Survey

Prior to starting any construction activities, the Contractor and Contracting Officer shall make a joint survey of the condition of trees, shrubs and grassed areas immediately adjacent to work sites and adjacent to the assigned storage area and access routes as applicable. During this survey, the Contracting Officer will identify any trees or other vegetation that is to be saved. The Contractor shall then prepare a brief report, indicating on a layout plan the condition of the vegetation surveyed and identifying which vegetation is to be saved. This report will be signed by both the Contracting Officer and the Contractor upon mutual agreement as to its accuracy and completeness.

1.2.6 Meetings

The Contractor shall meet with the Contracting Officer's representatives to alter the environmental protection plan as needed for compliance with the environmental pollution control program.

1.2.7 Notification

The Contracting Officer will notify the Contractor in writing of any

observed noncompliance with the previously mentioned Federal, State or local laws or regulations, permits, and other elements of the Contractor's environmental protection plan. The Contractor shall, after receipt of such notice, inform the Contracting Officer of proposed corrective action and take such action when approved. If the Contractor fails to comply promptly, the Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No time extensions shall be granted or costs or damages allowed to the Contractor for any such suspensions.

1.2.8 Litigation

If work is suspended, delayed, or interrupted due to a court order of competent jurisdiction, the Contracting officer will determine whether the order is due in any part to the acts or omissions of the Contractor, or subcontractors at any tier, not required by the terms of the contract. If it is determined that the order is not due to Contractor's failing, such suspension, delay, or interruption shall be considered as ordered by the Contracting Officer in the administration of the contract under the contract clause SUSPENSION OF WORK.

1.2.9 Previously Used Equipment

The Contractor shall thoroughly clean all construction equipment previously used at other sites before it is brought into the work areas, ensuring that soil residuals and any other foreign materials are removed.

1.2.10 Payment

No separate payment will be made for work covered under this section; all costs associated with this section shall be included in the contract unit and/or lump sum prices in the Bidding Schedule.

1.3 LAND RESOURCES

The Contractor shall confine all activities to areas defined by contract drawings and specifications. Prior to the beginning of any construction, the Contractor shall identify the land resources to be preserved within the work area. Except in areas indicated on the drawings or specified to be cleared, the Contractor shall not remove, cut, deface, injure, or destroy land resources including trees, shrubs, vines, grasses, topsoil, and land forms without permission. No ropes, cables, or guys shall be fastened to or attached to any trees for anchorage unless specifically authorized. Where such emergency use is permitted, the Contractor shall provide effective protection for land and vegetation resources at all times as defined in the following subparagraphs. Stone, earth or other material displaced into uncleared areas shall be removed.

1.3.1 Work Area Limits

Prior to any construction, the Contractor shall mark the areas that need not be disturbed under this contract. Isolated areas within the general work area which are to be saved and protected shall also be marked or fenced. Monuments and markers shall be protected before construction operations commence. Where construction operations are to be conducted during darkness, the markers shall be visible. The Contractor's personnel shall be knowledgeable of the purpose for marking and/or protecting particular objects.

1.3.2 Landscape

Trees, shrubs, vines, grasses, land forms and other landscape features indicated and defined on the drawings to be preserved shall be clearly identified by marking, fencing, or wrapping with boards, or any other approved techniques.

1.3.3 Unprotected Erodible Soils

Earthwork brought to final grade shall be finished as indicated. Side slopes and back slopes shall be protected as soon as practicable upon completion of rough grading. All earthwork shall be planned and conducted to minimize the duration of exposure of unprotected soils. Except in cases where the constructed feature obscures borrow areas, quarries, and waste material areas, these areas shall not initially be totally cleared. Clearing of such areas shall progress in reasonably sized increments as needed to use the developed areas as approved by the Contracting Officer.

1.3.4 Disturbed Areas

The Contractor shall effectively prevent erosion and control sedimentation through approved methods including, but not limited to, the following:

a. Retardation and control of runoff. Runoff from the construction site or from storms shall be controlled, retarded, and diverted to protected drainage courses by means of diversion ditches, benches, berms, and by any measures required by area wide plans under the Clean Water Act.

b. Erosion and sedimentation control devices. The Contractor shall construct or install temporary and permanent erosion and sedimentation control features as indicated in the project Construction Stormwater Pollution Prevention Plan. Berms, drains, grassing, and mulching shall be maintained until permanent drainage and erosion control facilities are completed and operative.

1.3.5 Contractor Facilities and Work Areas

The Contractor's field offices, staging areas, stockpile storage, and temporary buildings shall be placed in areas designated on the drawings or as directed by the Contracting Officer. Temporary movement or relocation of Contractor facilities shall be made only when approved. Borrow areas shall be managed to minimize erosion and to prevent sediment from entering nearby waters. Spoil areas shall be managed and controlled to limit spoil intrusion into areas designated on the drawings and to prevent erosion of soil or sediment from entering nearby waters. Spoil areas shall be developed in accordance with the grading plan indicated on the drawings. Temporary excavation and embankments for plant and/or work areas shall be controlled to protect adjacent areas from despoilment.

1.4 WATER RESOURCES

The Contractor shall keep construction activities under surveillance, management, and control to avoid pollution of surface and ground waters. Toxic or hazardous chemicals shall not be applied to soil or vegetation when such application may cause contamination of the fresh water reserve. Monitoring of water areas affected by construction shall be the Contractor's responsibility. All water areas affected by construction

activities shall be monitored by the Contractor.

1.4.1 Washing and Curing Water

Waste waters directly derived from construction activities shall not be allowed to enter water areas. Waste waters shall be collected and pumped to CDF Cell No. 1 or CDF Cell No. 2 as shown on the contract drawings, or as directed by the Contracting Officer, where suspended material can be settled out or the water evaporates to separate pollutants from the water. Analysis shall be performed and results reviewed and approved before water in retention ponds is discharged.

1.5 AIR RESOURCES

Equipment operation and activities or processes performed by the Contractor in accomplishing the specified construction shall be in accordance with the State's Department of Environmental Protection rules and all Federal emission and performance laws and standards. Ambient Air Quality Standards set by the Environmental Protection Agency shall be maintained. Monitoring of air quality shall be the Contractor's responsibility. All air areas affected by the construction activities shall be monitored by the Contractor. Monitoring results will be periodically reviewed by the Contracting Officer to ensure compliance.

1.5.1 Particulates

Dust particles; aerosols and gaseous by-products from construction activities; and processing and preparation of materials, such as from asphaltic batch plants; shall be controlled at all times, including weekends, holidays and hours when work is not in progress. The Contractor shall maintain excavations, stockpiles, haul roads, permanent and temporary access roads, plant sites, spoil areas, borrow areas, and other work areas within or outside the project boundaries free from particulates which would cause the air pollution standards and Action Levels as specified in the project SSHP to be exceeded or which would cause a hazard or a nuisance. Sprinkling, chemical treatment of an approved type, light bituminous treatment, baghouse, scrubbers, electrostatic precipitators or other methods will be permitted to control particulates in the work area. Sprinkling, to be efficient, must be repeated to keep the disturbed area damp at all times. The Contractor must have sufficient, competent equipment available to accomplish these tasks. Particulate control shall be performed as the work proceeds and whenever a particulate nuisance or hazard occurs.

1.5.2 Hydrocarbons and Carbon Monoxide

Hydrocarbons and carbon monoxide emissions from equipment shall be controlled to the limits prescribed in the project SSHP at all times.

1.5.3 Odors

Odors shall be controlled at all times for all construction activities, processing and preparation of materials.

1.5.4 Sound Intrusions

The Contractor shall keep construction activities under surveillance and control to minimize environmental damage by noise. The noise limits prescribed in the project SSHP shall govern this work.

1.6 WASTE DISPOSAL

1.6.1 Solid Wastes

Solid wastes (excluding clearing debris) shall be placed in containers which are emptied on a regular schedule. Handling and disposal shall be conducted to prevent contamination. Segregation measures shall be employed so that no hazardous or toxic waste will become co-mingled with solid waste. The Contractor shall transport solid waste off the site and dispose of it in compliance with Federal, State, and local requirements for solid waste disposal.

1.6.2 Chemical Wastes

Chemicals shall be dispensed ensuring no spillage to ground or water. Periodic inspections of dispensing areas to identify leakage and initiate corrective action shall be performed and documented. This documentation will be periodically reviewed by the Contracting Officer. Chemical waste shall be collected in corrosion resistant, compatible containers. Collection drums shall be monitored and removed to a staging or storage area when contents are within 6 inches of the top. Wastes shall be stored and disposed of in accordance with Federal, State, and local laws and regulations.

1.6.3 Hazardous Wastes

The Contractor shall take sufficient measures to prevent spillage of hazardous and toxic materials during dispensing and shall collect waste in suitable containers observing compatibility. Spills of hazardous or toxic materials shall be immediately reported to the Contracting Officer. Cleanup and cleanup costs due to spills shall be the Contractor's responsibility.

1.7 POST CONSTRUCTION CLEANUP

The Contractor shall clean up all areas used for construction.

1.8 RESTORATION OF LANDSCAPE DAMAGE

The Contractor shall restore landscape features damaged or destroyed during construction operations outside the limits of the approved work areas.

1.9 MAINTENANCE OF POLLUTION FACILITIES

The Contractor shall maintain permanent and temporary pollution control facilities and devices for the duration of the contract or for that length of time construction activities create the particular pollutant.

1.10 TRAINING OF CONTRACTOR PERSONNEL

The Contractor's personnel shall be trained in all phases of environmental protection. The training shall include methods of detecting and avoiding pollution, familiarization with pollution standards, both statutory and contractual, and installation and care of devices, vegetative covers, and instruments required for monitoring purposes to ensure adequate and continuous environmental pollution control.

1.11 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Environmental Protection Plan; GA

See paragraph ENVIRONMENTAL PROTECTION PLAN for requirements.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

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SECTION 01451

CONTRACTOR QUALITY CONTROL

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 3740	(1996) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM E 329	(1995b) Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction

FEDERAL AQUISITION REGULATION (FAR)

FAR 52.246-12	(1995) INSPECTION OF CONSTRUCTION
FAR 52.212-3	(1995) COMMENCEMENT, PROSECUTION, AND COMPLETION OF WORK.

1.2 PAYMENT

Separate payment will not be made for providing and maintaining an effective Quality Control program, and all costs associated therewith shall be included in the applicable unit prices or lump-sum prices contained in the Bidding Schedule.

1.3 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Contractor Quality Control Plan; GA

See paragraph QUALITY CONTROL PLAN for requirements.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

The Contractor is responsible for quality control and shall establish and maintain an effective quality control system in compliance with the Contract Clause FAR 52.246-12. The quality control system shall consist of plans, procedures, and organization necessary to produce an end product which complies with the contract requirements. The system shall cover all construction operations, both on-site and off-site, and shall be keyed to the proposed construction sequence. The project superintendent will be held responsible for the quality of work on the job and is subject to removal by the Contracting Officer for non-compliance with quality requirements specified in the contract. The project superintendent in this context shall mean the individual with the responsibility for the overall management of the project including quality and production.

3.2 QUALITY CONTROL PLAN

3.2.1 General

The Contractor shall furnish for review by the Contracting Officer, not later than 10 days after receipt of notice to proceed, the Contractor Quality Control (CQC) Plan proposed to implement the requirements of the Contract Clause FAR 52.246-12. The plan shall identify personnel, procedures, control, instructions, testing, records, and forms to be used. Construction will be permitted to begin only after acceptance of the CQC Plan by the Contracting Officer and the Government.

3.2.2 Content of the CQC Plan

The CQC Plan shall include, as a minimum, the following to cover all construction operations, both on-site and offsite, including work by subcontractors, fabricators, suppliers, and purchasing agents:

a. A description of the quality control organization, including a chart showing lines of authority and acknowledgement that the CQC staff shall implement the three phase control system for all aspects of the work specified. The staff shall include a CQC System Manager who shall report to the project superintendent.

b. The name, qualifications (in resume format), duties, responsibilities, and authorities of each person assigned a CQC function.

c. A copy of the letter to the CQC System Manager signed by an authorized official of the firm which describes the responsibilities and delegates sufficient authorities to adequately perform the functions of the CQC System Manager, including authority to stop work which is not in compliance with the contract. The CQC System Manager shall issue letters of direction to all other various quality control representatives outlining duties, authorities, and responsibilities. Copies of these letters will also be furnished to the Government.

d. Procedures for scheduling, reviewing, certifying, and managing submittals, including those of subcontractors, offsite fabricators, suppliers, and purchasing agents. These procedures shall be in accordance with Section 01330 SUBMITTALS PROCEDURES.

e. Control, verification, and acceptance testing procedures for each specific test to include the test name, specification paragraph requiring test, feature of work to be tested, test frequency, and person responsible for each test. (Laboratory facilities will be approved by the Government and the Contracting Officer prior to use).

f. Procedures for tracking preparatory, initial and follow-up control phases, and control, verification and acceptance tests including documentation.

g. Procedures for tracking construction deficiencies from identification through acceptable corrective action. These procedures will establish verification that identified deficiencies have been corrected.

h. Reporting procedures, including proposed reporting formats.

i. A list of the definable features of work. A definable feature of work is a task which is separate and distinct from other tasks and has separate control requirements. It could be identified by different trades or disciplines, or it could be work by the same trade in a different environment. Although each section of the specifications may generally be considered as a definable feature of work, there are frequently more than one definable feature under a particular section. This list will be agreed upon during the coordination meeting, as required by paragraph COORDINATION MEETING.

3.2.3 Acceptance of Plan

Acceptance of the Contractor's plan by both the Contracting Officer and the Government is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during the construction. The Contracting Officer reserves the right to require the Contractor to make changes in the CQC Plan and operations including removal of personnel, as necessary, to obtain the quality specified.

3.2.4 Notification of Changes

After acceptance of the CQC Plan, the Contractor shall notify the Contracting Officer in writing of any proposed change. Proposed changes are subject to acceptance by the CQC System Manager.

3.3 COORDINATION MEETING

After the Preconstruction Conference, before start of construction, and prior to acceptance by the Contracting Officer and the Government of the CQC Plan, the Contractor shall meet with the Contracting Officer and an Authorized Government Representative to discuss the Contractor's quality control system. During the meeting, a mutual understanding of the system details shall be developed, including the forms for recording the CQC operations, control activities, testing, administration of the system for both on-site and offsite work, and the interrelationship of the Contractor's Management and control with the Government's Quality Assurance. Minutes of the meeting shall be prepared by the Contractor and signed by both the Contractor and the Contracting Officer. The minutes shall become a part of the contract file. There may be occasions when subsequent conferences will be called by either party to reconfirm mutual understandings and/or address deficiencies in the CQC system or procedures which may require corrective action by the Contractor.

3.4 QUALITY CONTROL ORGANIZATION

3.4.1 Personnel Requirements

The requirements for the CQC organization are a CQC System Manager and sufficient number of additional qualified personnel to ensure contract compliance. The Contractor shall provide a CQC organization which shall be at the site at all times during progress of the work and with complete authority to take any action necessary to ensure compliance with the contract. All CQC staff members shall be subject to acceptance by the Contracting Officer.

3.4.2 CQC System Manager

The Contractor shall identify as CQC System Manager an individual within his organization at the site of the work who shall be responsible for overall management of CQC and have the authority to act in all CQC matters for the Contractor. This CQC System Manager shall be on the site at all times during construction and will be employed by the Contractor. The CQC System Manager shall be assigned as the CQC Representative but may have other duties as project superintendent in addition to quality control. An alternate for the CQC System Manager will be identified in the plan to serve in the event of the CQC System Manager's absence.

3.4.3 CQC Personnel

A staff shall be maintained under the direction of the CQC System Manager to perform all QC activities. The staff must be of sufficient size to ensure adequate QC coverage of all work phases, work shifts, and work crews involved in the construction. These personnel may perform other duties, but must be fully qualified by experience and technical training to perform their assigned QC responsibilities and must be allowed sufficient time to carry out these responsibilities. The QC plan will clearly state the duties and responsibilities of each staff member.

3.4.4 Organizational Changes

The Contractor shall maintain the CQC staff at full strength at all times. When it is necessary to make changes to the CQC staff the Contractor shall revise the CQC Plan to reflect the changes and submit the changes to the Contracting Officer for acceptance.

3.5 SUBMITTALS

Submittals shall be made as specified in Section 01330 SUBMITTAL PROCEDURES. The CQC organization shall be responsible for certifying that all submittals are in compliance with the contract requirements.

3.6 CONTROL

Contractor Quality Control is the means by which the Contractor ensures that the construction, to include that of subcontractors and suppliers, complies with the requirements of the contract. At least three phases of control shall be conducted by the CQC System Manager for each definable feature of work as follows:

3.6.1 Preparatory Phase

This phase shall be performed prior to beginning work on each definable

feature of work, after all required plans/documents/materials are approved/accepted, and after copies are at the work site. This phase shall include:

a. A review of each paragraph of applicable specifications.

b. A review of the contract drawings.

c. A check to assure that all materials and/or equipment have been tested, submitted, and approved.

d. Review of provisions that have been made to provide required control inspection and testing.

e. Examination of the work area to assure that all required preliminary work has been completed and is in compliance with the contract.

f. A physical examination of required materials, equipment, and sample work to assure that they are on hand, conform to approved shop drawings or submitted data, and are properly stored.

g. A review of the appropriate activity hazard analysis to assure safety requirements are met.

h. Discussion of procedures for controlling quality of the work including repetitive deficiencies. Document construction tolerances and workmanship standards for that feature of work.

i. A check to ensure that the portion of the plan for the work to be performed has been accepted by the Contracting Officer.

j. Discussion of the initial control phase.

k. The Contracting Officer shall be notified at least 24 hours in advance of beginning the preparatory control phase. This phase shall include a meeting conducted by the CQC System Manager and attended by the superintendent, and other CQC personnel (as applicable), the Contracting Officer and Government Representatives. The results of the preparatory phase actions shall be documented by separate minutes prepared by the CQC System Manager and attached to the daily CQC report. The Contractor shall instruct applicable workers as to the acceptable level of workmanship required in order to meet contract specifications.

3.6.2 Initial Phase

This phase shall be accomplished at the beginning of a definable feature of work. The following shall be accomplished:

a. A check of work to ensure that it is in full compliance with contract requirements. Review minutes of the preparatory meeting.

b. Verify adequacy of controls to ensure full contract compliance. Verify required control inspection and testing.

c. Establish level of workmanship and verify that it meets minimum acceptable workmanship standards.

d. Resolve all differences.

e. Check safety to include compliance with and upgrading of the safety plan and activity hazard analysis. Review the activity analysis with each worker.

f. The Contracting Officer shall be notified at least 24 hours in advance of beginning the initial phase. Separate minutes of this phase shall be prepared by the CQC System Manger and attached to the daily CQC report. Exact location of initial phase shall be indicated for future reference and comparison with follow-up phases.

g. The initial phase should be repeated for each new crew to work on-site, or any time acceptable specified quality standards are not being met.

3.6.3 Follow-up Phase

Daily checks shall be performed to assure control activities, including control testing, are providing continued compliance with contract requirements, until completion of the particular feature of work. The checks shall be made a matter of record in the CQC documentation. Final follow-up checks shall be conducted and all deficiencies corrected prior to the start of additional features of work which may be affected by the deficient work. The Contractor shall not build upon or conceal non-conforming work.

3.6.4 Additional Preparatory and Initial Phases

Additional preparatory and initial phases shall be conducted on the same definable features of work if the quality of on-going work is unacceptable, if there are changes in the applicable CQC staff, on-site production supervision or work crew, if work on a definable feature is resumed after a substantial period of inactivity, or if other problems develop.

3.7 TESTS

3.7.1 Testing Procedure

The Contractor shall perform specified or required tests to verify that control measures are adequate to provide a product which conforms to contract requirements. Upon request, the Contractor shall furnish to the Contracting Officer duplicate samples of test specimens for possible testing by the Contracting Officer. Testing includes operation and/or acceptance tests when specified. The Contractor shall procure the services of a Government approved testing laboratory. The Contractor shall perform the following activities and record and provide the following data:

a. Verify that testing procedures comply with contract requirements.

b. Verify that facilities and testing equipment are available and comply with testing standards.

c. Check test instrument calibration data against certified standards.

d. Verify that recording forms and test identification control number system, including all of the test documentation requirements, have

been prepared.

e. Results of all tests taken, both passing and failing tests, shall be recorded on the daily CQC report for the date taken. Specification paragraph reference, location where tests were taken, and the sequential control number identifying the test shall be given. If approved by the Contracting Officer, actual test reports shall be submitted with a reference to the test number and date taken. An information copy of tests performed by an offsite or commercial test facility shall be provided directly to the Contracting Officer. Failure to submit timely test reports as stated may result in nonpayment for related work performed and disapproval of the test facility for this contract.

3.7.2 Testing Laboratories

3.7.2.1 Capability Check

The Contracting Officer reserves the right to check laboratory equipment in the proposed laboratory for compliance with the standards set forth in the contract specifications and to check the laboratory technician's testing procedures and techniques. Laboratories utilized for testing soils, concrete, asphalt, and steel shall meet criteria detailed in ASTM D 3740 and ASTM E 329.

3.7.2.2 Capability Recheck

If the selected laboratory fails the capability check, the Contractor will be assessed a charge of $1,200.00 to reimburse the Contracting Officer for each succeeding recheck of the laboratory or the checking of a subsequently selected laboratory. Such costs will be deducted from the contract amount due the Contractor.

3.7.3 Furnishing or Transportation of Samples for Testing

Costs incidental to the transportation of samples or materials shall be borne by the Contractor.

3.8 COMPLETION INSPECTION

3.8.1 Punch-Out Inspection

Near the completion of all work or any increment thereof established by a completion time stated in the Special Clause FAR 52.212-3, or stated elsewhere in the specifications, the CQC System Manager shall conduct an inspection of the work and develop a "punch list" of items which do not conform to the approved drawings and specifications. Such a list of deficiencies shall be included in the CQC documentation, as required by paragraph DOCUMENTATION below, and shall include the estimated date by which the deficiencies will be corrected. The CQC System Manager or staff shall make a second inspection to ascertain that all deficiencies have been corrected. Once this is accomplished, the Contractor shall notify the Contracting Officer that the facility is ready for a Pre-Final inspection.

3.8.2 Pre-Final Inspection

The Contracting Officer will perform this inspection to verify that the facility is complete and ready to be occupied. A "Pre-Final Punch List" may be developed as a result of this inspection. The CQC System Manager

shall ensure that all items on this list have been corrected and so notify the Contracting Officer so that a "Final" inspection with the Government can be scheduled. Any items noted on the "Pre-Final" inspection shall be corrected in a timely manner. These inspections and any deficiency corrections required by this paragraph shall be accomplished within the time slated for completion of the entire work or any particular increment thereof if the project is divided into increments by separate completion dates.

3.8.3 Final Acceptance Inspection

The Contractor's Quality Control Inspection personnel, his superintendent or other primary management person, and the Contracting Officer's Representative will be in attendance at this inspection. The final acceptance inspection will be formally scheduled by the Contracting Officer based upon results of the Pre-Final inspection. Notice will be given to the CQC System Manager at least 14 days prior to the final acceptance inspection and must include the Contractor's assurance that all specific items identified to the Contractor as being unacceptable, along with all remaining work performed under the contract, will be complete and acceptable by the date scheduled for the final acceptance inspection. Failure of the Contractor to have all contract work acceptably complete for this inspection will be cause for the Contracting Officer to bill the Contractor for the Contracting Officer's additional inspection costs in accordance with the contract clause FAR 52.246-12.

3.9 DOCUMENTATION

The Contractor shall maintain current records providing factual evidence that required quality control activities and/or tests have been performed. These records shall include the work of subcontractors and suppliers and shall be on an acceptable form that includes, as a minimum, the following information:

a. Contractor/subcontractor and their area of responsibility.

b. Operating plant/equipment with hours worked, idle, or down for repair.

c. Work performed each day, giving location, description, and by whom. When Network Analysis (NAS) is used, identify each phase of work performed each day by NAS activity number.

d. Test and/or control activities performed with results and references to specifications/drawings requirements. The control phase shall be identified (Preparatory, Initial, Follow-up). List of deficiencies noted, along with corrective action.

e. Quantity of materials received at the site with statement as to acceptability, storage, and reference to specifications/drawings requirements.

f. Submittals reviewed, with contract reference, by whom, and action taken.

g. Offsite surveillance activities, including actions taken.

h. Job safety evaluations stating what was checked, results, and instructions or corrective actions.

i. Instructions given/received and conflicts in plans and/or specifications.

j. Contractor's verification statement.

These records shall indicate a description of trades working on the project; the number of personnel working; weather conditions encountered; and any delays encountered. These records shall cover both conforming and deficient features and shall include a statement that equipment and materials incorporated in the work and workmanship comply with the contract. The original and one copy of these records in report form shall be furnished to the Contracting Officer daily within 24 hours after the date covered by the report, except that reports need not be submitted for days on which no work is performed. As a minimum, one report shall be prepared and submitted for every seven days of no work and on the last day of a no work period. All calendar days shall be accounted for throughout the life of the contract. The first report following a day of no work shall be for that day only. Reports shall be signed and dated by the CQC System Manager. The report from the CQC System Manager shall include copies of test reports and copies of reports prepared by all subordinate quality control personnel.

3.10 SAMPLE FORMS

Sample forms are enclosed at the end of this section.

3.11 NOTIFICATION OF NONCOMPLIANCE

The Contracting Officer will notify the Contractor of any detected noncompliance with the foregoing requirements. The Contractor shall take immediate corrective action after receipt of such notice. Such notice, when delivered to the Contractor at the work site, shall be deemed sufficient for the purpose of notification. If the Contractor fails or refuses to comply promptly, the Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to such stop orders shall be made the subject of claim for extension of time or for excess costs or damages by the Contractor.

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SECTION 01500

CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

CORPS OF ENGINEERS (CE)

CE EM 385-1-1	(1996) Safety and Health Requirements Manual

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2002) National Electrical Code

1.2 AVAILABILITY AND USE OF ELECTRIC SERVICE

1.2.1 Field Office

The Contracting Officer will make available to the Contractor without charge, from the point of existing outlets and supplies, all reasonably required amounts of electricity at the field office located at 103 Sawyer Street. The Contractor shall carefully conserve utilities furnished without charge.

1.2.2 Temporary Connections

The Contractor, at his own expense and in a workmanlike manner satisfactory to the Contracting Officer, shall install and maintain all necessary temporary connections and distribution lines and, if necessary to determine charges, all meters required to measure the amount of each utility used; and he shall remove them prior to final acceptance of the construction.

1.2.3 Temporary Equipment and Lines

All required temporary electrical equipment and lines shall be furnished, installed, connected, and maintained by the Contractor according to the CE EM 385-1-1, Section 11.D and shall be removed prior to final acceptance of the work. Temporary wiring shall conform to Article 305 of NFPA 70. Materials and equipment need not be new, but must be in good repair and serviceable condition. Prior to being energized, the systems and devices will be checked and approved for polarity, continuity of ground, and resistance to ground. Periodic inspections of systems and devices will be made by the Contractor at intervals not to exceed one (1) week.

1.3 TELEPHONE SERVICE

1.3.1 Field Office

One phone line will be provided at the Contractor's field office located at

103 Sawyer Street. The Contractor shall be responsible for long distance charges.

1.3.2 Site Communication

The Contractor shall provide and maintain portable radios or equal means of communication which will be in an easily accessible location at each of the large construction areas on the project. Such means of communication shall be accessible during all work hours.

1.4 WATER

A potable water source for dust, decontamination, and for other Contractor uses will be provided at 103 Sawyer Street without charge to the Contractor. The Contracting Officer will not guarantee pressure and/or volume. The Contractor shall provide piping, booster pumps and storage tanks as required.

1.5 SANITATION

Adequate sanitary conveniences of a type approved for the use of persons employed on the work shall be provided by the Contractor, properly secluded from public observation, and maintained by the Contractor in such a manner as required or approved by the Contracting Officer. These conveniences shall be maintained at all times without nuisance. Upon completion of the work, the conveniences shall be removed by the Contractor from the premises, leaving the premises clean and free from nuisance. Toilet facilities, located within the support zone at 103 Sawyer Street, will be available to the Contractor.

1.6 EMPLOYEE PARKING

Contractor employees shall park privately owned vehicles in an area designated by the Contracting Officer. This area will be within reasonable walking distance of the construction site. Contractor employee parking shall not interfere with existing and established parking requirements of the site.

PART 2 PRODUCTS

2.1 FIELD OFFICE

Field office shall be a trailer provided to the Contractor within the support zone located at 103 Sawyer Street. The trailer will include, as a minimum, two moveable office desks, chairs for all desks, an enclosed toilet and one telephone. Office will provide approximately 132 square feet of space for the Contractor. Office shall be equipped with a door with a cylinder lock, adequate heating, lighting, and ventilation facilities.

PART 3 EXECUTION

3.1 CLEANING DURING CONSTRUCTION

3.1.1 Daily Cleaning

Execute daily cleaning to keep the work, the site, and adjacent properties free from accumulation of waste materials, rubbish, and windblown debris, resulting from construction operations.

3.1.2 On-Site Container

Provide on-site containers for the collection of waste materials, debris, and rubbish.

3.1.3 Removal of Waste

Remove waste materials, debris, and rubbish from the site periodically and dispose of off site in accordance with applicable laws and regulations.

3.1.4 Burning

No burning of brush or debris will be permitted at the site.

3.2 SECURITY AT THE SITE

The Contractor shall be responsible for site security during the course of the work. Security within the support zone located at 103 Sawyer Street will be provided by the Contracting Officer.

3.3 TRAFFIC REGULATION AND CONTROL

3.3.1 Vehicular Flow

The Contractor shall be responsible for maintaining vehicular traffic flow on all roads at and adjacent to the entrance to the site during the progress of the work. The Contractor shall erect caution signs along the roads adjacent to the site entrance warning of slow-moving construction traffic entering and exiting the site. The signs shall be constructed and located as prescribed by the Massachusetts Highway Department and maintained throughout the progress of the work.

3.3.2 Site Entrance

During operations involving access road construction at the site entrance, the Contractor shall provide signs, equipment, and personnel to protect and regulate traffic on the adjacent highway in accordance with Massachusetts Highway Department regulations.

3.4 REMOVAL OF TEMPORARY MATERIALS AND EQUIPMENT

Remove temporary materials, equipment, services, and construction prior to completion of work. Clean and repair damage caused by installation or use of temporary facilities. Return site to pre-construction condition.

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PART 3 EXECUTION (Not Applicable)

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SECTION 01720

FIELD ENGINEERING

PART 1 GENERAL

1.1 SUMMARY

1.1.1 Engineering Services

The Contractor shall provide and pay for field engineering services required for the project, including the following:

a. Survey work required in execution of the project and for determining quantities of work performed for submission of progress payment requisitions.

b. Civil, structural or other professional engineering services specified, or required to execute Contractor's construction methods.

1.1.2 Existing Control Points

The Contracting Officer's Representative will identify existing control points and property line corner stakes indicated on the drawings, as required.

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES.

SD-07 Certificates

Surveyor and Professional Engineer Qualifications; FIO

Name and address of the Surveyor and Professional Engineer and proof of registration. Resumes showing experience in similar projects shall also be included.

1.3 QUALIFICATIONS

1.3.1 Registered Land Surveyor

Registered land surveyor, licensed in Massachusetts, and approved by the Contracting Officer.

1.3.2 Registered Professional Engineer

Registered professional engineer of the discipline required for the specific service on the project, licensed in Massachusetts.

1.4 LAYOUT OF WORK

a. The Contracting Officer has established bench marks and horizontal

control points at the site of the work. These are described and indicated on contract drawings, or can be obtained from the Engineer.

b. From these control points the Contractor shall lay out the work by establishing all lines and grades at the site necessary to control the work and shall be responsible for all measurements that may be required for the execution of the work to the location and limit marks prescribed in the specifications or on the contract drawings. The Contractor shall establish and maintain at the site of the work such stakes and markers as are necessary for control and guidance of his construction operations. All survey data shall be recorded in accordance with standard and approved methods. All field notes, sketches, recordings and computations made by the Contractor in establishing above horizontal and vertical control points shall be available at all times during the progress of the work for ready examination by the Contracting Officer or his duly authorized representative.

c. The Contractor shall furnish, at his own expense, all such stakes, spikes, steel pins, templates, platforms, equipment, tools and material and all labor as may be required in laying out any part of the work from the control points established by the Contracting Officer. It shall be the responsibility of the Contractor to maintain and preserve all stakes and other markers established by him until authorized to remove them. If any of the control points established at the site by the Contracting Officer are destroyed by or through the negligence of the Contractor prior to their authorized removal, they may be replaced by the Contracting Officer, and the expense of replacement will be deducted from any amount due or which may become due the Contractor. The Contracting Officer may require that work be suspended at any time when horizontal and vertical control are not reasonably adequate to permit checking the work. Such suspension will be withdrawn upon proper replacement of the control points.

d. During the layout of the work, the Contractor shall notify the Contracting Officer of any inconsistencies or conflicts which arise due to the supplied control points or features of the project.

PART 2 PRODUCTS (Not Applicable)

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SECTION 01780

CLOSEOUT SUBMITTALS

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES.

SD-11 Closeout Submittals

Record Drawings; GA.

Drawings showing final record conditions of the project. The manually prepared drawings shall consist of 1 set of completed final record original transparency drawings, 2 sets of blue-line prints of the transparencies, and the approved marked working record prints.

Record of Equipment and Materials; GA.

Two copies of the record listing the materials and equipment actually incorporated into the construction of the project.

Warranty Management Plan; GA.

Two sets of the warranty management plan containing information relevant to the warranty of materials and equipment incorporated into the construction project including the date of the start of warranty of construction. The Contractor shall furnish with each warranty the name, address, and telephone number of each of the guarantor's representatives nearest to the project location. The plan shall also include information relevant to the Contractor's own warranty on work performed.

Pre-Final Inspection Punch-List; FIO.

Two copies of the listing of completed punch-list items.

1.2 PROJECT RECORD DOCUMENTS

1.2.1 Record Drawings

This paragraph covers record drawings completed as a requirement of the contract. The terms "drawings," "contract drawings," "drawing files," "working record drawings" and "final record drawings" refer to contract drawings which are to be used for final record drawings.

1.2.1.1 Contracting Officer Furnished Materials

One set of mylar drawings revised to reflect all bid amendments will be provided by the Contracting Officer at the preconstruction conference for projects requiring manually prepared record drawings.

1.2.1.2 Working Record Drawings and Final Record Drawings

The Contractor shall revise 2 sets of paper drawings by red-line process to show the as-built conditions during the prosecution of the project. These working record drawings shall be kept current on a weekly basis and available on the jobsite at all times. Changes from the contract plans which are made in the work or additional information which might be uncovered in the course of construction shall be accurately and neatly recorded as they occur by means of details and notes. Final record drawings shall be prepared after the completion of specific phases of work (Foundations, Utilities, Structural Steel, etc., as appropriate for the project). The working drawings and final record drawings will be jointly reviewed for accuracy and completeness by the Contracting Officer and the Contractor prior to incremental submission of each monthly pay estimate. If the Contractor fails to maintain the working and final record drawings as specified herein, the Contracting Officer will deduct from the monthly progress payment an amount representing the estimated cost of maintaining the record drawings. This monthly deduction will continue until an agreement can be reached between the Contracting Officer and the Contractor regarding the accuracy and completeness of updated drawings. The working and final record drawings shall show the following information, but not be limited thereto:

a. The actual location, kinds and sizes of all sub-surface utility lines. In order that the location of these lines and appurtenances may be determined in the event the surface openings or indicators become covered over or obscured, the record drawings shall show, by offset dimensions to two permanently fixed surface features, the end of each run including each change in direction. Valves, splice boxes and similar appurtenances shall be located by dimensioning along the utility run from a reference point. The average depth below the surface of each run shall also be recorded.

b. The location and dimensions of any changes within the building structure.

c. Correct grade, elevations, cross section, or alignment of roads, earthwork, structures or utilities if any changes were made from contract plans.

d. Changes in details of design or additional information obtained from working drawings specified to be prepared and/or furnished by the Contractor; including but not limited to fabrication, erection, installation plans and placing details, pipe sizes, insulation material,dimensions of equipment foundations, etc.

e. The topography, invert elevations and grades of drainage installed or affected as part of the project construction.

f. Changes or modifications which result from the final inspection.

g. Where contract drawings or specifications present options, only the option selected for construction shall be shown on the final record

prints.

h. If borrow material for this project is from sources on Government property, or if Government property is used as a spoil area, the Contractor shall furnish a contour map of the final borrow pit/spoil area elevations.

i. Systems designed or enhanced by the Contractor, such as, HVAC controls, fire alarm, fire sprinkler, irrigation systems, sheeting and shoring, and dewatering systems.

j. Modifications (change order price shall include the Contractor's cost to change working and final record drawings to reflect modifications) and comply with the following procedures.

(1) Directions in the modification for posting descriptive changes shall be followed.

(2) A Modification Circle shall be placed at the location of each deletion.

(3) For new details or sections which are added to a drawing, a Modification Circle shall be placed by the detail or section title.

(4) For minor changes, a Modification Circle shall be placed by the area changed on the drawing, (each location).

(5) For major changes to a drawing, a Modification Circle shall be placed by the title of the affected plan, section, or detail at each location.

(6) For changes to schedules or drawings, a Modification Circle shall be placed either by the schedule heading or by the change in the schedule.

(7) The Modification Circle size shall be 1/2 inch diameter unless the area where the circle is to be placed is crowded. Smaller size circle shall be used for crowded areas.

1.2.1.3 Drawing Preparation

The record drawings shall be modified as may be necessary to correctly show the features of the project as it has been constructed by bringing the contract set into agreement with approved working record prints, adding such additional drawings as may be necessary. At the time of final inspection, 3 copies of the working record prints shall be delivered to the Contracting Officer for review and approval. These working record marked prints shall be neat, legible and accurate. These drawings are part of the permanent records of this project and shall be returned to the Contracting Officer. Any drawings damaged or lost by the Contractor shall be satisfactorily replaced by the Contractor at no expense to the Contracting Officer.

1.2.1.4 Manually Prepared Drawings

Only personnel proficient in the preparation of manually prepared drawings shall be employed to modify the original contract drawing or prepare additional new drawings. Additions and corrections to the contract drawings shall be neat, clean and legible, shall be done to the same level

of detail, and shall match the adjacent existing line work, and lettering being annotated in type, density, size and style. Drafting work shall be done using the same medium (pencil, plastic lead or ink) that was employed on the original contract drawings and with graphite lead on paper base material. The Contracting Officer will review record drawings for accuracy and conformance to the above specified drafting standards. Corrections, changes, additions, and deletions required shall meet these standards. The title block to be used for any new record drawings shall be similar to that used on the original drawings.

a. When final revisions have been completed, each record drawing shall be lettered or stamped with the words "RECORD DRAWING " followed by the name of the Contractor in letters at least 3/16 inch high. Original contract drawings shall be marked either "record" drawings denoting no revisions on the sheet or "Revised record" denoting one or more revisions. All original contract drawings shall be dated in the revision block.

b. After receipt of the approved marked working record drawings and approval of completed sections of final record drawings, the Contractor shall within 10 days for each specific phase of work for contracts less than $5 million make the final record drawing submittal. This submittal shall consist of the completed final record drawings, two blue line prints of these drawings and the return of the approved marked record prints. The drawings shall be complete in all details. Paper prints and reproducible drawings will become the property of the Contracting Officer upon final approval. Failure to submit final record drawings and marked prints as required herein will be cause for withholding any payment due the Contractor under this contract. Approval and acceptance of final record drawings shall be accomplished before final payment is made to the Contractor.

1.2.1.5 Payment

No separate payment will be made for record drawings required under this contract, and all costs in connection therewith shall be considered a subsidiary obligation of the Contractor.

1.2.2 Record of Equipment and Materials

The Contractor shall furnish two copies of preliminary record of equipment and materials used on the project 15 days prior to final inspection. This preliminary submittal will be reviewed and returned 5 days after final inspection with Contracting Officer comments. Two sets of final record of equipment and materials shall be submitted 10 days after final inspection. The designations shall be keyed to the related area depicted on the contract drawings. The record shall list the following data:

RECORD OF DESIGNATED EQUIPMENT AND MATERIALS DATA

Description	Specification Section	Manufacturer and Catalog Number	Composition and Size	Where Used

1.2.3 Final Approved Shop Drawings

The Contractor shall furnish final approved project shop drawings 30 days after transfer of the completed facility.

1.2.4 Construction Contract Specifications

The Contractor shall furnish construction contract specifications, including modifications thereto 30 days after transfer of the completed facility.

1.2.5 Real Property Equipment

The Contractor shall furnish a list of installed equipment furnished under this contract. The list shall include all information usually listed on manufacturer's name plate. The "EQUIPMENT-IN-PLACE LIST" shall include, as applicable, the following for each piece of equipment installed: description of item, location (by room number), model number, serial number, capacity, name and address of manufacturer, name and address of equipment supplier, condition, spare parts list, manufacturer's catalog, and warranty. A draft list shall be furnished at time of transfer. The final list shall be furnished 30 days after transfer of the completed facility.

1.3 WARRANTY MANAGEMENT

1.3.1 Warranty Management Plan

The Contractor shall develop a warranty management plan which shall contain information relevant to the warranty of construction as required by the SPECIAL CONTRACT REQUIREMENTS. Warranty information made available during the construction phase shall be submitted to the Contracting Officer for approval prior to each monthly pay estimate. Approved information shall be assembled in a binder and shall be turned over to the Contracting Officer upon acceptance of the work. The construction warranty period shall begin on the date of project acceptance and shall continue for the full product warranty period. A joint 4 month and 9 month warranty inspection shall be conducted, measured from time of acceptance, by the Contractor, the Contracting Officer and the Customer Representative. Information contained in the warranty management plan shall include, but shall not be limited to, the following:

a. Written warranty by the manufacturer stating the period of construction warranty beginning and ending, coinciding with the one year construction warranty specified in the contract. Product warranty that extends beyond the specified one year construction warranty period shall be shown with separate warranty expiration dates.

b. Name, address, and telephone number of subcontractors, suppliers, or manufacturers to be contacted regarding warranty.

1.4 OPERATION AND MAINTENANCE MANUALS

Operation manuals and maintenance manuals shall be submitted as specified. Operation manuals and maintenance manuals provided in a common volume shall be clearly differentiated and shall be separately indexed.

1.5 FINAL CLEANING/INSPECTION

The site shall have waste, surplus materials, and rubbish removed. The project area shall have temporary structures, barricades, project signs, and construction facilities removed. A list of completed clean-up items shall be included as part of the punch-list inspections.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

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SECTION 02230

CLEARING AND GRUBBING

PART 1 GENERAL

1.1 DEFINITIONS

1.1.1 Clearing

Clearing shall consist of the felling, trimming, and cutting of trees into sections and the satisfactory disposal of the trees and other vegetation designated for removal, including down timber, snags, brush, and rubbish occurring in the areas to be cleared.

1.1.2 Grubbing

Grubbing shall consist of the removal and disposal of stumps, roots larger than 3 inches in diameter, and matted roots from the designated grubbing areas.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 CLEARING

Trees, stumps, roots, brush, and other vegetation in areas to be cleared shall be cut off flush with or below the original ground surface, except such trees and vegetation as may be indicated or directed to be left standing. Trees designated to be left standing within the cleared areas shall be trimmed of dead branches 1-1/2 inches or more in diameter and shall be trimmed of all branches the heights indicated or directed. Limbs and branches to be trimmed shall be neatly cut close to the bole of the tree or main branches. Cuts more than 1-1/2 inches in diameter shall be painted with an approved tree-wound paint. Trees and vegetation to be left standing shall be protected from damage incident to clearing, grubbing, and construction operations by the erection of barriers or by such other means as the circumstances require. Clearing shall also include the removal and disposal of structures that obtrude, encroach upon, or otherwise obstruct the work.

3.2 GRUBBING

Material to be grubbed, together with logs and other organic or metallic debris not suitable for foundation purposes, shall be removed to a depth of not less than 18 inches below the original surface level of the ground in areas indicated to be grubbed and in areas indicated as construction areas under this contract, such as areas for buildings, and areas to be paved. Depressions made by grubbing shall be filled with suitable material and compacted to make the surface conform with the original adjacent surface of the ground.

3.3 DISPOSAL OF MATERIALS

Logs, stumps, roots, brush, rotten wood, and other refuse from the clearing

and grubbing operations shall be stockpiled at locations as directed by the Contracting Officer. The disposal of the material will be by the Contracting Officer.

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SECTION 02315

EXCAVATION, FILLING AND BACKFILLING FOR STRUCTURES

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 33	(2001) Standard Specification for Concrete Aggregates
ASTM D 1556	(1990; R1996) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu.m.))
ASTM D 2216	(1992) Laboratory Determination of Water (Moisture) Content of Soil, and Rock
ASTM D 2487	(1993) Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2922	(1996) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 2937	(1994) Density of Soil in Place by the Drive-Cylinder Method
ASTM D 3017	(1988; R1993) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D 4253	(2000) Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Test
ASTM D 4254	(2000) Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density

MASSACHUSETTS CONTINGENCY PLAN (MCP)

310 CMR 40.0985(6)	(1999) Determination of Method 2 Soil Standards Considering Leaching Potential

1.2 DEFINITIONS

1.2.1 Compaction

The process of mechanically stabilizing a material by increasing its density at a controlled moisture condition. "Degree of Compaction" is expressed as a percentage of the maximum density obtained by the test procedure described in ASTM D 1557 for general soil types, or ASTM D 4253 and ASTM D 4254 (relative density for isolated cohesionless materials).

1.2.2 Granular Fill

A layer of clean, crushed rock, stone, or natural sand or gravel having a high porosity which is placed beneath a building slab, footing, or concrete structure, at a specific degree of compaction to attain a maximum bearing strength and minimized consolidation or differential settlement under load.

1.2.3 Satisfactory Materials

Satisfactory material shall comprise any materials classified by ASTM D 2487 as GW, GP, GC, GM, GW-GM, GW-GC, GP-GM, GP-GC, SW, SP, SM, SC, SP-SM, SP-SC, SW-SM, and SW-SC, and be free from roots and other organic material, trash, debris, frozen materials, and stones larger than 3 inches in any diameter are satisfactory.

1.2.4 Structural Fill

A specified soil mix or gradation of materials constructed to attain maximum bearing strength and minimize consolidation or differential settlement under load.

1.2.5 Subgrade

Subgrade as used in this section refers to the surface of the soil exposed by excavation or grubbing, upon which additional soil or structure will be placed.

1.2.6 Unsatisfactory Materials

Existing, in situ soil or other material which can be identified as having insufficient strength characteristics or stability to carry intended loads in fill or structures without excessive consolidation or loss of stability. Unsatisfactory material are classified as OL, OH, Pt, CL, and CH by ASTM D 2487 are unsatisfactory. Unsatisfactory materials also include man-made fills, trash, refuse, demolition debris, or backfills from previous construction. Unsatisfactory materials also include materials classified as satisfactory which contain root and other organic matter or frozen materials. The Contracting Officer shall be notified of an contaminated materials.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Field Density Tests; GA
Testing of Fill Materials; GA

Copies of all laboratory and field test reports within 24 hours of the completion of the test.

SD-07 Certificates

Testing Laboratory Qualifications; GA

Qualifications of the commercial testing laboratory(s) or Contractor's testing facilities.

Certified Clean Materials; GA

Submit certificates of compliance that all fill materials brought to the site are clean materials.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Structural Fill

Structural fill materials shall comprise any materials classified by ASTM D 2487 as GW, GP, SW, and SP, and be free from roots and other organic material, trash, debris, frozen materials, and stones larger than 3 inches in any diameter are satisfactory. Structural fill should be compacted to at least 95 percent of the maximum dry density as determined by ASTM D 1557 when used for raising the grade throughout the site, below footings or mats, or for rough grading. The material shall be clean so as not to introduce contaminated material. Evaluation for analytical comparison of fill materials shall be in accordance with the direct exposure criteria for soils set forth under the Massachusetts Contingency Plan 310 CMR 40.0985(6).

Sieve Size	Percent Passing
1/2 inch	50-85
No. 4	40-75
No. 50	8-28
No. 200	0-5

2.1.2 Granular fill

Provide granular fill under concrete floor slabs, footings, and foundations consisting of clean crushed stone, crushed gravel, or uncrushed gravel, conforming with ASTM C 33 coarse aggregate grading size of 57, 67, or 7. The material shall be clean so as not to introduce contaminated material. Evaluation for analytical comparison of fill materials shall be in accordance with the direct exposure criteria for soils set forth under the Massachusetts Contingency Plan 310 CMR 40.0985(6).

Sieve Size	57	67	7
1 1/2 inches	100	-	-
1 inch	95-100	100	-
3/4 inch	-	90-100	100
1/2 inch	25-60	-	90-100
3/8 inch	-	20-55	40-70
No.4	0-10	0-10	0-15
No.8	0-5	0-5	0-5

2.1.3 Satisfactory Material

Satisfactory materials shall be comprised of any materials classified by ASTM D 2487 GW, GP, GC, GM, GW-GM, GW-GC, GP-GM, GP-GC, SW, SP, SM, SC, SP-SM, SP-SC, SW-SM, and SW-SC, and be free from roots and other organic material, trash, debris, frozen materials, and stones larger than 3 inches in any diameter are satisfactory. The material shall be clean so as not to introduce contaminated material. Evaluation for analytical comparison of fill materials shall be in accordance with the direct exposure criteria for soils set forth under the Massachusetts Contingency Plan 310 CMR 40.0985(6).

Sieve Size	Percent Passing
1/2 inch	40-85
No. 4	35-75
No. 50	5-40
No. 200	0-10

PART 3 EXECUTION

3.1 CLEARING AND GRUBBING

The areas within lines 25 feet outside of each building and structure line shall be cleared and grubbed of trees, stumps, roots, brush and other vegetation, debris, existing foundations, pavements, utility lines, structures, fences, and other items that would interfere with construction operations. Stumps, logs, roots, and other organic matter shall be completely removed and the resulting depressions shall be filled with suitable materials and compacted in accordance with paragraph FILLING AND BACKFILLING. Materials removed shall be disposed of in the designated waste disposal areas.

3.2 EXCAVATION

Excavation shall conform to the dimensions and elevations indicated for each building, structure, and footing except as specified, and shall include trenching for utility and foundation drainage systems to a point 5 feet beyond the building line of each building and structure. Excavation shall extend a sufficient distance from walls and footings to allow for placing and removal of forms. Excavations below indicated depths will not be permitted except to remove unsatisfactory material. Unsatisfactory material encountered below the grades shown shall be replaced with suitable materials and compacted in accordance with paragraph FILLING AND BACKFILLING. Satisfactory material removed below the depths indicated, without specific direction of the Contracting Officer, shall be replaced, at no additional cost to the Government, with suitable materials and compacted in accordance with paragraph FILLING AND BACKFILLING, to the indicated excavation grade; except that concrete footings shall be increased in thickness to the bottom of the overdepth excavations. Determination of elevations and measurements of approved overdepth excavation of unsatisfactory material below grades indicated shall be done under the direction of the Contracting Officer.

3.3 DRAINAGE AND DEWATERING

3.3.1 Drainage

Surface water shall be directed away from excavation and construction sites to prevent erosion and undermining of foundations. Diversion ditches,

dikes and grading shall be provided and maintained as necessary during construction. Excavated slopes and backfill surfaces shall be protected to prevent erosion and sloughing. Excavation shall be performed so that the site, the area immediately surrounding the site, and the area affecting operations at the site shall be continually and effectively drained.

3.3.2 Dewatering

Groundwater flowing toward or into excavations shall be controlled to prevent sloughing of excavation slopes and walls, boils, uplift and heave in the excavation and to eliminate interference with orderly progress of construction. French drains, sumps, ditches or trenches will not be permitted within 3 feet of the foundation of any structure, except with specific written approval, and after specific contractual provisions for restoration of the foundation area have been made. Control measures shall be taken by the time the excavation reaches the water level in order to maintain the integrity of the in situ material. While the excavation is open, the water level shall be maintained continuously.

3.4 SHORING

Shoring, including sheet piling, shall be furnished and installed as necessary to protect workmen, banks, adjacent paving, structures, and utilities. Shoring, bracing, and sheeting shall be removed as excavations are backfilled, in a manner to prevent caving.

3.5 CLASSIFICATION OF EXCAVATION

Excavation will be unclassified regardless of the nature of material encountered.

3.6 BLASTING

Blasting will not be permitted.

3.7 UTILITY AND DRAIN TRENCHES

Trenches for underground utilities systems and drain lines shall be excavated to the required alignments and depths. The bottoms of trenches shall be graded to secure the required slope and shall be tamped if necessary to provide a firm pipe bed. Recesses shall be excavated to accommodate bells and joints so that pipe will be uniformly supported for the entire length. Rock, where encountered, shall be excavated to a depth of at least 6 inches below the bottom of the pipe, and the overdepth shall be backfilled with satisfactory material placed and compacted in conformance with paragraph FILLING AND BACKFILLING.

3.8 EXCAVATED MATERIALS

Satisfactory excavated material required for fill or backfill shall be placed in the proper section of the permanent work required under this section or shall be separately stockpiled if it cannot be readily placed. Satisfactory material in excess of that required for the permanent work and all unsatisfactory material shall be disposed of as specified in accordance with Massachusetts Contingency Plan (MCP) regulations.

3.9 FINAL GRADE OF SURFACES TO SUPPORT CONCRETE

Excavation to final grade shall not be made until just before concrete is

to be placed. Only excavation methods that will leave the foundation rock in a solid and unshattered condition shall be used. Approximately level surfaces shall be roughened, and sloped surfaces shall be cut as indicated into rough steps or benches to provide a satisfactory bond. Shales shall be protected from slaking and all surfaces shall be protected from erosion resulting from ponding or flow of water.

3.10 SUBGRADE PREPARATION

Unsatisfactory materials in surfaces to receive fill or in excavated areas shall be removed and replaced with satisfactory materials as directed by the Contracting Officer. The surface shall be scarified to a depth of 6 inches before the fill is started. Sloped surfaces steeper than 1 vertical to 4 horizontal shall be plowed, stepped, benched, or broken up so that the fill material will bond with the existing material. When subgrades are less than the specified density, the ground surface shall be broken up to a minimum depth of 6 inches, pulverized, and compacted to the specified density. When the subgrade is part fill and part excavation or natural ground, the excavated or natural ground portion shall be scarified to a depth of 12 inches and compacted as specified for the adjacent fill. Material shall not be placed on surfaces that are muddy, frozen, or contain frost. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment well suited to the soil being compacted. Material shall be moistened or aerated as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used. Minimum subgrade density shall be as specified in paragraph FILLING AND BACKFILLING.

3.11 FILLING AND BACKFILLING

Fill materials, specified in paragraph MATERIALS, shall be used in bringing fills and backfills to the lines and grades indicated on the contract drawings and for replacing unsatisfactory materials. Fill materials shall be placed in horizontal layers not exceeding 8 inches in loose thickness, or 6 inches when hand-operated compactors are used. After placing, each layer shall be plowed, disked, or otherwise broken up, moistened or aerated as necessary, thoroughly mixed and compacted as specified. Backfilling shall not begin until construction below finish grade has been approved, underground utilities systems have been inspected, tested and approved, forms removed, and the excavation cleaned of trash and debris. Backfill shall be brought to indicated finish grade. Backfill shall not be placed in wet or frozen areas. Where pipe is coated or wrapped for protection against corrosion, the backfill material up to an elevation 2 feet above sewer lines and 1 foot above other utility lines shall be free from stones larger than 1 inch in any dimension. Heavy equipment for spreading and compacting backfill shall not be operated closer to foundation or retaining walls than a distance equal to the height of backfill above the top of footing; the area remaining shall be compacted in layers not more than 4 inches in compacted thickness with power-driven hand tampers suitable for the material being compacted. Backfill shall be placed carefully around pipes or tanks to avoid damage to coatings, wrappings, or tanks. Backfill shall not be placed against foundation walls prior to 7 days after completion of the walls. As far as practicable, backfill shall be brought up evenly on each side of the wall and sloped to drain away from the wall.

Granular fill shall be used as a bedding material in areas directly beneath footings, slabs, and structures, as indicated on the contract drawings. Granular fill shall extend a minimum of 1 foot laterally beyond the

footings, slabs and structure, as indicated on the contract drawings.

Where necessary, structural fill shall be used beneath and adjacent to footings, slabs, and structures to bring existing subgrade to the lines and grades as indicated on the contract drawings. Structural fill placed adjacent to footings slabs and other structures shall extend on a 1:1 plane projected upward from the closest bottom corner of the excavation to the grades indicated on the contract drawings, or in accordance with local, state, and federal OSHA regulations for excavations.

Satisfactory materials shall be used as fill and backfill in areas not beneath or adjacent footings, slabs, and structures, to bring existing grades to the lines and grades indicated on the contract drawings, and for general grading purposes.

Each layer of fill and backfill shall be compacted to not less than the percentage of maximum density specified below:

	Percent Laboratory maximum density	
	Cohesive material	Cohesionless material
Granular Fill and Structural Fill Beside and under structures, building slabs, paved areas, around footings.		95
Satisfactory Fill In areas not beside and under structures, building slabs, paved areas, around footings.		95
Subgrade Under building slabs, steps, and paved areas, top 12 inches		95

Approved compacted subgrades that are disturbed by the Contractor's operations or adverse weather shall be scarified and compacted as specified herein before to the required density prior to further construction thereon. Recompaction over underground utilities and heating lines shall be by hand tamping.

3.12 TESTING

Testing shall be the responsibility of the Contractor and shall be performed at no additional cost to the Government. Testing shall be performed by an approved commercial testing laboratory or may be performed by the Contractor subject to approval. Field in-place density shall be determined in accordance with ASTM D 1556 or ASTM D 2922. When ASTM D 2922 is used, the calibration curves shall be checked and adjusted if necessary by the procedure described in ASTM D 2922, paragraph ADJUSTING CALIBRATION CURVE. ASTM D 2922 results in a wet unit weight of soil and, when using this method, ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall also be checked along with density calibration checks as described in ASTM D 3017. The calibration checks of both the density and moisture gauges

shall be made at the beginning of a job on each different type of material encountered and at intervals as directed by the Contracting Officer. ASTM D 2937 shall be used only for soft, fine-grained, cohesive soils. The following number of tests, if performed at the appropriate time, shall be the minimum acceptable for each type operation.

3.12.1 In-Place Densities

In-place density and moisture content test results shall be included with the Contractor's daily construction quality control reports.

3.12.1.1 In-Place Density of Subgrade

One test per 500 square foot or fraction thereof.

3.12.2 In-Place Density of Fills and Backfills

One test per lift for fill or backfill areas compacted by other than hand or hand-operated machines. The density for each lift of fill or backfill materials for trenches, pits, building perimeters, or other structures, which are compacted with hand or hand-operated machines shall be tested as follows: one test per each area less than 500 square feet, or one test for each 200 linear foot of long narrow fills 200 feet or more in length. If ASTM D 2922 is used, in-place densities shall be checked by ASTM D 1556 as follows: one check per lift for each 1000 linear feet of long narrow fills, and a minimum of 1 check per lift for other fill and backfill areas.

3.12.3 Moisture Content

In the stockpile, excavation, or borrow areas, a minimum of one test per day per type of material or source of materials being placed is required during stable weather conditions. During unstable weather, tests shall be made as dictated by local conditions and approved moisture content shall be tested in accordance with ASTM D 2216.

3.12.4 Optimum Moisture and Laboratory Maximum Density

Tests shall be made for each type material or source of material, including borrow material to determine the optimum moisture and laboratory maximum density values. A minimum of one moisture-density relation test shall be performed on each different type of material used.

3.13 GRANULAR FILL

Granular fill under concrete floors and area-way slabs on grade shall be placed directly on the subgrade and shall be compacted with a minimum of two passes of a hand-operated plate-type vibratory compactor.

3.14 STRUCTURAL AND SATISFACTORY FILL

Fill placed beside structures may be compacted to 95 percent of the maximum dry density as determined by ASTM D 1557. Initially, structural fill should be placed in lifts not exceeding 8 inches loose thickness. Thicker lifts may be used pursuant to approval based on results of field compaction performance. The moisture content of all compacted fill should fall within 3 percentage points of the optimum moisture content measured by ASTM D 1557, except compact the top 12 inches of subgrade to 95 percent of ASTM D 1557 maximum density.

3.15 GRADING

Areas within 25 feet outside of each building and structure line shall be constructed true-to-grade, shaped to drain, and shall be maintained free of trash and debris until final inspection has been completed and the work has been accepted.

3.16 PROTECTION

Settlement or washing that occurs in graded, topsoiled, or backfilled areas prior to acceptance of the work, shall be repaired and grades re-establishes to the required elevations and slopes.

-- End of Section --

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SECTION 02316

EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 1556	(1990; R 1996) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1998) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))
ASTM D 2167	(1994) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2487	(1998) Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2922	(1996) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(1988; R1996el) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

MASSACHUSETTS CONTINGENCY PLAN (MCP)

310 CMR 40.0985(6)	(1999) Determination of Method 2 Soil Standards Considering Leaching Potential

1.2 DEGREE OF COMPACTION

Degree of compaction shall be expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Field Density Tests; GA
Testing of Backfill Materials; GA

Copies of all laboratory and field test reports within 24 hours of the completion of the test.

SD-07 Certificates

Testing Laboratory Qualifications; GA

Qualifications of the commercial testing laboratory(s) or Contractor's testing facilities.

Certified Clean Materials; GA

Submit certificates of compliance that all fill materials brought to the site are clean materials.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Satisfactory Materials

Satisfactory materials shall comprise any materials classified by ASTM D 2487 as GW, GP, GM, GP-GM, GW-GM, GC, GP-GC, GM-GC, SW, SP, SW-SM, SW-SC, SP-SM, SP-SC.

2.1.2 Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Unsatisfactory materials also include man-made fills, trash, refuse, or backfills from previous construction. Unsatisfactory material also includes material classified as satisfactory which contains root and other organic matter, frozen material, and stones larger than 1 inch. The Contracting Officer shall be notified of any contaminated materials.

2.1.3 Cohesionless and Cohesive Materials

Cohesionless materials shall include materials classified in ASTM D 2487 as GW, GP, SW, and SP. Cohesive materials shall include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM shall be identified as cohesionless only when the fines are nonplastic.

2.1.4 Rock

Rock shall consist of boulders measuring 1/2 cubic yard or more and materials that cannot be removed without systematic drilling and blasting such as rock material in ledges, bedded deposits, unstratified masses and conglomerate deposits, and below ground concrete or masonry structures, exceeding 1/2 cubic yard in volume, except that pavements shall not be considered as rock.

2.1.5 Unyielding Material

Unyielding material shall consist of rock and gravelly soils with stones greater than 3 inches in any dimension or as defined by the pipe manufacturer, whichever is smaller.

2.1.6 Unstable Material

Unstable material shall consist of materials too wet to properly support the utility pipe, conduit, or appurtenant structure.

2.1.7 Select Granular Material

Select granular material shall consist of well-graded sand, gravel, crushed gravel, crushed stone or crushed slag composed of hard, tough and durable particles, and shall contain not more than 10 percent by weight of material passing a No. 200 mesh sieve and no less than 95 percent by weight passing the 1 inch sieve. The maximum allowable aggregate size shall be 1 inch, or the maximum size recommended by the pipe manufacturer, whichever is smaller.

2.1.8 Initial Backfill Material

Initial backfill shall consist of select granular material or satisfactory materials free from rocks 1 inch or larger in any dimension or free from rocks of such size as recommended by the pipe manufacturer, whichever is smaller. When the pipe is coated or wrapped for corrosion protection, the initial backfill material shall be free of stones larger than 1 inch in any dimension or as recommended by the pipe manufacturer, whichever is smaller.

2.2 PLASTIC MARKING TAPE

Plastic marking tape shall be acid and alkali-resistant polyethylene film, 6 inches wide with minimum thickness of 0.004 inch. Tape shall have a minimum strength of 1750 psi lengthwise and 1500 psi crosswise. The tape shall be manufactured with integral wires, foil backing or other means to enable detection by a metal detector when the tape is buried up to 3 feet deep. The tape shall be of a type specifically manufactured for marking and locating underground utilities. The metallic core of the tape shall be encased in a protective jacket or provided with other means to protect it from corrosion. Tape color shall be as specified in TABLE 1 and shall bear a continuous printed inscription describing the specific utility.

TABLE 1. Tape Color

Red:	Electric
Yellow:	Gas, Oil, Dangerous Materials
Orange:	Telephone, Telegraph, Television, Police, and Fire Communications
Blue:	Water Systems
Green:	Sewer Systems

PART 3 EXECUTION

3.1 EXCAVATION

Excavation shall be performed to the lines and grades indicated. Rock excavation shall include removal and disposition of material defined as rock in paragraph MATERIALS. Earth excavation shall include removal and disposal of material not classified as rock excavation. During excavation, material satisfactory for backfilling shall be stockpiled in an orderly manner at a distance from the banks of the trench equal to 1/2 the depth of the excavation, but in no instance closer than 2 feet. Excavated material not required or not satisfactory for backfill shall be removed from the site in accordance with 310 CMR 40.0985 guidelines. Grading shall be done

as may be necessary to prevent surface water from flowing into the excavation, and any water accumulating shall be removed to maintain the stability of the bottom and sides of the excavation. Unauthorized overexcavation shall be backfilled in accordance with paragraph BACKFILLING AND COMPACTION at no additional cost to the Government.

3.1.1 Trench Excavation Requirements

The trench shall be excavated as recommended by the manufacturer of the pipe to be installed. Trench walls below the top of the pipe shall be sloped, or made vertical, and of such width as recommended in the manufacturer's installation manual. Where no manufacturer's installation manual is available, trench walls shall be made vertical. Trench walls more than 5 feet high shall be shored, cut back to a stable slope, or provided with equivalent means of protection for employees who may be exposed to moving ground or cave in. Trench walls which are cut back shall be excavated to at least the angle of repose of the soil. Special attention shall be given to slopes which may be adversely affected by weather or moisture content. The trench width below the top of pipe shall not exceed 24 inches plus pipe outside diameter (O.D.) for pipes of less than 24 inches inside diameter and shall not exceed 36 inches plus pipe outside diameter for sizes larger than 24 inches inside diameter. Where recommended trench widths are exceeded, redesign, stronger pipe, or special installation procedures shall be utilized by the Contractor. The cost of redesign, stronger pipe, or special installation procedures shall be borne by the Contractor without any additional cost to the Government.

3.1.1.1 Bottom Preparation

The bottoms of trenches shall be accurately graded to provide uniform bearing and support for the bottom quadrant of each section of the pipe. Bottom shall be excavated to the specified grades, in preparation for the placement of select granular material. Bell holes shall be excavated to the necessary size at each joint or coupling to eliminate point bearing. Stones of 1 inch or greater in any dimension, or as recommended by the pipe manufacturer, whichever is smaller, shall be removed to avoid point bearing.

3.1.1.2 Removal of Unyielding Material

Where unyielding material is encountered in the bottom of the trench, such material shall be removed 12 inches below the required grade and replaced with suitable materials as provided in paragraph BACKFILLING AND COMPACTION.

3.1.1.3 Removal of Unstable Material

Where unstable material is encountered in the bottom of the trench, such material shall be removed to the depth directed and replaced to the proper grade with select granular material as provided in paragraph BACKFILLING AND COMPACTION. When removal of unstable material is required due to the Contractor's fault or neglect in performing the work, the resulting material shall be excavated and replaced by the Contractor without additional cost to the Government.

3.1.1.4 Excavation for Appurtenances

Excavation for cast-in-place manholes, catchbasins, inlets, or similar structures shall be of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown. For prefabricated manholes, catchbasins, inlets, or

similar structures, the Contractor will be responsible to obtain installation instructions from the manufacturer and perform the excavation, backfill, and site grading in accordance with those instructions. Excavation for pre-cast manholes, catchbasins, inlets, or similar structures shall be over excavated two feet (horizontal measurement) on each side of the structure to allow for compaction and minor adjustments in orientation.

For all appurtenances, rock shall be cleaned of loose debris and cut to a firm surface either level, stepped, or serrated, as shown or as directed. Loose disintegrated rock and thin strata shall be removed. Removal of unstable material shall be as specified above. When concrete or masonry is to be placed in an excavated area, special care shall be taken not to disturb the bottom of the excavation. Excavation to the final grade level shall not be made until just before the concrete or masonry is to be placed.

3.1.2 Stockpiles

Stockpiles of satisfactory shall be placed and graded as specified. Stockpiles shall be kept in a neat and well drained condition, giving due consideration to drainage at all times. The ground surface at stockpile locations shall be cleared, grubbed, and sealed by rubber-tired equipment, excavated satisfactory and unsatisfactory materials shall be separately stockpiled. Stockpiles of satisfactory materials shall be protected from contamination which may destroy the quality and fitness of the stockpiled material. If the Contractor fails to protect the stockpiles, and any material becomes unsatisfactory, such material shall be removed and replaced with satisfactory material from approved sources at no additional cost to the Government. Locations of stockpiles of satisfactory materials shall be subject to prior approval of the Contracting Officer.

3.2 BACKFILLING AND COMPACTION

Backfill material shall consist of satisfactory material, select granular material, or initial backfill material as required. Backfill shall be placed in layers not exceeding 6 inches loose thickness for compaction by hand operated machine compactors, and 8 inches loose thickness for other than hand operated machines, unless otherwise specified. Each layer shall be compacted to at least 95 percent maximum density for cohesionless soils and 90 percent maximum density for cohesive soils, unless otherwise specified.

3.2.1 Trench Backfill

Trenches shall be backfilled to the grade shown. The trench shall not be backfilled until all specified tests are performed.

3.2.1.1 Replacement of Unyielding Material

Unyielding material removed from the bottom of the trench shall be replaced with select granular material.

3.2.1.2 Replacement of Unstable Material

Unstable material removed from the bottom of the trench or excavation shall be replaced with compacted select granular material placed in layers not exceeding 6 inches loose thickness.

3.2.1.3 Bedding and Initial Backfill

Bedding shall be of the type and thickness shown on the construction drawings. Select granular material shall be placed and compacted with approved tampers to the springlines of the pipe utility pipe or conduit. The backfill shall be brought up evenly on both sides of the pipe for the full length of the pipe. Care shall be taken to ensure thorough compaction of the fill under the haunches of the pipe.

3.2.1.4 Final Backfill

The remainder of the trench, except for special materials for buildings, pavement and structures, shall be filled with satisfactory material. Backfill material shall be placed and compacted as follows:

a. Structures: Backfill shall be placed up to the elevation at which the requirements in Section 02315 EXCAVATION, FILLING AND BACKFILLING FOR STRUCTURES. Water flooding or jetting methods of compaction will not be permitted.

b. Turfed or Seeded Areas and Miscellaneous Areas: Backfill shall be deposited in layers of a maximum of 12 inch loose thickness, and compacted to 95 percent maximum density for cohesionless soils. Water jetting shall not be allowed to penetrate the initial backfill. This requirement shall also apply to all other areas not specifically designated above.

3.2.2 Backfill for Appurtenances

After the manhole, catchbasin, inlet, or similar structure has been constructed, backfill shall be placed in such a manner that the structure will not be damaged by the shock of falling earth. Foundations for all manhole, catchbasin, inlet, or similar structures are to be backfilled using 12 inches of granular material and compacted to 95 percent maximum density, as indicated on the contract documents. Satisfactory backfill material shall be deposited and compacted as specified for final backfill, and shall be brought up evenly on all sides of the structure to prevent eccentric loading and excessive stress, to the grades indicated on the contract documents.

3.3 SPECIAL REQUIREMENTS

Special requirements for both excavation and backfill relating to the specific utilities are as follows:

3.3.1 Gas Distribution

Trenches shall be excavated to a depth that will provide not less than 18 inches of cover in rock excavation and not less than 24 inches of cover in other excavation. Trenches shall be graded as specified for pipe-laying requirements in Section 02556 GAS DISTRIBUTION SYSTEM.

3.3.2 Water and Sewer Lines

Trenches shall be of a depth to provide a minimum cover of 4 feet from the existing ground surface, or from the indicated finished grade, whichever is lower, to the top of the pipe.

3.3.3 Heat Distribution System

Initial backfill material shall be free of stones larger than 1/4 inch in any dimension.

3.3.4 Electrical Distribution System

Direct burial cable and conduit or duct line shall have a minimum cover of 24 inches from the finished grade, unless otherwise indicated.

3.3.5 Plastic Marking Tape

Warning tapes shall be installed directly above the pipe, at a depth of 18 inches below finished grade unless otherwise shown.

3.4 TESTING

Testing shall be the responsibility of the Contractor and shall be performed at no additional cost to the Government.

3.4.1 Testing Facilities

Tests shall be performed by an approved commercial testing laboratory or may be tested by facilities furnished by the Contractor. No work requiring testing will be permitted until the facilities have been inspected and approved by the Contracting Officer.

3.4.2 Testing of Backfill Materials

Classification of backfill materials shall be determined in accordance with ASTM D 2487 and the moisture-density relations of soils shall be determined in accordance with ASTM D 1557. A minimum of one soil classification and one moisture-density relation test shall be performed on each different type of material used for bedding and backfill.

3.4.3 Field Density Tests

Tests shall be performed in sufficient numbers to ensure that the specified density is being obtained. A minimum of one field density test per lift of backfill for every 100 feet of installation shall be performed. One moisture density relationship shall be determined for every 300 cubic yards of material used. Field in-place density shall be determined in accordance with ASTM D 1556, ASTM D 2167, or ASTM D 2922. When ASTM D 2922 is used, the calibration curves shall be checked and adjusted using the sand cone method as described in paragraph Calibration of the ASTM publication. ASTM D 2922 results in a wet unit weight of soil and when using this method, ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in ASTM D 3017. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job, on each different type of material encountered, at intervals as directed by the Contracting Officer. Copies of calibration curves, results of calibration tests, and field and laboratory density tests shall be furnished to the Contracting Officer. Trenches improperly compacted shall be reopened to the depth directed, then refilled and compacted to the density specified at no additional cost to the Government.

3.4.4 Displacement of Sewers

After other required tests have been performed and the trench backfill compacted to the finished grade surface, the pipe shall be inspected to

determine whether significant displacement has occurred. This inspection shall be conducted in the presence of the Contracting Officer. Pipe sizes larger than 36 inches shall be entered and examined, while smaller diameter pipe shall be inspected by shining a light or laser between manholes or manhole locations, or by the use of television cameras passed through the pipe. If, in the judgement of the Contracting Officer, the interior of the pipe shows poor alignment or any other defects that would cause improper functioning of the system, the defects shall be remedied as directed at no additional cost to the Government.

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SECTION 02531

SANITARY SEWERS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 94/C 94M	(2000) Ready-Mixed Concrete
ASTM C 150	(1999a) Portland Cement
ASTM C 270	(2000) Mortar for Unit Masonry
ASTM D 1784	(1999a) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 2680	(1995a)Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping
ASTM D 3034	(1998) Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D 3212	(1996a) Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM F 402	(1993; R 1999) Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings
ASTM F 794	(1999) Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
ASTM F 949	(2000) Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 49	(1994) Hazardous Chemicals Data
NFPA 325-1	(1994) Fire Hazard Properties of Flammable Liquids, Gases, and Volatile Solids
NFPA 704	(1996) Identification of the Fire Hazards of Materials for Emergency Response

UNI-BELL PVC PIPE ASSOCIATION (UBPPA)

UBPPA UNI-B-6	(1990) Recommended Practice for the Low-Pressure Air Testing of Installed Sewer Pipe
UBPPA UNI-B-9	(1990; Addenda 1994) Recommended Performance Specification for Polyvinyl Chloride (PVC) Profile Wall Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter (Nominal Pipe Sizes 4-48 inch)

1.2 GENERAL REQUIREMENTS

The construction required herein shall include appurtenant structures and building sewers to points of connection with the building drains 5 feet outside the building to which the sewer system is to be connected. The Contractor shall replace damaged material and redo unacceptable work at no additional cost to the Government. Excavation and backfilling is specified in Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS. Backfilling shall be accomplished after inspection by the Contracting Officer. Before, during, and after installation, plastic pipe and fittings shall be protected from any environment that would result in damage or deterioration to the material. The Contractor shall have a copy of the manufacturer's instructions available at the construction site at all times and shall follow these instructions unless directed otherwise by the Contracting Officer. Solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install the plastic pipe shall be stored in accordance with the manufacturer's recommendation and shall be discarded if the storage period exceeds the recommended shelf life. Solvents in use shall be discarded when the recommended pot life is exceeded. In addition, the sanitary sewer lines will be installed within a flood plain; therefore, all sanitary sewer lines shall be resistant to salt water corrosion.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Product(s); GA

Provide descriptive information regarding product(s) to be furnished. Where appropriate, provide dimensional information regarding item(s). Provide instructions regarding use and/or installation, as appropriate.

SD-07 Certificates

Portland Cement; GA

Certificates of compliance stating the type of cement used.

Pipeline Leakage Tests; GA

Pipeline Deflection Tests; GA

SD-08 Manufacturer's Instructions

Placing Pipe; FIO

Printed copies of the manufacturer's recommendations for installation procedures of the material being placed, prior to installation.

PART 2 PRODUCTS

2.1 PIPE

Pipe shall conform to the respective specifications and other requirements specified below.

2.1.1 Plastic Pipe

Polyvinyl chloride (PVC) composite sewer piping shall conform to ASTM D 2680. Size 8 inch through 15 inch diameter.

2.1.1.1 PVC Pipe

ASTM D 3034, Type PSM with a maximum SDR of 35, Size 15 inches or less in diameter. ASTM F 949 for corrugated sewer pipes with a smooth interior. UBPPA UNI-B-9 and ASTM F 794, Series 46, for ribbed sewer pipe with smooth interior, size 8 inch through 48 inch diameters. PVC shall be certified by the compounder as meeting the requirements of ASTM D 1784, cell Class 12454B. The pipe stiffness shall be greater than or equal to 735/D for cohesionless material pipe trench backfills.

2.2 REQUIREMENTS FOR FITTINGS

Fittings shall be compatible with the pipe supplied and shall have a strength not less than that of the pipe. Fittings shall conform to the respective specifications and other requirements specified below.

2.2.1 Fittings for Plastic Pipe

PVC composite sewer pipe fittings shall conform to ASTM D 2680.

2.2.1.1 Fittings for PVC Pipe

ASTM D 3034 for type PSM pipe. ASTM F 949 for corrugated sewer pipe with a smooth interior. UBPPA UNI-B-9 and ASTM F 794, Series 46, for ribbed sewer pipe with smooth interior.

2.3 JOINTS

Joints installation shall comply with the manufacturer's instructions. Fittings and gaskets utilized for waste drains or industrial waste lines shall be certified by the manufacturer as oil resistant.

2.3.1 Plastic Pipe Jointing

Flexible plastic pipe (PVC) gasketed joints shall conform to ASTM D 3212.

2.4 BRANCH CONNECTIONS

Branch connections shall be made by use of regular fittings or solvent cemented saddles as approved. Saddles for PVC composite pipe shall conform to Figure 2 of ASTM D 2680; and saddles for PVC pipe shall conform to Table 4 of ASTM D 3034.

2.5 CEMENT MORTAR

Cement mortar shall conform to ASTM C 270, Type M with Type II cement.

2.5.1 Portland Cement

Portland cement shall conform to ASTM C 150, Type II for concrete used in concrete pipe, concrete pipe fittings, and manholes and type optional with the Contractor for cement used in concrete cradle, concrete encasement, and thrust blocking.

2.5.2 Portland Cement Concrete

Portland cement concrete shall conform to ASTM C 94/C 94M, compressive strength of 4000 psi at 28 days, except for concrete cradle and encasement or concrete blocks for manholes. Concrete used for cradle and encasement shall have a compressive strength of 2500 psi minimum at 28 days. Concrete in place shall be protected from freezing and moisture loss for 7 days.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Adjacent Facilities

3.1.1.1 Water Lines

Where the location of the sewer is not clearly defined by dimensions on the drawings, the sewer shall not be closer horizontally than 10 feet to a water-supply main or service line, except that where the bottom of the water pipe will be at least 12 inches above the top of the sewer pipe, the horizontal spacing may be a minimum of 6 feet. Where gravity-flow sewers cross above water lines, the sewer pipe for a distance of 10 feet on each side of the crossing shall be fully encased in concrete or shall be acceptable pressure pipe with no joint closer horizontally than 3 feet to the crossing. The thickness of the concrete encasement including that at the pipe joints shall be not less than 4 inches.

3.1.1.2 Roads

Water pipe shall be encased in a sleeve of rigid conduit for the lengths shown. A minimum clearance of at least 2 inches between the inner wall of the sleeve and the maximum outside diameter of the sleeved pipe and joints shall be provided. Sand bedding shall be provided for the water pipe through the sleeve. Sleeves of ferrous material shall be provided with the corrosion protection as required for the conditions encountered at the site of installation.

3.1.1.3 Structural Foundations

Where sewer pipe is to be installed within 3 feet of an existing or

proposed building or structural foundation such as a retaining wall, control tower footing, water tank footing, or any similar structure, the sewer pipe shall be sleeved as specified above. Contractor shall ensure there is no damage to these structures, and no settlement or movement of foundations or footing.

3.1.2 Pipe Laying

a. Pipe shall be protected during handling against impact shocks and free fall; the pipe interior shall be free of extraneous material.

b. Pipe laying shall proceed upgrade with the spigot ends of bell-and-spigot pipe and tongue ends of tongue-and-groove pipe pointing in the direction of the flow. Each pipe shall be laid accurately to the line and grade shown on the drawings. Pipe shall be laid and centered so that the sewer has a uniform invert. As the work progresses, the interior of the sewer shall be cleared of all superfluous materials.

c. Before making pipe joints, all surfaces of the portions of the pipe to be joined shall be clean and dry. Lubricants, primers, and adhesives shall be used as recommended by the pipe manufacturer. The joints shall then be placed, fitted, joined, and adjusted to obtain the degree of water tightness required.

d. Installations of solvent weld joint pipe, using PVC pipe and fittings, shall be in accordance with ASTM F 402. The Contractor shall ensure adequate trench ventilation and protection for workers installing the pipe.

3.1.2.1 Trenches

Trenches shall be kept free of water and as dry as possible during bedding, laying, and jointing and for as long a period as required. When work is not in progress, open ends of pipe and fittings shall be satisfactorily closed so that no trench water or other material will enter the pipe or fittings.

3.1.2.2 Backfill

As soon as possible after the joint is made, sufficient backfill material shall be placed along the pipe to prevent pipe movement off line or grade. Plastic pipe shall be completely covered to prevent damage from ultraviolet light.

3.1.2.3 Width of Trench

If the maximum width of the trench at the top of the pipe, as specified in Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS, is exceeded for any reason other than by direction, the Contractor shall install, at no additional cost to the Government, concrete cradling, pipe encasement, or other bedding required to support the added load of the backfill.

3.1.2.4 Jointing

Joints between different pipe materials shall be made as specified, using approved jointing materials.

3.1.2.5 Handling and Storage

Pipe, fittings and joint material shall be handled and stored in accordance with the manufacturer's recommendations. Storage facilities for plastic pipe, fittings, joint materials and solvents shall be classified and marked in accordance with NFPA 704, with classification as indicated in NFPA 49 and NFPA 325-1.

3.1.3 Leakage Tests

Lines shall be tested for leakage by low pressure air testing, infiltration tests or exfiltration tests, as appropriate. Low pressure air testing for PVC pipe shall be as prescribed in UBPPA UNI-B-6. Prior to infiltration or exfiltration tests, the trench shall be backfilled up to at least the lower half of the pipe. If required, sufficient additional backfill shall be placed to prevent pipe movement during testing, leaving the joints uncovered to permit inspection. Visible leaks encountered shall be corrected regardless of leakage test results. When the water table is 2 feet or more above the top of the pipe at the upper end of the pipeline section to be tested, infiltration shall be measured using a suitable weir or other device acceptable to the Contracting Officer. When the Contracting Officer determines that infiltration cannot be properly tested, an exfiltration test shall be made by filling the line to be tested with water so that a head of at least 2 feet is provided above both the water table and the top of the pipe at the upper end of the pipeline to be tested. The filled line shall be allowed to stand until the pipe has reached its maximum absorption, but not less than 4 hours. After absorption, the head shall be re-established. The amount of water required to maintain this water level during a 2-hour test period shall be measured. Leakage as measured by either the infiltration test or exfiltration test shall not exceed 25 gal per inch diameter per mile of pipeline per day. When leakage exceeds the maximum amount specified, satisfactory correction shall be made and retesting accomplished. Testing, correction, and retesting shall be made at no additional cost to the Government.

3.1.4 Test for Deflection

When flexible pipe is used, a deflection test shall be made on the entire length of the installed pipeline not less than 30 days after the completion of all work including the leakage test, backfill, and placement of any fill, grading, paving, concrete, or superimposed loads. Deflection shall be determined by use of a deflection device or by use of a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft. The ball, cylinder, or circular sections shall have a diameter, or minor diameter as applicable, of 92.5 percent of the inside diameter of the pipe. A tolerance of plus 0.5 percent will be permitted. The ball, cylinder, or circular sections shall be of a homogeneous material throughout, shall have a density greater than 1.0 as related to water at 39.2 degrees F, and shall have a surface brinell hardness of not less than 150. The device shall be center bored and through bolted with a 1/4 inch minimum diameter steel shaft having a yield strength of 70,000 psi or more, with eyes at each end for attaching pulling cables. The eye shall be suitably backed with flange or heavy washer; a pull exerted on the opposite end of the shaft shall produce compression throughout the remote end of the ball, cylinder or circular section. Circular sections shall be spaced so that the distance from the external faces of the front and back sections shall equal or exceed the diameter of the circular section. Failure of the ball, cylinder, or circular section to pass freely through a pipe run, either by being pulled through or by being flushed through with water,

shall be cause for rejection of that run. When a deflection device is used for the test in lieu of the ball, cylinder, or circular sections described, such device shall be approved prior to use. The device shall be sensitive to 1.0 percent of the diameter of the pipe being measured and shall be accurate to 1.0 percent of the indicated dimension. Installed pipe showing deflections greater than 7.5 percent of the normal diameter of the pipe shall be retested by a run from the opposite direction. If the retest also fails, the suspect pipe shall be replaced at no cost to the Government.

3.2 CONCRETE CRADLE AND ENCASEMENT

The pipe shall be supported on a concrete cradle, or encased in concrete where indicated or directed.

3.3 INSTALLATION OF WYE BRANCHES

Wye branches shall be installed where sewer connections are indicated or where directed. Cutting into piping for connections shall not be done except in special approved cases. When the connecting pipe cannot be adequately supported on undisturbed earth or tamped backfill, the pipe shall be encased in concrete backfill or supported on a concrete cradle as directed. Concrete required because of conditions resulting from faulty construction methods or negligence by the Contractor shall be installed at no additional cost to the Government. The installation of wye branches in an existing sewer shall be made by a method which does not damage the integrity of the existing sewer. One acceptable method consists of removing one pipe section, breaking off the upper half of the bell of the next lower section and half of the running bell of wye section. After placing the new section, it shall be rotated so that the broken half of the bell will be at the bottom. The two joints shall then be made with joint packing and cement mortar.

3.4 CONNECTING TO EXISTING MANHOLES

Pipe connections to existing manholes shall be made so that finish work will conform as nearly as practicable to the applicable requirements specified for new manholes, including all necessary concrete work, cutting, and shaping. The connection shall be centered on the manhole. Holes for the new pipe shall be of sufficient diameter to allow packing cement mortar around the entire periphery of the pipe but no larger than 1.5 times the diameter of the pipe. Cutting the manhole shall be done in a manner that will cause the least damage to the walls.

3.6 BUILDING CONNECTIONS

Building connections shall include the lines to and connection with the building waste drainage piping at a point approximately 5 feet outside the building, unless otherwise indicated. Where building drain piping is not installed, the Contractor shall terminate the building connections approximately 5 feet from the site of the building at a point and in a manner designated.

3.7 CLEANOUTS AND OTHER APPURTENANCES

Cleanouts and other appurtenances shall be installed where shown on the drawings or as directed by the Contracting Officer, and shall conform to the detail of the drawings.

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SECTION 02556

GAS DISTRIBUTION SYSTEM

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN GAS ASSOCIATION (AGA)

AGA Manual	(1994; addenda/correction Jan 1996) A.G.A. Plastic Pipe Manual for Gas Service

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI B109.2	(2000) Diaphragm Type Gas Displacement Meters (500 Cubic Feet per Hour Capacity and Over)

AMERICAN PETROLEUM INSTITUTE (API)

API Spec 5L	(2000) Line Pipe
API Spec 6D	(1994; Supple 1 Jun 1996; Supple 2 Dec 1997) Pipeline Valves (Gate, Plug, Ball, and Check Valves)
API Std 1104	(1999) Welding of Pipeline and Related Facilities

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53/A 53M	(1999b) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 181/A 181M	(2000) Carbon Steel Forgings, for General-Purpose Piping
ASTM D 2513	(2000) Thermoplastic Gas Pressure Pipe, Tubing, and Fittings
ASTM D 2517	(2000) Reinforced Epoxy Resin Gas Pressure Pipe and Fittings
ASTM D 2683	(1998) Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
ASTM D 3261	(1997) Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing

ASTM D 3308	(1997) PTFE Resin-Skived Tape
ASTM D 3350	(1999) Polyethylene Plastics Pipe and Fittings Materials

ASME INTERNATIONAL (ASME)

ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch)
ASME B16.5	(1996; B16.5a) Pipe Flanges and Flanged Fittings NPS 1/2 thru NPS 24
ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings
ASME B16.11	(1996) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.34	(1997) Valves - Flanged, Threaded, and Welding End
ASME B16.40	(1985; R 1994) Manually Operated Thermoplastic Gas Shutoffs and Valves in Gas Distribution Systems
ASME B31.1	(2001) Power Piping
ASME B31.8	(1995) Gas Transmission and Distribution Piping Systems
ASME BPVC SEC VIII D1	(1998) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage
ASME BPVC SEC IX	(1998) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

49 CFR 192	Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(1998) Standard Marking System for Valves, Fittings, Flanges and Unions

NACE INTERNATIONAL (NACE)

NACE RP0185	(1996) Extruded, Polyolefin Resin Coating Systems with Soft Adhesives for Underground or Submerged Pipe

NACE RP0274	(1998) High Voltage Electrical Inspection of Pipeline Coatings Prior to Installation

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 25	(1991) Red Iron Oxide, Zinc Oxide, Raw Linseed Oil and Alkyd Primer (Without Lead and Chromate Pigments)
SSPC SP 1	(1982) Solvent Cleaning
SSPC SP 3	(1995) Power Tool Cleaning
SSPC SP 6	(1994) Commercial Blast Cleaning
SSPC SP 7	(1994) Brush-Off Blast Cleaning

UNDERWRITERS LABORATORIES (UL)

UL Gas&Oil Dir	(1999) Gas and Oil Equipment Directory

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Pipe, Fittings, and Associated Materials; GA

Drawings shall contain complete schematic and piping diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of the system and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

SD-03 Product Data

Materials and Equipment; GA

A complete list of equipment and materials, including manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions, including, but not limited to the following:

a. Dielectric Waterways and Flange Kits.

b. Meters.

c. Pressure Reducing Valves.

d. Regulators.

e. Emergency Gas Supply Connection.

Spare Parts Data; GA

Spare parts lists for each different item of material and equipment specified, after approval of the detail drawings and not later than one month prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

Connections to Existing Lines; GA

Notification of the Contractor's schedule for making connections to existing gas lines, at least 10 days in advance.

Welding Steel Piping; GA

A copy of qualified welding procedures along with a list of names and identification symbols of performance qualified welders and welding operators.

Jointing Polyethylene and Fiberglass Piping; GA

A copy of qualified jointing procedures, training procedures, qualifications of trainer, and training test results for joiners and inspectors.

Connection and Abandonment Plan; GA

A copy of procedures for gas line tie in, hot taps, abandonment/removal or demolition, purging, and plugging as applicable in accordance with ASME B31.8.

SD-06 Test Reports

Pressure and Leak Tests; GA

Data from all pressure tests of the distribution system.

SD-07 Certificates

Utility Work; GA

Certification from the Operating Agency/Utility Company that work for which the Utility is responsible has been completed.

Training; GA

A copy of each inspector's and jointer's training certificate with respective test results.

SD-10 Operation and Maintenance Data

Gas Distribution System; GA

Six copies, in booklet form and indexed, of site specific natural gas operation and maintenance manual for each gas distribution system including system operation, system maintenance, equipment operation, and equipment maintenance manuals described below. If operation and maintenance manuals are provided in a common volume, they shall be clearly differentiated

and separately indexed.

The System Operation Manual shall include but not be limited to the following:

a. Maps showing piping layout and locations of all system valves and gas line markers.

b. Step-by-step procedures required for system startup, operation, and shutdown. System components and equipment shall be indexed to the gas maps.

c. Isolation procedures and valve operations to shut down or isolate each section of the system. Valves and other system components shall be indexed to the gas maps.

d. Descriptions of Site Specific Standard Operation Procedures including permanent and temporary pipe repair procedures, system restart and test procedures for placing repaired lines back in service, and procedures for abandoning gas piping and system components.

e. Descriptions of Emergency Procedures including: isolation procedures including required valve operations with valve locations indexed to gas map, recommended emergency equipment, checklist for major emergencies and procedures for connecting emergency gas supply.

The Equipment Operation Manual shall include, but not be limited to, detail drawings, equipment data, and manufacturer supplied operation manuals for all equipment, valves and system components.

The System Maintenance Manuals shall include, but not be limited to:

a. Maintenance check list for entire gas distribution system.

b. Descriptions of site specific standard maintenance procedures.

c. Maintenance procedures for installed cathodic protection systems.

d. Piping layout, equipment layout, and control diagrams of the systems as installed.

e. Identification of pipe materials and manufacturer by location, pipe repair procedures, and jointing procedures at transitions to other piping materials or piping from different manufacturer.

The Equipment Maintenance Manuals shall include but not be limited to the following:

a. Identification of valves and other equipment by materials, manufacturer, vendor identification and location.

b. Maintenance procedures and recommended maintenance tool kits for all valves and equipment.

c. Recommended repair methods, either field repair, factory repair, or whole-item replacement for each valve component or piece of equipment or component item.

d. Routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide.

1.3 GENERAL REQUIREMENTS

1.3.1 Welding Steel Piping

Piping shall be welded in accordance with qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPVC IX or API Std 1104. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified at least 24 hours in advance of tests and the tests shall be performed at the work site if practicable. The Contracting Officer shall be furnished with a copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record.

1.3.2 Jointing Polyethylene and Fiberglass Piping

Piping shall be joined by performance qualified joiners using qualified procedures in accordance with AGA Manual. Manufacturer's prequalified joining procedures shall be used. Joints shall be inspected by an inspector qualified in the joining procedures being used and in accordance with AGA Manual. Joiners and inspectors shall be qualified at the jobsite by a person who has been trained and certified by the manufacturer of the pipe, to train and qualify joiners and inspectors in each joining procedure to be used on the job. Training shall include use of equipment, explanation of the procedure, and successfully making joints which pass tests specified in AGA Manual. The Contracting Officer shall be notified at least 24 hours in advance of the date to qualify joiners and inspectors. The Contractor shall provide the Contracting Officer a copy report of each inspector's and joiner's training and test results.

1.3.3 Standard Products

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Asbestos or products containing asbestos shall not be used. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site. Valves, flanges, and fittings shall be marked in accordance with MSS SP-25.

1.3.4 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

1.3.5 Handling

Pipe and components shall be handled carefully to ensure a sound, undamaged condition. Particular care shall be taken not to damage pipe coating. No pipe or material of any kind shall be placed inside another pipe or fitting after the coating has been applied, except as specified in paragraph INSTALLATION. Plastic pipe shall be handled in conformance with AGA Manual.

PART 2 PRODUCTS

2.1 PIPE, FITTINGS, AND ASSOCIATED MATERIALS

2.1.1 Steel Pipe

Steel pipe shall conform to ASTM A 53/A 53M, Grade A or B, Type E or S, Schedule 40; or API Spec 5L seamless or electric resistance welded, Schedule 40, black steel pipe as specified in ASME B31.8. Furnace buttwelded pipe may be used in sizes 1-1/2 inches and smaller.

2.1.2 Small Fittings

Fittings 1-1/2 inches and smaller shall conform to ASME B16.11.

2.1.3 Fittings, 2 Inches and Larger

Pipe flanges and flanged fittings including bolts, nuts, and bolt patterns shall be in accordance with ASME B16.5. Buttweld fittings shall be in accordance with ASME B16.9.

2.1.4 Steel Forged Branch Connections

Connections shall conform to ASTM A 181/A 181M, Class 60, carbon steel.

2.1.5 Flange Gaskets

Gaskets shall be non-asbestos compressed material in accordance with ASME B16.21, 1/16 inch minimum thickness, full face or self-centering flat ring type. The gaskets shall contain aramid fibers bonded with nitrile butadiene rubber (NBR), or glass fibers bonded with polytetrafluoroethylene, suitable for maximum 600 degrees F service and meeting applicable requirements of ASME B31.8.

2.1.6 Pipe Threads

Pipe threads shall conform to ASME B1.20.1.

2.1.7 Polyethylene Pipe, Tubing, Fittings and Joints

Polyethylene pipe, tubing, fittings and joints shall conform to ASTM D 3350 and ASTM D 2513, pipe designations PE 2406 and PE 3408, as specified in ASME B31.8. Pipe sections shall be marked as required by ASTM D 2513. Butt fittings shall conform to ASTM D 3261 and socket fittings shall conform to ASTM D 2683. Fittings shall match the service rating of the pipe.

2.1.8 Fiberglass Pipe, Fittings and Adhesive

Fiberglass pipe, fittings and adhesive shall conform to ASTM D 2517. Pipe sections shall be marked as required by ASTM D 2517.

2.1.9 Sealants for Steel Pipe Threaded Joints

2.1.9.1 Sealing Compound

Joint sealing compound shall be as listed in UL Gas&Oil Dir, Class 20 or less.

2.1.9.2 Tape

Polytetrafluoroethylene tape shall conform to ASTM D 3308.

2.1.10 Identification

Pipe flow markings and metal tags for each valve, meter, and regulator shall be provided as required by the Contracting Officer.

2.1.11 Insulating Joint Materials

Insulating joint materials shall be provided between flanged or threaded metallic pipe systems where shown to isolate galvanic or electrolytic action.

2.1.11.1 Threaded Joints

Joints for threaded pipe shall be steel body nut type, dielectric waterways with insulating gaskets.

2.1.11.2 Flanged Joints

Joints for flanged pipe shall consist of full face sandwich-type flange insulating gasket of the dielectric type, insulating sleeves for flange bolts and insulating washers for flange nuts.

2.1.12 Gas Transition Fittings

Gas transition fittings shall be manufactured steel fittings approved for jointing steel and polyethylene or fiberglass pipe. Approved transition fittings are those that conform to AGA Manual requirements for transition fittings.

2.2 VALVES

Valves shall be suitable for shutoff or isolation service and shall conform to the following:

2.2.1 Steel Valves

Steel valves 1-1/2 inches and smaller installed underground shall conform to ASME B16.34, carbon steel, socket weld ends, with square wrench operator adaptor. Steel valves 1-1/2 inches and smaller installed aboveground shall conform to ASME B16.34, carbon steel, socket weld or threaded ends with handwheel or wrench operator. Steel valves 2 inches and larger installed aboveground shall conform to API Spec 6D, carbon steel, buttweld or flanged ends with handwheel or wrench operator.

2.2.2 Polyethylene Valves

Polyethylene valves shall conform to ASME B16.40. Polyethylene valves, in sizes 1/2 inch to 6 inches, may be used with polyethylene distribution and service lines, in lieu of steel valves, for underground installation only.

2.3 PRESSURE REGULATORS

Regulators shall have ferrous bodies, shall provide backflow and vacuum protection, and shall be designed to meet the pressure, load and other service conditions.

2.3.1 Gas Main Regulators

Pressure regulators for main distribution lines, supplied from a source of gas which is at a higher pressure than the maximum allowable operating pressure for the system, and shall be equipped with pressure regulating devices of adequate capacity. In addition to the pressure regulating devices, a suitable method shall be provided to prevent overpressuring of the system in accordance with ASME B31.8. Suitable protective devices are as follows:

a. Spring-loaded relief valve meeting the provisions of ASME BPVC SEC VIII D1.

b. Pilot-loaded back pressure regulator used as relief valve, so designed that failure of the pilot system will cause the regulator to open.

c. Weight-loaded relief valves.

d. Monitoring regulator installed in series with the primary pressure regulator.

e. Series regulator installed upstream from the primary regulator, set to limit the pressure on the inlet of the primary regulator continuously to the maximum allowable operating pressure of the system, or less.

f. Automatic shutoff device installed in series with the primary regulator, set to shut off when the pressure on the distribution system reaches the maximum allowable operating pressure of the system, or less. This device shall remain closed until manually reset.

g. Spring-loaded, diaphragm type relief valves.

2.3.2 Service Line Regulators

Pressure regulators for individual service lines shall have ferrous bodies. Regulator shall be capable of reducing distribution line pressure to pressures required for users. Regulators shall be provided where gas will be distributed at pressures in excess of 10 inches of water column. Pressure relief shall be set at a lower pressure than would cause unsafe operation of any connected user. Regulators for liquified petroleum gas shall be adjusted to 10 to 12 inches of water column. Pressure relief for liquified petroleum gas shall be set at 16 inches of water column. Regulator shall have single port with orifice diameter no greater than that recommended by the manufacturer for the maximum gas pressure at the regulator inlet. Regulator valve vent shall be of resilient materials designed to withstand flow conditions when pressed against the valve port. Regulator shall be capable of regulating downstream pressure within limits of accuracy and shall be capable of limiting the buildup of pressure under no-flow conditions to 50 percent or less of the discharge pressure maintained under flow conditions. Regulator shall have a self contained service regulator. Regulator pipe connections shall not exceed 2 inch size.

2.4 METERS

Meters shall conform to ANSI B109.2. Meters shall be pipe mounted and be provided with a strainer immediately upstream. Meters shall be provided with over-pressure protection as specified in ASME B31.8. Meters shall be suitable for accurately measuring and handling gas at pressures, temperatures, and flow rates indicated. Meter shall be of manufacture type and model as approved by the supplier of natural gas.

2.5 PROTECTIVE COVERING MATERIALS

Continuously extruded polyethylene and adhesive coating system materials shall conform to NACE RP0185, Type A.

PART 3 EXECUTION

3.1 EXCAVATION AND BACKFILLING

Earthwork shall be as specified in Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.

3.2 GAS MAINS

Pipe for gas mains shall be steel polyethylene or fiberglass.

3.3 SERVICE LINES AND EMERGENCY GAS SUPPLY CONNECTION

Service lines shall be constructed of materials specified for gas mains and shall extend from a gas main to and including the point of delivery within 5 feet of the building. The point of delivery is the meter set assembly, service regulator and shutoff valve. The service lines shall be connected to the gas mains as indicated. Where indicated, service line shall be provided with an isolation valve of the same size as the service line. The service lines shall be as short and as straight as practicable between the point of delivery and the gas main and shall not be bent or curved laterally unless necessary to avoid obstructions or otherwise permitted. Service lines shall be laid with as few joints as practicable using standard lengths of pipe. Shorter lengths shall be used only for closures. Polyethylene or fiberglass service lines shall not be installed aboveground except as permitted in ASME B31.8.

3.4 WORKMANSHIP AND DEFECTS

Pipe, tubing, and fittings shall be clear and free of cutting burrs and defects in structure or threading and shall be thoroughly brushed and blown free of chips and scale. Defective pipe, tubing, or fittings shall be replaced and shall not be repaired.

3.5 PROTECTIVE COVERING

3.5.1 Protective Covering for Underground Steel Pipe

Except as otherwise specified, protective coverings shall be applied mechanically in a factory or field plant especially equipped for the purpose. Valves and fittings that cannot be coated and wrapped mechanically shall have the protective covering applied by hand, preferably at the plant that applies the covering to the pipe. Joints shall be coated and wrapped by hand. Hand coating and wrapping shall be done in a manner

and with materials that will produce a covering equal in thickness to that of the covering applied mechanically.

3.5.1.1 Thermoplastic Resin Coating System

The coating system shall conform to NACE RP0185, Type A. The exterior of the pipe shall be cleaned to a commercial grade blast cleaning finish in accordance with SSPC SP 6. Adhesive compound shall be applied to the pipe. Immediately after the adhesive is applied, a seamless tube of polyethylene shall be extruded over the adhesive to produce a bonded seamless coating. The nominal thickness of the pipe coating system shall be 10 mils (plus or minus 10 percent) of adhesive and 40 mils (plus or minus 10 percent) of polyethylene for pipes up to 16 inches in diameter. For pipes 18 inches and larger in diameter, the pipe coating system thickness shall be 10 mils (plus or minus 10 percent) adhesive and 60 mils (plus or minus 10 percent) polyethylene. Joint coating and field repair material shall be applied as recommended by the coating manufacturer and shall be one of the following:

a. Heat shrinkable polyethylene sleeves.

b. Polyvinyl chloride pressure-sensitive adhesive tape.

c. High density polyethylene/bituminous rubber compound tape.

The coating system shall be inspected for holes, voids, cracks, and other damage during installation.

3.5.1.2 Inspection of Pipe Coatings

Any damage to the protective covering during transit and handling shall be repaired before installation. After field coating and wrapping has been applied, the entire pipe shall be inspected by an electric holiday detector with impressed current set at a value in accordance with NACE RP0274 using a full-ring, spring-type coil electrode. The holiday detector shall be equipped with a bell, buzzer, or other type of audible signal which sounds when a holiday is detected. All holidays in the protective covering shall be repaired immediately upon detection. The Contracting Officer reserves the right to inspect and determine the suitability of the detector. Labor, materials, and equipment necessary for conducting the inspection shall be furnished by the Contractor.

3.5.2 Protective Covering for Aboveground Piping Systems

Finish painting shall conform to the applicable paragraphs of Section 09900 PAINTING, GENERAL and as follows:

3.5.2.1 Ferrous Surfaces

Shop primed surfaces shall be touched up with ferrous metal primer same type paint as the shop primer. Surfaces that have not been shop primed shall be solvent-cleaned in accordance with SSPC SP 1. Surfaces that contain loose rust, loose mill scale, and other foreign substances shall be mechanically cleaned by power wire brushing in accordance with SSPC SP 3 or brush-off blast cleaned in accordance with SSPC SP 7 and primed with ferrous metal primer in accordance with SSPC Paint 25. Primed surfaces shall be finished with two coats of exterior alkyd paint.

3.5.2.2 Nonferrous Surfaces

Nonferrous surfaces shall not be painted.

3.5.3 Protective Covering for Piping in Valve Boxes and Manholes

Piping in valve boxes or manholes shall receive protective coating as specified for underground steel pipe.

3.6 INSTALLATION

Gas distribution system and equipment shall be installed in conformance with the manufacturer's recommendations and applicable sections of ASME B31.8, AGA Manual and 49 CFR 192. Abandoning existing gas piping shall be done in accordance with ASME B31.8. Pipe shall be cut without damaging the pipe. Unless otherwise authorized, cutting shall be done by an approved type of mechanical cutter. Wheel cutters shall be used where practicable. On steel pipe 6 inches and larger, an approved gas-cutting-and-beveling machine may be used. Cutting of plastic pipe shall be in accordance with AGA Manual. Valve installation in plastic pipe shall be designed to protect the plastic pipe against excessive torsional or shearing loads when the valve is operated and from other stresses which may be exerted through the valve or valve box.

3.6.1 Installing Pipe Underground

Gas mains and service lines shall be graded as indicated. Joints in steel pipe shall be welded except as otherwise permitted for installation of valves. Mains shall have 24 inch minimum cover; service lines shall have 18 inch minimum cover; and both mains and service lines shall be placed on firmly compacted select material for the full length. Where indicated, the main shall be encased, bridged, or designed to withstand any anticipated external loads as specified in ASME B31.8. The encasement material shall be standard weight black steel pipe with a protective coating as specified. The pipe shall be separated from the casing by insulating spacers and sealed at the ends with casing bushings. Trench shall be excavated below pipe grade, bedded with bank sand, and compacted to provide full-length bearing. Laying the pipe on blocks to produce uniform grade will not be permitted. The pipe shall be clean inside before it is lowered into the trench and shall be kept free of water, soil, and all other foreign matter that might damage or obstruct the operation of the valves, regulators, meters, or other equipment. When work is not in progress, open ends of pipe or fittings shall be securely closed by expandable plugs or other suitable means. Minor changes in line or gradient of pipe that can be accomplished through the natural flexibility of the pipe material without producing permanent deformation and without overstressing joints may be made when approved. Changes in line or gradient that exceed the limitations specified shall be made with fittings. When cathodic protection is furnished, electrically insulated joints or flanges shall be provided. When polyethylene or fiberglass piping is installed underground, foil backed magnetic tape shall be placed above the pipe to permit locating with a magnetic detector. After laying of pipe and testing, trench shall be backfilled in accordance with Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITY SYSTEMS.

3.6.2 Installing Pipe Aboveground

Aboveground piping shall be protected against dirt and other foreign matter as specified for underground piping. Joints in steel pipe shall be welded; however, joints in pipe 1-1/2 inches in diameter and smaller may be threaded; joints may also be threaded to accommodate the installation of

valves. Flanges shall be of the weld neck type to match wall thickness of pipe.

3.7 PIPE JOINTS

Pipe joints shall be designed and installed to effectively sustain the longitudinal pullout forces caused by the contraction of piping or superimposed loads.

3.7.1 Threaded Steel Joints

Threaded joints in steel pipe shall have tapered threads evenly cut and shall be made with UL approved graphite joint sealing compound for gas service or polytetrafluoroethylene tape applied to the male threads only. Caulking of threaded joints to stop or prevent leaks will not be permitted.

3.7.2 Welded Steel Joints

Gas pipe weldments shall be as indicated. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connection may be made with either welding tees or forged branch outlet fittings. Branch outlet fittings shall be forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.8. Weld defects shall be removed and repairs made to the weld, or the weld joints shall be entirely removed and rewelded. After filler metal has been removed from its original package, it shall be protected or stored so that its characteristics or welding properties are not affected adversely. Electrodes that have been wetted or have lost any of their coating shall not be used.

3.7.3 Polyethylene and Fiberglass Pipe Jointing Procedures

Jointing procedures shall conform to AGA Manual. Indiscriminate heat fusion joining of plastic pipe or fittings made from different polyethylene resins by classification or by manufacturer shall be avoided if other alternative joining procedures are available. If heat fusion joining of dissimilar polyethylenes is required, special procedures are required. The method of heat fusion joining dissimilar polyethylene resins shall be tested in accordance with paragraph TESTS, subparagraph Destructive Tests of Plastic Pipe Joints.

3.7.4 Connections Between Metallic and Plastic Piping

Connections shall be made only outside, underground, and with approved transition fittings.

3.8 VALVE BOXES

Valve boxes of cast iron not less than 3/16 inch thick shall be installed at each underground valve except where concrete or other type of housing is indicated. Valve boxes shall be provided with locking covers that require a special wrench for removal. Wrench shall be furnished for each box. The word "gas" shall be cast in the box cover. When the valve is located in a roadway, the valve box shall be protected by a suitable concrete slab at least 3 square feet. When in a sidewalk, the top of the box shall be in a concrete slab 2 feet square and set flush with the sidewalk. Boxes shall be adjustable extension type with screw or slide-type adjustments. Valve

boxes shall be separately supported, not resting on the pipe, so that no traffic loads can be transmitted to the pipe. Valves shall only be located in valve boxes or inside of buildings.

3.9 PRESSURE REGULATOR INSTALLATION

3.9.1 Service Line Regulators

A shutoff valve, meter set assembly, and service regulator shall be installed on the service line outside the building, 18 inches above the ground on the riser. An insulating joint shall be installed on the inlet side of the meter set assembly and service regulator and shall be constructed to prevent flow of electrical current. A 3/8 inch tapped fitting equipped with a plug shall be provided on both sides of the service regulator for installation of pressure gauges for adjusting the regulator. All service regulator vents and relief vents shall terminate in the outside air in rain and insect resistant fittings. The open end of the vent shall be located where gas can escape freely into the atmosphere, away from any openings into the building and above areas subject to flooding.

3.10 METER INSTALLATION

Meters shall be installed in accordance with ASME B31.8. Permanent gas meters shall be installed with provisions for isolation and removal for calibration and maintenance, and shall be suitable for operation in conjunction with an energy monitoring and control system.

3.11 CONNECTIONS TO EXISTING LINES

Connections between new work and existing gas lines, where required, shall be made in accordance with ASME B31.8, using proper fittings to suit the actual conditions. When connections are made by tapping into a gas main, the connecting fittings shall be the same size as the pipe being connected.

3.11.1 Connections to Publicly or Privately Operated Gas Utility Lines

Contractor shall provide materials for the connections to the existing gas lines. Final connections and the turning on of gas shall be made by the utility. Existing lines that are to be a abandoned or taken out of service shall be disconnected, purged and capped, plugged or otherwise effectively sealed by the Utility. The Contractor shall notify the Contracting Officer, in writing, 10 days before final connections and turning on of gas lines. The Contractor shall make necessary arrangements with the Utility for tie in and activation of new gas lines. Only the Operating Agency/Utility Company may reactivate the system after tie in. The Contractor shall furnish a certification by the Operating Agency/Utility Company that all Utility work has been satisfactorily completed.

3.12 CATHODIC PROTECTION

Cathodic protection shall be provided for all metallic gas piping installed underground.

3.13 TESTS

3.13.1 Destructive Tests of Plastic Pipe Joints

Each day, prior to making polyethylene heat fusion joints or fiberglass adhesive joints, a joint of each size and type to be installed that day

shall be made by each person performing joining of plastic pipe that day and destructively tested. At least 3 longitudinal straps shall be cut from each joint. Each strap shall be visually examined, shall not contain voids or discontinuities on the cut surfaces of the joint area, and shall be deformed by bending, torque, or impact, and if failure occurs, it must not initiate in the joint area. If a joint fails the visual or deformation test, the qualified joiner who made that joint shall not make further field joints in plastic pipe on this job until that person has been retrained and requalified. The results of the destructive tests shall be recorded to include the date and time of the tests, size and type of the joints, ambient conditions, fusion iron temperature and names of inspectors and joiners.

3.13.2 Pressure and Leak Tests

The system of gas mains and service lines shall be tested after construction and before being placed in service using air as the test medium. The test pressure shall be 50 psig. However, the maximum test pressure shall not be more than three times the design pressure of the pipe. Prior to testing the system, the interior shall be blown out, cleaned and cleared of all foreign materials. All meters, regulators, and controls shall be removed before blowing out and cleaning and reinstalled after clearing of all foreign materials. Testing of gas mains and service lines shall be done with due regard for the safety of employees and the public during the test. Persons not working on the test operations shall be kept out of the testing area while testing is proceeding. The test shall be made on the system as a whole or on sections that can be isolated. Joints in sections shall be tested prior to backfilling when trenches must be backfilled before the completion of other pipeline sections. The test shall continue for at least 24 hours from the time of the initial readings to the final readings of pressure and temperature. The initial test readings of the instrument shall not be made for at least 1 hour after the pipe has been subjected to the full test pressure, and neither the initial nor final readings shall be made at times of rapid changes in atmospheric conditions. The temperatures shall be representative of the actual trench conditions. There shall be no indication of reduction of pressure during the test after corrections have been made for changes in atmospheric conditions in conformity with the relationship $T(1)P(2)=T(2)P(1)$, in which T and P denote absolute temperature and pressure, respectively, and the numbers denote initial and final readings. During the test, the entire system shall be completely isolated from all compressors and other sources of air pressure. Each joint shall be tested by means of soap and water or an equivalent nonflammable solution prior to backfilling or concealing any work. The testing instruments shall be approved by the Contracting Officer. All labor, materials and equipment for conducting the tests shall be furnished by the Contractor and shall be subject to inspection at all times during the tests. The Contractor shall maintain safety precautions for air pressure testing at all times during the tests.

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DIVISION 02 - SITE WORK

SECTION 02769

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SECTION 02769

PROTECTION AND MODIFICATION OF EXISTING UTILITIES

PART 1 GENERAL

1.1 SUMMARY

The work covered by this section consists of furnishing all plant, labor, equipment, materials and of performing all operations in connection with protection of existing utilities encountered and modification of existing utilities necessary due to the new work.

1.2 APPLICABLE PUBLICATIONS (Not Applicable)

1.3 PAYMENT

No separate payment will be made for work and materials covered in this section of the specifications unless otherwise specified.

1.4 PRIVATE UTILITIES AND PUBLIC AGENCIES

The following tabulation of utility owners and public agencies is provided for the convenience of the Contractor:

City of New Bedford
Department of Public Works
Engineering Division
Duarte Andrade
508-979-1527

City of New Bedford
Water Department
Cliff Souza
508-979-1556

City of New Bedford
Department of Public Works
Wastewater Division
Ron LaBelle
508-991-6158

NSTAR Gas
Harry Gerrard
800-232-1604
Ext. 5296

Verizon
Engineering
Paul Bourque
508-991-3530

NSTAR Electric
Michael Wall
508-441-5100

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 EXCAVATION FOR MODIFICATION OF UTILITIES

Except as otherwise specified, all excavation and backfilling required to perform the work in this Section shall be performed in accordance with Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS. In the State of Massachusetts, the Contractor is required to call Dig Safe, tel. no. 1-888-DIG-SAFE, prior to any excavation.

3.2 PROTECTION OF UTILITY LINES

Existing utility lines that are shown on the drawings, or the locations of which are made known to the Contractor prior to excavation, and that are to be retained, as well as utility lines constructed during excavation operations, shall be protected from damage during excavation and backfilling, and, if damaged, shall be satisfactorily repaired by the Contractor at no additional cost to the Government. Prior to commencement of excavation, the Contractor shall coordinate with the Contracting Officer to stake out exact locations of existing utilities and establish, in detail,the proposed method of protection of existing utilities. In the event that the Contractor damages any existing utility lines that are not shown on the drawings, or the locations of which are not known to the Contractor, report thereof shall be made immediately to the Contracting Officer. If the Contracting Officer determines that repairs shall be made by the Contractor, such repairs will be ordered under the Contract Clause entitled "DIFFERING SITE CONDITIONS."

3.3 REMOVAL OF UTILITY LINES

When utility lines that are to be removed, relocated, or supported are encountered within the area of operations, the Contracting Officer and utility company or owner shall be notified in ample time for the necessary measures to be taken to prevent interruption of the service.

3.4 STORM DRAINAGE

Prior to disruption of any existing storm drains, the Contractor shall make provisions for temporary bypass pumping, as appropriate, to relieve the storm drain system. The Contractor shall bypass pump during storm events as necessary to prevent any surcharge in the system.

3.5 ABANDONMENT OF EXISTING UTILITIES

Abandonment of existing utilities shall be as specified on the drawings. No separate payment will be made unless a lump sum item specifically identified on the bid schedule.

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DIVISION 03 - CONCRETE

SECTION 03100

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SECTION 03100

STRUCTURAL CONCRETE FORMWORK

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ACI INTERNATIONAL (ACI)

ACI 347R	(1994) Guide to Formwork for Concrete

AMERICAN HARDBOARD ASSOCIATION (AHA)

AHA ANSI/AHA A135.4	(1995) Basic Hardboard

DEPARTMENT OF COMMERCE (DOC)

DOC PS 1	(1996) Voluntary Product Standard - Construction and Industrial Plywood

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Formwork; GA

Drawings showing details of formwork, including dimensions of fiber voids, joints, supports, studding and shoring, and sequence of form and shoring removal.

Cast-in-Place Foundation; GA

Stamped structural calculations and foundation drawing of the building and all outside structures performed by the Contractor's structural engineer. The drawings will show the Pre-Engineered Building column lines/anchor bolt and baseplate setting plan coordinated with the concrete dimensions. Furnish foundation reactions in KIPS at all columns.

SD-03 Product Data

Design; GA

Design analysis and calculations for form design and methodology used in the design.

Form Materials; FIO

Manufacturer's data including literature describing form materials, accessories, and form releasing agents.

Form Releasing Agents; FIO

Manufacturer's recommendation on method and rate of application of form releasing agents.

1.3 DESIGN

Formwork shall be designed in accordance with methodology of ACI 347R for anticipated loads, lateral pressures, and stresses. Forms shall be capable of producing a surface which meets the requirements of the class of finish specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. Forms shall be capable of withstanding the pressures resulting from placement and vibration of concrete.

1.4 STORAGE AND HANDLING

Fiber voids shall be stored above ground level in a dry location. Fiber voids shall be kept dry until installed and overlaid with concrete.

PART 2 PRODUCTS

2.1 FORM MATERIALS

2.1.1 Forms For Class A and Class B Finish

Forms for Class A and Class B finished surfaces shall be plywood panels conforming to DOC PS 1, Grade B-B concrete form panels, Class I or II. Other form materials or liners may be used provided the smoothness and appearance of concrete produced will be equivalent to that produced by the plywood concrete form panels. Forms for round columns shall be the prefabricated seamless type.

2.1.2 Forms For Class C Finish

Forms for Class C finished surfaces shall be shiplap lumber; plywood conforming to DOC PS 1, Grade B-B concrete form panels, Class I or II; tempered concrete form hardboard conforming to AHA ANSI/AHA A135.4; other approved concrete form material; or steel, except that steel lining on wood sheathing shall not be used. Forms for round columns may have one vertical seam.

2.1.3 Forms For Class D Finish

Forms for Class D finished surfaces, except where concrete is placed against earth, shall be wood or steel or other approved concrete form material.

2.1.4 Form Ties

Form ties shall be factory-fabricated metal ties, shall be of the removable or internal disconnecting or snap-off type, and shall be of a design that will not permit form deflection and will not spall concrete upon removal. Solid backing shall be provided for each tie. Except where removable tie

rods are used, ties shall not leave holes in the concrete surface less than 1/4 inch nor more than 1 inch deep and not more than 1 inch in diameter.

2.1.5 Form Releasing Agents

Form releasing agents shall be commercial formulations that will not bond with, stain or adversely affect concrete surfaces. Agents shall not impair subsequent treatment of concrete surfaces depending upon bond or adhesion nor impede the wetting of surfaces to be cured with water or curing compounds.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Formwork

Forms shall be mortar tight, properly aligned and adequately supported to produce concrete surfaces meeting the surface requirements specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE and conforming to construction tolerance given in TABLE 1. Where concrete surfaces are to have a Class A or Class B finish, joints in form panels shall be arranged as approved. Where forms for continuous surfaces are placed in successive units, the forms shall fit over the completed surface to obtain accurate alignment of the surface and to prevent leakage of mortar. Forms shall not be reused if there is any evidence of surface wear and tear or defects which would impair the quality of the surface. Surfaces of forms to be reused shall be cleaned of mortar from previous concreting and of all other foreign material before reuse. Form ties that are to be completely withdrawn shall be coated with a nonstaining bond breaker.

3.2 CHAMFERING

Except as otherwise shown, external corners that will be exposed shall be chamfered, beveled, or rounded by moldings placed in the forms.

3.3 COATING

Forms for Class A and Class B finished surfaces shall be coated with a form releasing agent before the form or reinforcement is placed in final position. The coating shall be used as recommended in the manufacturer's printed or written instructions. Forms for Class C and D finished surfaces may be wet with water in lieu of coating immediately before placing concrete, except that in cold weather with probable freezing temperatures, coating shall be mandatory. Surplus coating on form surfaces and coating on reinforcing steel and construction joints shall be removed before placing concrete.

3.4 REMOVAL OF FORMS

Forms shall be removed preventing injury to the concrete and ensuring the complete safety of the structure. Formwork for columns, walls, side of beams and other parts not supporting the weight of concrete may be removed when the concrete has attained sufficient strength to resist damage from the removal operation but not before at least 72 hours has elapsed since concrete placement. Supporting forms and shores shall not be removed from beams, floors and walls until the structural units are strong enough to carry their own weight and any other construction or natural loads. Supporting forms or shores shall not be removed before the concrete

strength has reached 70 percent of design strength, as determined by field cured cylinders or other approved methods. This strength shall be demonstrated by job-cured test specimens, and by a structural analysis considering the proposed loads in relation to these test strengths and the strength of forming and shoring system. The job-cured test specimens for form removal purposes shall be provided in numbers as directed and shall be in addition to those required for concrete quality control. The specimens shall be removed from molds at the age of 24 hours and shall receive, insofar as possible, the same curing and protection as the structures they represent.

TABLE 1

TOLERANCES FOR FORMED SURFACES

1.	Variations from the plumb:	In any 10 feet of length ---------- 1/4 inch
	a. In the lines and surfaces of columns, piers, walls and in arises	Maximum for entire length ---------- 1 inch
	b. For exposed corner columns, control-joint grooves, and other conspicuous lines	In any 20 feet of length ---------- ---- 1/4 inch Maximum for entire length---------- 1/2 inch
2.	Variation from the level or from the grades indicated on the drawings:	In any 10 feet of length ----------1/4 inch In any bay or in any 20 feet of length---------- 3/8 inch
	a. In slab soffits, ceilings, beam soffits, and in arises, measured before removal of supporting shores	Maximum for entire length ---------- 3/4 inch
	b. In exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines	In any bay or in any 20 feet of length ---------- ----- 1/4 inch Maximum for entire length---------- 1/2 inch
3.	Variation of the linear building lines from established position in plan	In any 20 feet --------- 1/2 inch Maximum ----------1 inch
4.	Variation of distance between walls, columns, partitions	1/4 inch per 10 feet of distance, but not more than 1/2 inch in any one bay, and not more than 1 inch total variation
5.	Variation in the sizes and locations of sleeves, floor openings, and wall opening	Minus ---------- 1/4 inch Plus ---------- 1/2 inch
6.	Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls	Minus ---------- 1/4 inch Plus ---------- 1/2 inch
7.	Footings:	

a. Variation of dimensions in plan	Minus ---------- 1/2 inch Plus ---------- 2 inches when formed or plus 3 inches when placed against unformed excavation
b. Misplacement of eccentricity	2 percent of the footing width in the direction of misplacement but not more than 2 inches
c. Reduction in thickness of specified thickness	Minus ---------- 5 percent
8. Variation in steps:	Riser ---------- 1/8 inch
a. In a flight of stairs	Tread ---------- 1/4 inch
b. In consecutive steps	Riser ---------- 1/16 inch Tread ---------- 1/8 inch

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SECTION 03150

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EXPANSION JOINTS, CONTRACTION JOINTS, AND WATERSTOPS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 111	(1983) Inorganic Matter or Ash in Bituminous Materials

AMERICAN HARDBOARD ASSOCIATION (AHA)

AHA ANSI/AHA A135.4	(1995) Basic Hardboard

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 109	(1993) Steel, Strip, Carbon, Cold-Rolled
ASTM A 167	(1996) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 480/A 480M	(1996a) General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
ASTM A 570/A 570M	(1996) Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality
ASTM B 152	(1994) Copper Sheet, Strip, Plate, and Rolled Bar
ASTM B 370	(1992) Copper Sheet and Strip for Building Construction
ASTM C 919	(1984; R 1992) Use of Sealants in Acoustical Applications
ASTM C 920	(1995) Elastomeric Joint Sealants
ASTM D 4	(1986; R 1993) Bitumen Content
ASTM D 6	(1995) Loss on Heating of Oil and Asphaltic Compounds

ASTM D 412	(1997) Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension
ASTM D 471	(1996) Rubber Property - Effect of Liquids
ASTM D 1190	(1996) Concrete Joint Sealer, Hot-Applied Elastic Type
ASTM D 1191	(1984; R 1994) Test Methods for Concrete Joint Sealers
ASTM D 1751	(1983; R 1991) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(1984; R 1996) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D 1854	(1996) Specification for Jet-Fuel-Resistant Concrete Joint Sealer, Hot-Poured Elastic Type
ASTM D 1855	(1989) Test Method for Jet-Fuel Resistant Concrete Joint Sealer, Hot-Applied Elastic Type
ASTM D 2628	(1991) Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements
ASTM D 2835	(1989; R 1993) Lubricant for Installation of Preformed Compression Seals in Concrete Pavements
ASTM D 5249	(1995) Backer Material for Use With Cold and Hot-Applied Joint Sealants in Portland-Cement Concrete and Asphalt Joints

CORPS OF ENGINEERS (COE)

COE CRD-C 513	(1974) Corps of Engineers Specifications for Rubber Waterstops
COE CRD-C 572	(1974) Corps of Engineers Specifications for Polyvinylchloride Waterstop

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Waterstops; GA

Shop drawings and fabrication drawings provided by the manufacturer or prepared by the Contractor.

SD-03 Product Data

Preformed Expansion Joint Filler; GA
Sealant; GA
Waterstops; GA

Manufacturer's literature, including safety data sheets, for preformed fillers and the lubricants used in their installation; field-molded sealants and primers (when required by sealant manufacturer); preformed compression seals; and waterstops.

Manufacturer's recommended instructions for installing preformed fillers, field-molded sealants; preformed compression seals; and waterstops; and for splicing non-metallic waterstops.

SD-04 Samples

Lubricant for Preformed Compression Seals; GA

Specimens identified to indicate the manufacturer, type of material, size and quantity of material, and shipment or lot represented. Each sample shall be a piece not less than 9 ft of 1 inch nominal width or wider seal or a piece not less than 12 ft of compression seal less than 1 inch nominal width. One quart of lubricant shall be provided.

Field-Molded Type; GA

One gallon of field-molded sealant and one quart of primer (when primer is recommended by the sealant manufacturer) identified to indicate manufacturer, type of material, quantity, and shipment or lot represented.

Non-metallic Materials; GA

Specimens identified to indicate manufacturer, type of material, size, quantity of material, and shipment or lot represented. Each sample shall be a piece not less than 12 inches long cut from each 200 ft of finished waterstop furnished, but not less than a total of 4 ft of each type, size, and lot furnished. One splice sample of each size and type for every 50 splices made in the factory and every 10 splices made at the job site. The splice samples shall be made using straight run pieces with the splice located at the mid-length of the sample and finished as required for the installed waterstop. The total length of each splice shall be not less than 12 inches long.

SD-07 Certificates

Preformed Expansion Joint Filler; GA
Sealant; GA
Waterstops; GA

Certificates of compliance stating that the joint filler and sealant materials and waterstops conform to the requirements

specified.

1.3 DELIVERY AND STORAGE

Material delivered and placed in storage shall be stored off the ground and protected from moisture, dirt, and other contaminants. Sealants shall be delivered in the manufacturer's original unopened containers. Sealants whose shelf life has expired shall be removed from the site.

PART 2 PRODUCTS

2.1 CONTRACTION JOINT STRIPS

Contraction joint strips shall be 1/8 inch thick tempered hardboard conforming to AHA ANSI/AHA A135.4, Class 1. In lieu of hardboard strips, rigid polyvinylchloride (PVC) or high impact polystyrene (HIPS) insert strips specifically designed to induce controlled cracking in slabs on grade may be used. Such insert strips shall have removable top section.

2.2 PREFORMED EXPANSION JOINT FILLER

Expansion joint filler shall be preformed material conforming to ASTM D 1751 or ASTM D 1752. Unless otherwise indicated, filler material shall be 3/8 inch thick and of a width applicable for the joint formed. Backer material, when required, shall conform to ASTM D 5249.

2.3 SEALANT

Joint sealant shall conform to the following:

2.3.1 Preformed Polychloroprene Elastomeric Type

ASTM D 2628.

2.3.2 Lubricant for Preformed Compression Seals

ASTM D 2835.

2.3.3 Hot-Poured Type

ASTM D 1190 tested in accordance with ASTM D 1191.

2.3.4 Field-Molded Type

ASTM C 920, Type M for horizontal joints or Type NS for vertical joints, Class 25, and Use NT. Bond breaker material shall be polyethylene tape, coated paper, metal foil or similar type materials. The back-up material shall be compressible, non-shrink, nonreactive with sealant, and non-absorptive material type such as extruded butyl or polychloroprene rubber.

2.3.5 Hot-Applied Jet-Fuel Resistant Type

ASTM D 1854 tested in accordance with ASTM D 1855.

2.4 WATERSTOPS

Intersection and change of direction waterstops shall be shop fabricated.

2.4.1 Flexible Metal

Copper waterstops shall conform to ASTM B 152 and ASTM B 370, O60 soft anneal temper and 20 oz mass per sq ft sheet thickness. Stainless steel waterstops shall conform to ASTM A 167 and ASTM A 480/A 480M, UNS S30453 (Type 304L), and 20 gauge thick strip.

2.4.2 Rigid Metal

Flat steel waterstops shall conform to ASTM A 109, No. 2 (half hard) temper, No. 2 edge, No. 1 (matte or dull) finish or ASTM A 570/A 570M, Grade 40.

2.4.3 Non-Metallic Materials`

Non-metallic waterstops shall be manufactured from a prime virgin resin; reclaimed material is not acceptable. The compound shall contain plasticizers, stabilizers, and other additives to meet specified requirements. Rubber waterstops shall conform to COE CRD-C 513. Polyvinylchloride waterstops shall conform to COE CRD-C 572. Thermoplastic elastomeric rubber waterstops shall conform to ASTM D 471.

2.4.4 Non-Metallic Hydrophilic

Swellable strip type compound of polymer modified chloroprene rubber that swells upon contact with water shall conform to ASTM D 412 as follows: Tensile strength 420 psi minimum; ultimate elongation 600 percent minimum. Hardness shall be 50 minimum on the type A durometer and the volumetric expansion ratio in distilled water at 70 degrees F shall be 3 to 1 minimum.

2.4.5 Preformed Elastic Adhesive

Preformed plastic adhesive waterstops shall be produced from blends of refined hydrocarbon resins and plasticizing compounds reinforced with inert mineral filler, and shall contain no solvents, asbestos, irritating fumes or obnoxious odors. The compound shall not depend on oxidizing, evaporating, or chemical action for its adhesive or cohesive strength.

2.4.5.1 Chemical Composition

The chemical composition of the sealing compound shall meet the requirements shown below:

PERCENT BY WEIGHT

COMPONENT	MIN.	MAX.	TEST
Bitumen (Hydrocarbon plastic)	50	70	ASTM D 4
Inert Mineral Filler	30	50	AASHTO T 111
Volatile Matter		2	ASTM D 6

2.4.5.2 Adhesion Under Hydrostatic Pressure

The sealing compound shall not leak at the joints for a period of 24 hours under a vertical 6 foot head pressure. In a separate test, the sealing compound shall not leak under a horizontal pressure of 10 psi which is reached by slowly applying increments of 2 psi every minute.

2.4.5.3 Sag of Flow Resistance

Sagging shall not be detected when tested as follows: Fill a wooden form 1 inch wide and 6 inches long flush with sealing compound and place in an oven at 135 degrees F in a vertical position for 5 days.

2.4.5.4 Chemical Resistance

The sealing compound when immersed separately in a 5% solution of caustic potash, a 5% solution of hydrochloric acid, 5% solution of sulfuric acid and a saturated hydrogen sulfide solution for 30 days at ambient room temperature shall show no visible deterioration.

PART 3 EXECUTION

3.1 JOINTS

Joints shall be installed at locations indicated and as authorized.

3.1.1 Contraction Joints

Contraction joints may be constructed by inserting tempered hardboard strips or rigid PVC or HIPS insert strips into the plastic concrete using a steel parting bar, when necessary, or by cutting the concrete with a saw after concrete has set. Joints shall be approximately 1/8 inch wide and shall extend into the slab one-fourth the slab thickness, minimum, but not less than 1 inch.

3.1.1.1 Joint Strips

Strips shall be of the required dimensions and as long as practicable. After the first floating, the concrete shall be grooved with a tool at the joint locations. The strips shall be inserted in the groove and depressed until the top edge of the vertical surface is flush with the surface of the slab. The slab shall be floated and finished as specified. Working of the concrete adjacent to the joint shall be the minimum necessary to fill voids and consolidate the concrete. Where indicated, the top portion of the strip shall be sawed out after the curing period to form a recess for sealer. The removable section of PVC or HIPS strips shall be discarded and the insert left in place. True alignment of the strips shall be maintained during insertion.

3.1.1.2 Sawed Joints

Joint sawing shall be early enough to prevent uncontrolled cracking in the slab, but late enough that this can be accomplished without appreciable spalling. Concrete sawing machines shall be adequate in number and power, and with sufficient replacement blades to complete the sawing at the required rate. Joints shall be cut to true alignment and shall be cut in sequence of concrete placement. Sludge and cutting debris shall be removed.

3.1.2 Expansion Joints

Preformed expansion joint filler shall be used in expansion and isolation joints in slabs around columns and between slabs on grade and vertical surfaces where indicated. The filler shall extend the full slab depth, unless otherwise indicated. The edges of the joint shall be neatly finished with an edging tool of 1/8 inch radius, except where a resilient floor surface will be applied. Where the joint is to receive a sealant, the filler strips shall be installed at the proper level below the finished

floor with a slightly tapered, dressed and oiled wood strip temporarily secured to the top to form a recess to the size shown on the drawings. The wood strip shall be removed after the concrete has set. The Contractor may opt to use a removable expansion filler cap designed and fabricated for this purpose in lieu of the wood strip. The groove shall be thoroughly cleaned of laitance, curing compound, foreign materials, protrusions of hardened concrete, and any dust which shall be blown out of the groove with oil-free compressed air.

3.1.3 Joint Sealant

Sawed contraction joints and expansion joints in slabs shall be filled with joint sealant, unless otherwise shown. Joint surfaces shall be clean, dry, and free of oil or other foreign material which would adversely affect the bond between sealant and concrete. Joint sealant shall be applied as recommended by the manufacturer of the sealant.

3.1.3.1 Joints With Preformed Compression Seals

Compression seals shall be installed with equipment capable of installing joint seals to the prescribed depth without cutting, nicking, twisting, or otherwise distorting or damaging the seal or concrete and with no more than 5 percent stretching of the seal. The sides of the joint and, if necessary, the sides of the compression seal shall be covered with a coating of lubricant. Butt joints shall be coated with liberal applications of lubricant.

3.1.3.2 Joints With Field-Molded Sealant

Joints shall not be sealed when the sealant material, ambient air, or concrete temperature is less than 40 degrees F. When the sealants are meant to reduce the sound transmission characteristics of interior walls, ceilings, and floors the guidance provided in ASTM C 919 shall be followed. Joints requiring a bond breaker shall be coated with curing compound or with bituminous paint. Bond breaker and back-up material shall be installed where required. Joints shall be primed and filled flush with joint sealant in accordance with the manufacturer's recommendations.

3.2 WATERSTOPS, INSTALLATION AND SPLICES

Waterstops shall be installed at the locations shown to form a continuous water-tight diaphragm. Adequate provision shall be made to support and completely protect the waterstops during the progress of the work. Any waterstop punctured or damaged shall be repaired or replaced. Exposed waterstops shall be protected during application of form release agents to avoid being coated. Suitable guards shall be provided to protect exposed projecting edges and ends of partially embedded waterstops from damage when concrete placement has been discontinued. Splices shall be made by certified trained personnel using approved equipment and procedures.

3.2.1 Copper And Stainless Steel

Splices in copper waterstops shall be lap joints made by brazing. Splices in stainless steel waterstops shall be welded using a TIG or MIG process utilizing a weld rod to match the stainless. All welds shall not be annealed to maintain physical properties. Carbon flame shall not be used in the annealing process. Damaged waterstops shall be repaired by removing damaged portions and patching. Patches shall overlap a minimum of 1 inch onto undamaged portion of the waterstop.

3.2.2 Flat Steel

Splices in flat steel waterstops shall be properly aligned, butt welded, and cleaned of excessive material.

3.2.3 Non-Metallic

Fittings shall be shop made using a machine specifically designed to mechanically weld the waterstop. A miter guide, proper fixturing (profile dependant), and portable power saw shall be used to miter cut the ends to be joined to ensure good alignment and contact between joined surfaces. The splicing of straight lengths shall be done by squaring the ends to be joined. Continuity of the characteristic features of the cross section of the waterstop (ribs, tabular center axis, protrusions, etc.) shall be maintained across the splice.

3.2.3.1 Rubber Waterstop

Splices shall be vulcanized or shall be made using cold bond adhesive as recommended by the manufacturer. Splices for TPE-R shall be as specified for PVC.

3.2.3.2 Polyvinyl Chloride Waterstop

Splices shall be made by heat sealing the adjacent waterstop edges together using a thermoplastic splicing iron utilizing a non-stick surface specifically designed for waterstop welding. The correct temperature shall be used to sufficiently melt without charring the plastic. The spliced area, when cooled, shall show no signs of separation, holes, or other imperfections when bent by hand in as sharp an angle as possible.

3.2.3.3 Quality Assurance

Edge welding will not be permitted. Centerbulbs shall be compressed or closed when welding to non-centerbulb type. Waterstop splicing defects which are unacceptable include, but are not limited to the following: 1) Tensile strength less than 80 percent of parent section. 2) Free lap joints. 3) Misalignment of centerbulb, ribs, and end bulbs greater than 1/16 inch. 4) Misalignment which reduces waterstop cross section more than 15 percent. 5) Bond failure at joint deeper than 1/16 inch or 15 percent of material thickness. 6) Misalignment of waterstop splice resulting in misalignment of waterstop in excess of 1/2 inch in 10 feet. 7) Visible porosity in the weld area, including pin holes. 8) Charred or burnt material. 9) Bubbles or inadequate bonding. 10) Visible signs of splice separation when cooled splice is bent by hand at a sharp angle.

3.2.4 Non-Metallic Hydrophilic Waterstop Installation

Ends to be joined shall be miter cut with sharp knife or shears. The ends shall be adhered with cyanacryiate (super glue) adhesive. When joining hydrophilic type waterstop to PVC waterstop, the hydrophilic waterstop shall be positioned as shown on the drawings. A liberal amount of a single component hydrophilic sealant shall be applied to the junction to complete the transition.

3.3 CONSTRUCTION JOINTS

Construction joints are specified in Section 03300 CAST-IN-PLACE STRUCTURAL

CONCRETE except that construction joints coinciding with expansion and contraction joints shall be treated as expansion or contraction joints as applicable.

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SECTION 03200

CONCRETE REINFORCEMENT

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ACI INTERNATIONAL (ACI)

ACI 318/318R	(1995) Building Code Requirements for Structural Concrete and Commentary

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 184/A 184M	(1996) Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A 185	(1997) Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
ASTM A 497	(1997) Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement
ASTM A 615/A 615M	(1996a) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 675/A 675M	(1990a; R 1995e1) Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties

AMERICAN WELDING SOCIETY (AWS)

AWS D1.4	(1998) Structural Welding Code - Reinforcing Steel

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI MSP-1	(1996) Manual of Standard Practice

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Concrete Reinforcement System; GA.

Detail drawings showing reinforcing steel placement, schedules, sizes, grades, and splicing and bending details. Drawings shall show support details including types, sizes and spacing.

SD-07 Certificates

Reinforcing Steel; GA.

Certified copies of mill reports attesting that the reinforcing steel furnished contains no less than 25 percent recycled scrap steel and meets the requirements specified herein, prior to the installation of reinforcing steel.

1.3 DELIVERY AND STORAGE

Reinforcement and accessories shall be stored off the ground on platforms, skids, or other supports.

PART 2 PRODUCTS

2.1 DOWELS

Dowels if used shall conform to ASTM A 675/A 675M, Grade 80 or ASTM A 499.

2.2 FABRICATED BAR MATS

Fabricated bar mats shall conform to ASTM A 184/A 184M.

2.3 REINFORCING STEEL

Reinforcing steel shall be deformed bars conforming to ASTM A 615/A , grade 60

2.4 WELDED WIRE FABRIC

Welded wire fabric shall conform to ASTM A 185 or ASTM A 497.

2.5 WIRE TIES

Wire ties shall be 16 gauge or heavier black annealed steel wire.

2.6 SUPPORTS

Bar supports for formed surfaces shall be designed and fabricated in accordance with CRSI MSP-1 and shall be steel or precast concrete blocks. Precast concrete blocks shall have wire ties and shall be not less than 4 inches square when supporting reinforcement on ground. Precast concrete block shall have compressive strength equal to that of the surrounding concrete. Where concrete formed surfaces will be exposed to weather or where surfaces are to be painted, steel supports within 1/2 inch of concrete surface shall be galvanized, plastic protected or of stainless steel. Concrete supports used in concrete exposed to view shall have the same color and texture as the finish surface. For slabs on grade, supports shall be precast concrete blocks, plastic coated steel fabricated with bearing plates, or specifically designed wire-fabric supports fabricated of plastic.

PART 3 EXECUTION

3.1 REINFORCEMENT

Reinforcement shall be fabricated to shapes and dimensions shown and shall conform to the requirements of ACI 318/318R. Reinforcement shall be cold bent unless otherwise authorized. Bending shall be accomplished at the mill. Bars shall not be bent after embedment in concrete. Safety caps shall be placed on all exposed ends of vertical concrete reinforcement bars that pose a danger to life safety. Wire tie ends shall face away from the forms.

3.1.1 Placement

Reinforcement shall be free from loose rust and scale, dirt, oil, or other deleterious coating that could reduce bond with the concrete. Reinforcement shall be placed in accordance with ACI 318/318R at locations shown plus or minus one bar diameter. Reinforcement shall not be continuous through expansion joints and shall be as indicated through construction or contraction joints. Concrete coverage shall be as indicated or as required by ACI 318/318R. If bars are moved more than one bar diameter to avoid interference with other reinforcement, conduits or embedded items, the resulting arrangement of bars, including additional bars required to meet structural requirements, shall be approved before concrete is placed.

3.1.2 Splicing

Splices of reinforcement shall conform to ACI 318/318R and shall be made only as required or indicated. Splicing shall be by lapping. Lap splices shall not be used for bars larger than No. 11 unless otherwise indicated. Welding shall conform to AWS D1.4. Welded butt splices shall be full penetration butt welds. Lapped bars shall be placed in contact and securely tied or spaced transversely apart to permit the embedment of the entire surface of each bar in concrete. Lapped bars shall not be spaced farther apart than one-fifth the required length of lap or 6 inches. Mechanical butt splices shall not be permitted unless approved by the Contracting Officer.

3.2 WELDED-WIRE FABRIC PLACEMENT

Welded-wire fabric shall be placed in slabs as indicated. Fabric placed in slabs on grade shall be continuous between expansion, construction, and contraction joints. Fabric placement at joints shall be as indicated. Lap splices shall be made in such a way that the overlapped area equals the distance between the outermost crosswires plus 2 inches. Laps shall be staggered to avoid continuous laps in either direction. Fabric shall be wired or clipped together at laps at intervals not to exceed 4 feet. Fabric shall be positioned by the use of supports.

3.3 DOWEL INSTALLATION

Dowels, if used, shall be installed in slabs on grade at locations indicated and at right angles to joint being doweled. Dowels shall be accurately positioned and aligned parallel to the finished concrete surface before concrete placement. Dowels shall be rigidly supported during concrete placement. One end of dowels shall be coated with a bond breaker.

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DIVISION 03 - CONCRETE

SECTION 03300

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SECTION 03300

CAST-IN-PLACE STRUCTURAL CONCRETE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ACI INTERNATIONAL (ACI)

ACI 117/117R	(1990; Errata) Standard Tolerances for Concrete Construction and Materials
ACI 211.1	(1991) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 214.3R	(1988; R 1997) Simplified Version of the Recommended Practice for Evaluation of Strength Test Results of Concrete
ACI 223	(1998) Standard Practice for the Use of Shrinkage-Compensating Concrete
ACI 301	(1999) Standard Specifications for Structural Concrete
ACI 305R	(1999) Hot Weather Concreting
ACI 318/318R	(1999) Building Code Requirements for Structural Concrete and Commentary
ACI 350/350R	(2001) Code Requirements for Environmental Engineering Concrete Structures

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182	(1991; R 1996) Burlap Cloth Made from Jute or Kenaf

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 1017/C 1017M	(1998) Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C 1059	(1999) Latex Agents for Bonding Fresh to Hardened Concrete
ASTM C 1064/C 1064M	(1999) Temperature of Freshly Mixed Portland Cement Concrete

ASTM C 1077	(1998) Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM C 1107	(1999) Packaged Dry, Hydraulic-Cement Grout(Nonshrink)
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM C 143/C 143M	(2000) Slump of Hydraulic Cement Concrete
ASTM C 150	(1999a) Portland Cement
ASTM C 171	(1997a) Sheet Materials for Curing Concrete
ASTM C 172	(1999) Sampling Freshly Mixed Concrete
ASTM C 173	(1994ael) Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C 192/C 192M	(2000) Making and Curing Concrete Test Specimens in the Laboratory
ASTM C 231	(1997el) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	(2000) Air-Entraining Admixtures for Concrete
ASTM C 309	(1998a) Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 31/C 31M	(2000el) Making and Curing Concrete Test Specimens in the Field
ASTM C 33	(1999ael) Concrete Aggregates
ASTM C 39/C 39M	(2001) Compressive Strength of Cylindrical Concrete Specimens
ASTM C 42/C 42M	(1999) Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C 494/C 494M	(1999ael) Chemical Admixtures for Concrete
ASTM C 552	(2000) Cellular Glass Thermal Insulation
ASTM C 578	(1995) Rigid, Cellular Polystyrene Thermal Insulation
ASTM C 591	(1994) Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C 595	(2000a) Blended Hydraulic Cements
ASTM C 78	(1994) Flexural Strength of Concrete (Using Simple Beam With Third-Point

	Loading)
ASTM C 845	(1996) Standard Specification for Expansive Hydraulic Cement
ASTM C 881	(1999) Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C 937	(1997) Grout Fluidifier for Preplaced-Aggregate Concrete
ASTM C 94/C 94M	(2000e2) Ready-Mixed Concrete
ASTM C 940	(1998a) Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory
ASTM D 1751	(1999) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(1984; R 1996el) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D 75	(1987; R 1997) Sampling Aggregates
ASTM E 96	(2000) Water Vapor Transmission of Materials

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 44	(1997) NIST Handbook 44: Specifications, Tolerances, and other Technical Requirements for Weighing and Measuring Devices

NATIONAL READY-MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA CPMB 100	(1996) Concrete Plant Standards
NRMCA QC 3	(1984) Quality Control Manual: Section 3, Plant Certifications Checklist: Certification of Ready Mixed Concrete Production Facilities
NRMCA TMMB 100	(2001) Truck Mixer Agitator and Front Discharge Concrete Carrier Standards

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 104	(1980) Method of Calculation of the Fineness Modulus of Aggregate
COE CRD-C 400	(1963) Requirements for Water for Use in Mixing or Curing Concrete
COE CRD-C 521	(1981) Standard Test Method for Frequency

	and Amplitude of Vibrators for Concrete
COE CRD-C 540	(1971; R 1981) Standard Specification for Nonbituminous Inserts for Contraction Joints in Portland Cement Concrete Airfield Pavements, Sawable Type
COE CRD-C 572	(1974) Corps of Engineers Specifications for Polyvinylchloride Waterstop
COE CRD-C 94	(1995) Surface Retarders

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Mixture Proportions; GA

The results of trial mixture design studies along with a statement giving the maximum nominal coarse aggregate size and the proportions of ingredients that will be used in the manufacture of each strength or class of concrete, at least 14 days prior to commencing concrete placing operations. Aggregate weights shall be based on the saturated surface dry condition. The statement shall be accompanied by test results from an approved independent commercial testing laboratory, showing that mixture design studies have been made with materials proposed for the project and that the proportions selected will produce concrete of the qualities indicated. No substitutions shall be made in the materials used in the mixture design studies without additional tests to show that the quality of the concrete is satisfactory.

SD-04 Samples

Surface Retarder; GA,

Sample of surface retarder material with manufacturer's instructions for application in conjunction with air-water cutting.

SD-06 Test Reports

Testing and Inspection for Contractor Quality Control; GA

Certified copies of laboratory test reports, including mill tests and all other test data, for portland cement, blended cement, pozzolan, ground granulated blast furnace slag, silica fume, aggregate, admixtures, and curing compound proposed for use on this project.

SD-07 Certificates

Qualifications; GA

Written documentation for Contractor Quality Control personnel.

1.3 QUALIFICATIONS

Contractor Quality Control personnel assigned to concrete construction shall be American Concrete Institute (ACI) Certified Workmen in one of the following grades or shall have written evidence of having completed similar qualification programs:

Concrete Field Testing Technician, Grade I
Concrete Laboratory Testing Technician, Grade I or II
Concrete Construction Inspector, Level II

Concrete Transportation Construction Inspector or Reinforced Concrete Special Inspector, Jointly certified by American Concrete Institute (ACI), Building Official and Code Administrators International (BOCA), International Conference of Building Officials (ICBO), and Southern Building Code Congress International (SBCCI).

The foreman or lead journeyman of the flatwork finishing crew shall have similar qualification for ACI Concrete Flatwork Technician/Finisher or equal, with written documentation.

1.4 SPECIAL REQUIREMENTS

A pre-installation meeting with the Contracting Officer will be required at least 10 days prior to start of construction of the water treatment plant foundation. The Contractor shall be responsible for calling the meeting; the Project Superintendent and active installation personnel shall be present.

1.5 GENERAL REQUIREMENTS

1.5.1 Tolerances

Except as otherwise specified herein, tolerances for concrete batching, mixture properties, and construction as well as definition of terms and application practices shall be in accordance with ACI 117/117R. Level and grade tolerance measurements of slabs shall be made as soon as possible after finishing; when forms or shoring are used, the measurements shall be made prior to removal. Dimensional tolerances shall be in conformance with Section 03100 STRUCTURAL CONCRETE FORMWORK.

1.5.2 Strength Requirements and w/c Ratio

1.5.2.1 Strength Requirements

Structural concrete for all work shall have a 28-day compressive strength of at least 4000 psi.

Concrete slabs on-grade shall have a 28-day flexural strength of 550 psi. Compressive strength shall be determined in accordance with ASTM C 39/C 39M. Flexural strength shall be determined in accordance with ASTM C 78.

a. Evaluation of Concrete Compressive Strength. Compressive strength specimens (6 by 12 inch cylinders) shall be fabricated by the Contractor and laboratory cured in accordance with ASTM C 31/C 31M and tested in accordance with ASTM C 39/C 39M. The strength of

the concrete will be considered satisfactory so long as the average of all sets of three consecutive test results equals or exceeds the specified compressive strength f'c and no individual test result falls below the specified strength f'c by more than 500 psi. A "test" is defined as the average of two companion cylinders, or if only one cylinder is tested, the results of the single cylinder test. Additional analysis or testing, including taking cores and/or load tests may be required at the Contractor's expense when the strength of the concrete in the structure is considered potentially deficient.

b. Investigation of Low-Strength Compressive Test Results. When any strength test of standard-cured test cylinders falls below the specified strength requirement by more than 500 psi or if tests of field-cured cylinders indicate deficiencies in protection and curing, steps shall be taken to assure that the load-carrying capacity of the structure is not jeopardized. When the strength of concrete in place is considered potentially deficient, cores shall be obtained and tested in accordance with ASTM C 42/C 42M. At least three representative cores shall be taken from each member or area of concrete in place that is considered potentially deficient. The location of cores will be determined by the Contracting Officer to least impair the strength of the structure. Concrete in the area represented by the core testing will be considered adequate if the average strength of the cores is equal to at least 85 percent of the specified strength requirement and if no single core is less than 75 percent of the specified strength requirement. Non-destructive tests (tests other than test cylinders or cores) shall not be used as a basis for acceptance or rejection. The Contractor shall perform the coring and repair the holes. Cores will be tested by the Government.

c. Load Tests. If the core tests are inconclusive or impractical to obtain or if structural analysis does not confirm the safety of the structure, load tests may be directed by the Contracting Officer in accordance with the requirements of ACI 318/318R (ACI 350/350R for sump structure). Concrete work evaluated by structural analysis or by results of a load test as being understrength shall be corrected in a manner satisfactory to the Contracting Officer. All investigations, testing, load tests, and correction of deficiencies shall be performed by and at the expense of the Contractor and must be approved by the Contracting Officer, except that if all concrete is found to be in compliance with the drawings and specifications, the cost of investigations, testing, and load tests will be at the expense of the Government.

d. *Evaluation of Concrete* Flexural Strength. Flexural strength specimens (beams) shall be fabricated by the Contractor and laboratory cured in accordance with ASTM C 31/C 31M and tested in accordance with ASTM C 78. The strength of the concrete will be considered satisfactory so long as the average of all sets of three consecutive test results equals or exceeds the specified flexural strength and no individual test result falls below the specified flexural strength by more than 50 psi.A "test" is defined as the average of two companion beams. Additional analysis or testing, including taking cores and/or load tests may be required at the Contractor's expense when the strength of the concrete in the slab is considered potentially deficient.

1.5.2.2 Water-Cement Ratio

Maximum water-cement ratio (w/c) shall be submitted to the Contracting Officer for approval.

1.5.3 Air Entrainment

Except as otherwise specified for lightweight concrete, all normal weight concrete shall be air entrained to contain between 4 and 7 percent total air, except that when the nominal maximum size coarse aggregate is 3/4 inch or smaller it shall be between 4.5 and 7.5 percent. Specified air content shall be attained at point of placement into the forms. Air content for normal weight concrete shall be determined in accordance with ASTM C 231.

1.5.4 Slump

Slump of the concrete, as delivered to the point of placement into the forms, shall be within the following limits. Slump shall be determined in accordance with ASTM C 143/C 143M.

Structural Element	Slump Minimum	Slump Maximum
Walls, columns and beams	2 in.	4 in.
Foundation walls, substructure walls, footings, slabs	1 in.	3 in.
Any structural concrete approved for placement by pumping:		
At pump	2 in.	6 in.
At discharge of line	1 in.	4 in.

1.5.5 Concrete Temperature

The temperature of the concrete as delivered shall not exceed 90 degrees F. When the ambient temperature during placing is 40 degrees F or less, or is expected to be at any time within 6 hours after placing, the temperature of the concrete as delivered shall be between 55 and 75 degrees F.

1.5.6 Size of Coarse Aggregate

The largest feasible nominal maximum size aggregate (NMSA) specified in paragraph AGGREGATES shall be used in each placement. However, nominal maximum size of aggregate shall not exceed any of the following: three-fourths of the minimum cover for reinforcing bars, three-fourths of the minimum clear spacing between reinforcing bars, one-fifth of the narrowest dimension between sides of forms, or one-third of the thickness of slabs or toppings.

1.5.7 Special Properties and Products

Concrete may contain admixtures other than air entraining agents, such as water reducers, superplasticizers, or set retarding agents to provide special properties to the concrete, if specified or approved. Any of these materials to be used on the project shall be used in the mix design studies.

1.6 MIXTURE PROPORTIONS

Concrete shall be composed of portland cement, other cementitious and pozzolanic materials as specified, aggregates, water and admixtures as specified.

1.6.1 Proportioning Studies for Normal Weight Concrete

Trial design batches, mixture proportioning studies, and testing requirements for various classes and types of concrete specified shall be the responsibility of the Contractor. Except as specified for flexural strength concrete, mixture proportions shall be based on compressive strength as determined by test specimens fabricated in accordance with ASTM C 192/C 192M and tested in accordance with ASTM C 39/C 39M. Samples of all materials used in mixture proportioning studies shall be representative of those proposed for use in the project and shall be accompanied by the manufacturer's or producer's test reports indicating compliance with these specifications. Trial mixtures having proportions, consistencies, and air content suitable for the work shall be made based on methodology described in ACI 211.1, using at least three different water-cement ratios for each type of mixture, which will produce a range of strength encompassing those required for each class and type of concrete required on the project. The maximum water-cement ratios required in subparagraph Water-Cement Ratio will be the equivalent water-cement ratio as determined by conversion from the weight ratio of water to cement plus pozzolan, silica fume, and ground granulated blast furnace slag (GGBF slag) by the weight equivalency method as described in ACI 211.1. In the case where silica fume or GGBF slag is used, the weight of the silica fume and GGBF slag shall be included in the equations in ACI 211.1 for the term P, which is used to denote the weight of pozzolan. If pozzolan is used in the concrete mixture, the minimum pozzolan content shall be 15 percent by weight of the total cementitious material, and the maximum shall be 35 percent. Laboratory trial mixtures shall be designed for maximum permitted slump and air content. Separate sets of trial mixture studies shall be made for each combination of cementitious materials and each combination of admixtures proposed for use. No combination of either shall be used until proven by such studies, except that, if approved in writing and otherwise permitted by these specifications, an accelerator or a retarder may be used without separate trial mixture study. Separate trial mixture studies shall also be made for concrete for any conveying or placing method proposed which requires special properties and for concrete to be placed in unusually difficult placing locations. The temperature of concrete in each trial batch shall be reported. For each water-cement ratio, at least three test cylinders for each test age shall be made and cured in accordance with ASTM C 192/C 192M. They shall be tested at 7 and 28 days in accordance with ASTM C 39/C 39M. From these test results, a curve shall be plotted showing the relationship between water-cement ratio and strength for each set of trial mix studies. In addition, a curve shall be plotted showing the relationship between 7 day and 28 day strengths. Each mixture shall be designed to promote easy and suitable concrete placement, consolidation and finishing, and to prevent segregation and excessive bleeding.

1.6.2 Average Compressive Strength Required for Mixtures

The mixture proportions selected during mixture design studies shall produce a required average compressive strength (f'cr) exceeding the specified compressive strength (f'c) by the amount indicated below. This required average compressive strength, f'cr, will not be a required

acceptance criteria during concrete production. However, whenever the daily average compressive strength at 28 days drops below f'cr during concrete production, or daily average 7-day strength drops below a strength correlated with the 28-day f'cr, the mixture shall be adjusted, as approved, to bring the daily average back up to f'cr. During production, the required f'cr shall be adjusted, as appropriate, based on the standard deviation being attained on the job.

1.6.2.1 Computations from Test Records

Where a concrete production facility has test records, a standard deviation shall be established in accordance with the applicable provisions of ACI 214.3R. Test records from which a standard deviation is calculated shall represent materials, quality control procedures, and conditions similar to those expected; shall represent concrete produced to meet a specified strength or strengths (f'c) within 1,000 psi of that specified for proposed work; and shall consist of at least 30 consecutive tests. A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days. Required average compressive strength f'cr used as the basis for selection of concrete proportions shall be the larger of the equations that follow using the standard deviation as determined above:

f'cr = f'c + 1.34S where units are in psi

f'cr = f'c + 2.33S - 500 where units are in psi

Where S = standard deviation

Where a concrete production facility does not have test records meeting the requirements above but does have a record based on 15 to 29 consecutive tests, a standard deviation shall be established as the product of the calculated standard deviation and a modification factor from the following table:

NUMBER OF TESTS	MODIFICATION FACTOR FOR STANDARD DEVIATION
15	1.16
20	1.08
25	1.03
30 or more	1.00

1.6.2.2 Computations without Previous Test Records

When a concrete production facility does not have sufficient field strength test records for calculation of the standard deviation, the required average strength f'cr shall be determined as follows:

a. If the specified compressive strength f'c is less than 3,000 psi,

f'cr = f'c + 1000 psi

b. If the specified compressive strength f'c is 3,000 to 5,000 psi,

f'cr = f'c + 1,200 psi

c. If the specified compressive strength f'c is over 5,000 psi,

$f'cr = f'c + 1,400$ psi

1.6.3 Average Flexural Strength Required for Mixtures

The mixture proportions selected during mixture design studies for flexural strength mixtures and the mixture used during concrete production shall be designed and adjusted during concrete production as approved, except that the overdesign for average flexural strength shall simply be 15 percent greater than the specified flexural strength at all times.

1.7 STORAGE OF MATERIALS

Cement and other cementitious materials shall be stored in weathertight buildings, bins, or silos which will exclude moisture and contaminants and keep each material completely separated. Aggregate stockpiles shall be arranged and used in a manner to avoid excessive segregation and to prevent contamination with other materials or with other sizes of aggregates. Aggregate shall not be stored directly on ground unless a sacrificial layer is left undisturbed. Reinforcing bars and accessories shall be stored above the ground on platforms, skids or other supports. Other materials shall be stored in such a manner as to avoid contamination and deterioration. Admixtures which have been in storage at the project site for longer than 6 months or which have been subjected to freezing shall not be used unless retested and proven to meet the specified requirements. Materials shall be capable of being accurately identified after bundles or containers are opened.

1.8 GOVERNMENT ASSURANCE INSPECTION AND TESTING

Day-to day inspection and testing shall be the responsibility of the Contractor Quality Control (CQC) staff. However, representatives of the Contracting Officer can and will inspect construction as considered appropriate and will monitor operations of the Contractor's CQC staff. Government inspection or testing will not relieve the Contractor of any of his CQC responsibilities.

1.8.1 Materials

The Contracting Officer will sample and test aggregates, cementitious materials, other materials, and concrete to determine compliance with the specifications as considered appropriate. The Contractor shall provide facilities and labor as may be necessary for procurement of representative test samples. Samples of aggregates will be obtained at the point of batching in accordance with ASTM D 75. Other materials will be sampled from storage at the jobsite or from other locations as considered appropriate. Samples may be placed in storage for later testing when appropriate.

1.8.2 Fresh Concrete

Fresh concrete will be sampled as delivered in accordance with ASTM C 172 and tested in accordance with these specifications, as considered necessary.

1.8.3 Hardened Concrete

Tests on hardened concrete will be performed by the Contracting Officer when such tests are considered necessary.

1.8.4 Inspection

Concrete operations may be tested and inspected by the Contracting Officer as the project progresses. Failure to detect defective work or material will not prevent rejection later when a defect is discovered nor will it obligate the Contracting Officer for final acceptance.

PART 2 PRODUCTS

2.1 CEMENTITIOUS MATERIALS

Cement shall conform to one of the following. Only one type and brand of each type of cement will be permitted in any one structure.

a. Portland cement conforming to ASTM C 150, Types IA, IIA, or IIIA.

b. Blended cement conforming to ASTM C 595, Types IA(PM), IA(SM), or IPA.

c. Expansive hydraulic cement conforming to ASTM C 845, Type E-IKA.

Refer to ACI 223 for the use of Type E-IKA cement. Type E-IKA cement compatibility with specified admixtures should be carefully checked.

2.2 AGGREGATES

Aggregates shall conform to the following.

2.2.1 Fine Aggregate

Fine aggregate shall conform to the quality and gradation requirements of ASTM C 33.

2.2.2 Coarse Aggregate

Coarse aggregate shall conform to ASTM C 33, Class 5S, size designation 57.

2.3 CHEMICAL ADMIXTURES

Chemical admixtures, when required or permitted, shall conform to the appropriate specification listed. Admixtures shall be furnished in liquid form and of suitable concentration for easy, accurate control of dispensing.

2.3.1 Air-Entraining Admixture

ASTM C 260 and shall consistently entrain the air content in the specified ranges under field conditions.

2.3.2 Accelerating Admixture

ASTM C 494/C 494M, Type C or E, except that calcium chloride or admixtures containing calcium chloride shall not be used.

2.3.3 Water-Reducing or Retarding Admixture

ASTM C 494/C 494M, Type A, B, or D, except that the 6-month and 1-year compressive and flexural strength tests are waived.

2.3.4 High-Range Water Reducer

ASTM C 494/C 494M, Type F or G, except that the 6-month and 1-year strength requirements are waived. The admixture shall be used only when approved in writing, such approval being contingent upon particular mixture control as described in the Contractor's Quality Control Plan and upon performance of separate mixture design studies.

2.3.5 Surface Retarder

COE CRD-C 94.

2.3.6 Expanding Admixture

Aluminum powder type expanding admixture conforming to ASTM C 937.

2.3.7 Other Chemical Admixtures

Chemical admixtures for use in producing flowing concrete shall comply with ASTM C 1017/C 1017M, Type I or II. These admixtures shall be used only when approved in writing, such approval being contingent upon particular mixture control as described in the Contractor's Quality Control Plan and upon performance of separate mixture design studies.

2.4 CURING MATERIALS

2.4.1 Impervious-Sheet

Impervious-sheet materials shall conform to ASTM C 171, type optional, except, that polyethylene sheet shall not be used.

2.4.2 Membrane-Forming Compound

Membrane-Forming curing compound shall conform to ASTM C 309, Type 1-D or 2, except that only a styrene acrylate or chlorinated rubber compound meeting Class B requirements shall be used for surfaces that are to be painted or are to receive bituminous roofing, or waterproofing, or floors that are to receive adhesive applications of resilient flooring. The curing compound selected shall be compatible with any subsequent paint, roofing, waterproofing, or flooring specified. Nonpigmented compound shall contain a fugitive dye, and shall have the reflective requirements in ASTM C 309 waived.

2.4.3 Burlap and Cotton Mat

Burlap and cotton mat used for curing shall conform to AASHTO M 182.

2.5 WATER

Water for mixing and curing shall be fresh, clean, potable, and free of injurious amounts of oil, acid, salt, or alkali, except that non-potable water may be used if it meets the requirements of COE CRD-C 400.

2.6 NONSHRINK GROUT

Nonshrink grout shall conform to ASTM C 1107 and shall be a commercial formulation suitable for the proposed application.

2.7 NONSLIP SURFACING MATERIAL

Nonslip surfacing material shall consist of 55 percent, minimum, aluminum

oxide or silicon-dioxide abrasive ceramically bonded together to form a homogeneous material sufficiently porous to provide a good bond with portland cement paste; or factory-graded emery aggregate consisting of not less than 45 percent aluminum oxide and 25 percent ferric oxide. The aggregate shall be well graded from particles retained on the No. 30 sieve to particles passing the No. 8 sieve.

2.8 LATEX BONDING AGENT

Latex agents for bonding fresh to hardened concrete shall conform to ASTM C 1059.

2.9 EPOXY RESIN

Epoxy resins for use in repairs shall conform to ASTM C 881, Type V, Grade 2. Class as appropriate to the existing ambient and surface temperatures.

2.10 EMBEDDED ITEMS

Embedded items shall be of the size and type indicated or as needed for the application. Dovetail slots shall be galvanized steel. Hangers for suspended ceilings shall be as specified. Inserts for shelf angles and bolt hangers shall be of malleable iron or cast or w ought steel.

2.11 FLOOR HARDENER

Floor hardener shall be a colorless aqueous solution containing zinc silicofluoride, magnesium silicofluoride, or sodium silicofluoride. These silicofluorides can be used individually or in combination. Proprietary hardeners may be used if approved in writing by the Contracting Officer.

2.12 PERIMETER INSULATION

Perimeter insulation shall be polystyrene conforming to ASTM C 578, Type II; polyurethane conforming to ASTM C 591, Type II; or cellular glass conforming to ASTM C 552, Type I or IV.

2.13 VAPOR BARRIER

Vapor barrier shall be polyethylene sheeting with a minimum thickness of 10 mils or other equivalent material having a vapor permeance rating not exceeding 0.5 perms as determined in accordance with ASTM E 96.

2.14 JOINT MATERIALS

2.14.1 Joint Fillers, Sealers, and Waterstops

Expansion joint fillers shall be preformed materials conforming to ASTM D 1751 or ASTM D 1752. Materials for waterstops shall be in accordance with Section 03150 EXPANSION JOINTS, CONTRACTION JOINTS, AND WATERSTOPS. Materials for and sealing of joints shall conform to the requirements of Section 07900 JOINT SEALING.

2.14.2 Contraction Joints in Slabs

Sawable type contraction joint inserts shall conform to COE CRD-C 540. Nonsawable joint inserts shall have sufficient stiffness to permit placement in plastic concrete without undue deviation from a straight line and shall conform to the physical requirements of COE CRD-C 540, with the

exception of Section 3.4 "Resistance to Sawing". Plastic inserts shall be polyvinyl chloride conforming to the materials requirements of COE CRD-C 572.

PART 3 EXECUTION

3.1 PREPARATION FOR PLACING

Before commencing concrete placement, the following shall be performed. Surfaces to receive concrete shall be clean and free from frost, ice, mud, and water. Forms shall be in place, cleaned, coated, and adequately supported, in accordance with Section 03100 STRUCTURAL CONCRETE FORMWORK. Reinforcing steel shall be in place, cleaned, tied, and adequately supported, in accordance with Section 03200 CONCRETE REINFORCEMENT. Transporting and conveying equipment shall be in-place, ready for use, clean, and free of hardened concrete and foreign material. Equipment for consolidating concrete shall be at the placing site and in proper working order. Equipment and material for curing and for protecting concrete from weather or mechanical damage shall be at the placing site, in proper working condition and in sufficient amount for the entire placement. When hot, windy conditions during concreting appear probable, equipment and material shall be at the placing site to provide windbreaks, shading, fogging, or other action to prevent plastic shrinkage cracking or other damaging drying of the concrete.

3.1.1 Foundations

3.1.1.1 Concrete on Earth Foundations

Earth (subgrade, base, or subbase courses) surfaces upon which concrete is to be placed shall be clean, damp, and free from debris, frost, ice, and standing or running water. Prior to placement of concrete, the foundation shall be well drained and shall be satisfactorily graded and uniformly compacted.

3.1.1.2 Excavated Surfaces in Lieu of Forms

Concrete for footings and walls may be placed directly against the soil provided the earth or rock has been carefully trimmed, is uniform and stable, and meets the compaction requirements of Section 02315 EXCAVATION, FILLING, AND BACKFILLING FOR STRUCTURES. The concrete shall be placed without becoming contaminated by loose material, and the outline of the concrete shall be within the specified tolerances.

3.1.2 Previously Placed Concrete

Concrete surfaces to which additional concrete is to be bonded shall be prepared for receiving the next horizontal lift by cleaning the construction joint surface with either air-water cutting, sandblasting, high-pressure water jet, or other approved method. Concrete at the side of vertical construction joints shall be prepared as approved by the Contracting Officer. Air-water cutting shall not be used on formed surfaces or surfaces congested with reinforcing steel. Regardless of the method used, the resulting surfaces shall be free from all laitance and inferior concrete so that clean surfaces of well bonded coarse aggregate are exposed and make up at least 10-percent of the surface area, distributed uniformly throughout the surface. The edges of the coarse aggregate shall not be undercut. The surface of horizontal construction joints shall be kept continuously wet for the first 12 hours during the 24-hour period prior to placing fresh concrete. The surface shall be

washed completely clean as the last operation prior to placing the next lift. For heavy duty floors and two-course floors a thin coat of neat cement grout of about the consistency of thick cream shall be thoroughly scrubbed into the existing surface immediately ahead of the topping placing. The grout shall be a 1:1 mixture of portland cement and sand passing the No. 8 sieve. The topping concrete shall be deposited before the grout coat has had time to stiffen.

3.1.2.1 Air-Water Cutting

Air-water cutting of a fresh concrete surface shall be performed at the proper time and only on horizontal construction joints. The air pressure used in the jet shall be 100 psi plus or minus, 10 psi, and the water pressure shall be just sufficient to bring the water into effective influence of the air pressure. When approved by the Contracting Officer, a surface retarder complying with the requirements of COE CRD-C 94 may be applied to the surface of the lift in order to prolong the period of time during which air-water cutting is effective. After cutting, the surface shall be washed and rinsed as long as there is any trace of cloudiness of the wash water. Where necessary to remove accumulated laitance, coatings, stains, debris, and other foreign material, high-pressure waterjet or sandblasting shall be used as the last operation before placing the next lift.

3.1.2.2 High-Pressure Water Jet

A stream of water under a pressure of not less than 3,000 psi shall be used for cutting and cleaning. Its use shall be delayed until the concrete is sufficiently hard so that only the surface skin or mortar is removed and there is no undercutting of coarse-aggregate particles. If the waterjet is incapable of a satisfactory cleaning, the surface shall be cleaned by sandblasting.

3.1.2.3 Wet Sandblasting

Wet sandblasting shall be used after the concrete has reached sufficient strength to prevent undercutting of the coarse aggregate particles. After wet sandblasting, the surface of the concrete shall then be washed thoroughly to remove all loose materials.

3.1.2.4 Waste Disposal

The method used in disposing of waste water employed in cutting, washing, and rinsing of concrete surfaces shall be such that the waste water does not stain, discolor, or affect exposed surfaces of the structures, or damage the environment of the project area. The method of disposal shall be subject to approval.

3.1.2.5 Preparation of Previously Placed Concrete

Concrete surfaces to which other concrete is to be bonded shall be abraded in an approved manner that will expose sound aggregate uniformly without damaging the concrete. Laitance and loose particles shall be removed. Surfaces shall be thoroughly washed and shall be moist but without free water when concrete is placed.

3.1.3 Vapor Barrier

Vapor barrier shall be provided beneath the interior on-grade concrete

floor slabs. The greatest widths and lengths practicable shall be used to eliminate joints wherever possible. Joints shall be lapped a minimum of 12 inches. Torn, punctured, or damaged vapor barrier material shall be removed and new vapor barrier shall be provided prior to placing concrete. For minor repairs, patches may be made using laps of at least 12 inches. Lapped joints shall be sealed and edges patched with pressure-sensitive adhesive or tape not less than 2 inches wide and compatible with the membrane. Vapor barrier shall be placed directly on underlying subgrade, base course, or capillary water barrier, unless it consists of crushed material or large granular material which could puncture the vapor barrier. In this case, the surface shall be choked with a light layer of sand, as approved, before placing the vapor barrier. A 3 inch minimum layer of compacted, clean concrete sand (fine granular material) shall be placed on top of the vapor barrier before placing concrete. Concrete placement shall be controlled so as to prevent damage to the vapor barrier, or any covering sand.

3.1.4 Perimeter Insulation

Perimeter insulation shall be installed at locations indicated. Adhesive shall be used where insulation is applied to the interior surface of foundation walls and may be used for exterior application.

3.1.5 Embedded Items

Before placement of concrete, care shall be taken to determine that all embedded items are firmly and securely fastened in place as indicated on the drawings, or required. Conduit and other embedded items shall be clean and free of oil and other foreign matter such as loose coatings or rust, paint, and scale. The embedding of wood in concrete will be permitted only when specifically authorized or directed. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable materials to prevent the entry of concrete into voids. Welding shall not be performed on embedded metals within 1 feet of the surface of the concrete. Tack welding shall not be performed on or to embedded items.

3.2 CONCRETE PRODUCTION

3.2.1 Batching, Mixing, and Transporting Concrete

Concrete shall be furnished from a ready-mixed concrete plant. Ready-mixed concrete shall be batched, mixed, and transported in accordance with ASTM C 94/C 94M, except as otherwise specified. Truck mixers, agitators, and nonagitating transporting units shall comply with NRMCA TMMB 100. Ready-mix plant equipment and facilities shall be certified in accordance with NRMCA QC 3. Approved batch tickets shall be furnished for each load of ready-mixed concrete. Site-mixed concrete shall conform to the following subparagraphs.

3.2.1.1 General

The batching plant shall be located off site close to the project. The batching, mixing and placing system shall have a capacity of at least 30 cubic yards per hour. The batching plant shall conform to the requirements of NRMCA CPMB 100 and as specified; however, rating plates attached to batch plant equipment are not required.

3.2.1.2 Batching Equipment

The batching controls shall be semiautomatic or automatic, as defined in NRMCA CPMB 100. A semiautomatic batching system shall be provided with interlocks such that the discharge device cannot be actuated until the indicated material is within the applicable tolerance. The batching system shall be equipped with accurate recorder or recorders that meet the requirements of NRMCA CPMB 100. The weight of water and admixtures shall be recorded if batched by weight. Separate bins or compartments shall be provided for each size group of aggregate and type of cementitious material, to prevent intermingling at any time. Aggregates shall be weighed either in separate weigh batchers with individual scales or, provided the smallest size is batched first, cumulatively in one weigh batcher on one scale. Aggregate shall not be weighed in the same batcher with cementitious material. Water may be measured by weight or volume. Water shall not be weighed or measured cumulatively with another ingredient. Filling and discharging valves for the water metering or batching system shall be so interlocked that the discharge valve cannot be opened before the filling valve is fully closed. Piping for water and for admixtures shall be free from leaks and shall be properly valved to prevent backflow or siphoning. Admixtures shall be furnished as a liquid of suitable concentration for easy control of dispensing. An adjustable, accurate, mechanical device for measuring and dispensing each admixture shall be provided. Each admixture dispenser shall be interlocked with the batching and discharging operation of the water so that each admixture is separately batched and individually discharged automatically in a manner to obtain uniform distribution throughout the water as it is added to the batch in the specified mixing period. When use of truck mixers makes this requirement impractical, the admixture dispensers shall be interlocked with the sand batchers. Different admixtures shall not be combined prior to introduction in water and shall not be allowed to intermingle until in contact with the cement. Admixture dispensers shall have suitable devices to detect and indicate flow during dispensing or have a means for visual observation. The plant shall be arranged so as to facilitate the inspection of all operations at all times. Suitable facilities shall be provided for obtaining representative samples of aggregates from each bin or compartment, and for sampling and calibrating the dispensing of cementitious material, water, and admixtures. Filling ports for cementitious materials bins or silos shall be clearly marked with a permanent sign stating the contents.

3.2.1.3 Scales

The weighing equipment shall conform to the applicable requirements of CPMB Concrete Plant Standard, and of NIST HB 44, except that the accuracy shall be plus or minus 0.2 percent of scale capacity. The Contractor shall provide standard test weights and any other auxiliary equipment required for checking the operating performance of each scale or other measuring devices. The tests shall be made at the specified frequency in the presence of the Contracting Officer. The weighing equipment shall be arranged so that the plant operator can conveniently observe all dials or indicators.

3.2.1.4 Batching Tolerances

(A) Tolerances with Weighing Equipment

MATERIAL	PERCENT OF REQUIRED WEIGHT
Cementitious materials	0 to plus 2

MATERIAL	PERCENT OF REQUIRED WEIGHT
Aggregate	plus or minus 2
Water	plus or minus 1
Chemical admixture	0 to plus 6

(B) Tolerances with Volumetric Equipment

For volumetric batching equipment used for water and admixtures, the following tolerances shall apply to the required volume of material being batched:

MATERIAL	PERCENT OF REQUIRED MATERIAL
Water:	plus or minus 1 percent
Chemical admixtures:	0 to plus 6 percent

3.2.1.5 Moisture Control

The plant shall be capable of ready adjustment to compensate for the varying moisture content of the aggregates and to change the weights of the materials being batched.

3.2.1.6 Concrete Mixers

Mixers shall be stationary mixers or truck mixers. Mixers shall be capable of combining the materials into a uniform mixture and of discharging this mixture without segregation. The mixers shall not be charged in excess of the capacity recommended by the manufacturer. The mixers shall be operated at the drum or mixing blade speed designated by the manufacturer. The mixers shall be maintained in satisfactory operating condition, and the mixer drums shall be kept free of hardened concrete. Should any mixer at any time produce unsatisfactory results, its use shall be promptly discontinued until it is repaired.

3.2.1.7 Stationary Mixers

Concrete plant mixers shall be drum-type mixers of tilting, nontilting, horizontal-shaft, or vertical-shaft type, or shall be pug mill type and shall be provided with an acceptable device to lock the discharge mechanism until the required mixing time has elapsed. The mixing time and uniformity shall conform to all the requirements in ASTM C 94/C 94M applicable to central-mixed concrete.

3.2.1.8 Truck Mixers

Truck mixers, the mixing of concrete therein, and concrete uniformity shall conform to the requirements of ASTM C 94/C 94M. A truck mixer may be used either for complete mixing (transit-mixed) or to finish the partial mixing done in a stationary mixer (shrink-mixed). Each truck shall be equipped with two counters from which it is possible to determine the number of revolutions at mixing speed and the number of revolutions at agitating speed. Water shall not be added at the placing site unless specifically approved; and in no case shall it exceed the specified w/c. Any such water shall be injected at the base of the mixer, not at the discharge end.

3.3 CONCRETE PRODUCTION, SMALL PROJECTS

Batch-type equipment shall be used for producing concrete. Ready-mixed concrete shall be batched, mixed, and transported in accordance with ASTM C 94/C 94M, except as otherwise specified. Truck mixers, agitators, and nonagitating transporting units shall comply with NRMCA TMMB 100. Ready-mix plant equipment and facilities shall be certified in accordance with NRMCA QC 3. Approved batch tickets shall be furnished for each load of ready-mixed concrete. Site-mixed concrete shall be produced in accordance with ACI 301, and plant shall conform to NRMCA CPMB 100.

3.4 TRANSPORTING CONCRETE TO PROJECT SITE

Concrete shall be transported to the placing site in truck mixers, agitators, nonagitating transporting equipment conforming to NRMCA TMMB 100 or by approved pumping equipment or conveyors.

3.5 CONVEYING CONCRETE ON SITE

Concrete shall be conveyed from mixer or transporting unit to forms as rapidly as possible and within the time interval specified by methods which will prevent segregation or loss of ingredients using following equipment. Conveying equipment shall be cleaned before each placement.

3.5.1 Buckets

The interior hopper slope shall be not less than 58 degrees from the horizontal, the minimum dimension of the clear gate opening shall be at least 5 times the nominal maximum-size aggregate, and the area of the gate opening shall not be less than 2 square feet. The maximum dimension of the gate opening shall not be greater than twice the minimum dimension. The bucket gates shall be essentially grout tight when closed and may be manually, pneumatically, or hydraulically operated except that buckets larger than 2 cubic yards shall not be manually operated. The design of the bucket shall provide means for positive regulation of the amount and rate of deposit of concrete in each dumping position.

3.5.2 Transfer Hoppers

Concrete may be charged into nonagitating hoppers for transfer to other conveying devices. Transfer hoppers shall be capable of receiving concrete directly from delivery vehicles and shall have conical-shaped discharge features. The transfer hopper shall be equipped with a hydraulically operated gate and with a means of external vibration to effect complete discharge. Concrete shall not be held in nonagitating transfer hoppers more than 30 minutes.

3.5.3 Trucks

Truck mixers operating at agitating speed or truck agitators used for transporting plant-mixed concrete shall conform to the requirements of ASTM C 94/C 94M. Nonagitating equipment shall be used only for transporting plant-mixed concrete over a smooth road and when the hauling time is less than 15 minutes. Bodies of nonagitating equipment shall be smooth, watertight, metal containers specifically designed to transport concrete, shaped with rounded corners to minimize segregation, and equipped with gates that will permit positive control of the discharge of the concrete.

3.5.4 Chutes

When concrete can be placed directly from a truck mixer, agitator, or

nonagitating equipment, the chutes normally attached to this equipment by the manufacturer may be used. A discharge deflector shall be used when required by the Contracting Officer. Separate chutes and other similar equipment will not be permitted for conveying concrete.

3.5.5 Belt Conveyors

Belt conveyors shall be designed and operated to assure a uniform flow of concrete from mixer to final place of deposit without segregation of ingredients or loss of mortar and shall be provided with positive means, such as discharge baffle or hopper, for preventing segregation of the concrete at the transfer points and the point of placing. Belt conveyors shall be constructed such that the idler spacing shall not exceed 36 inches. The belt speed shall be a minimum of 300 feet per minute and a maximum of 750 feet per minute. If concrete is to be placed through installed horizontal or sloping reinforcing bars, the conveyor shall discharge concrete into a pipe or elephant truck that is long enough to extend through the reinforcing bars.

3.5.6 Concrete Pumps

Concrete may be conveyed by positive displacement pump when approved. The pumping equipment shall be piston or squeeze pressure type; pneumatic placing equipment shall not be used. The pipeline shall be rigid steel pipe or heavy-duty flexible hose. The inside diameter of the pipe shall be at least 3 times the nominal maximum-size coarse aggregate in the concrete mixture to be pumped but not less than 4 inches. Aluminum pipe shall not be used.

3.6 PLACING CONCRETE

Mixed concrete shall be discharged within 1-1/2 hours or before the mixer drum has revolved 300 revolutions, whichever comes first after the introduction of the mixing water to the cement and aggregates. When the concrete temperature exceeds 85 degrees F, the time shall be reduced to 45 minutes. Concrete shall be placed within 15 minutes after it has been discharged from the transporting unit. Concrete shall be handled from mixer or transporting unit to forms in a continuous manner until the approved unit of operation is completed. Adequate scaffolding, ramps and walkways shall be provided so that personnel and equipment are not supported by in-place reinforcement. Placing will not be permitted when the sun, heat, wind, or limitations of facilities furnished by the Contractor prevent proper consolidation, finishing and curing. Sufficient placing capacity shall be provided so that concrete can be kept free of cold joints.

3.6.1 Depositing Concrete

Concrete shall be deposited as close as possible to its final position in the forms, and there shall be no vertical drop greater than 5 feet except where suitable equipment is provided to prevent segregation and where specifically authorized. Depositing of the concrete shall be so regulated that it will be effectively consolidated in horizontal layers not more than 12 inches thick, except that all slabs shall be placed in a single layer. Concrete to receive other construction shall be screeded to the proper level. Concrete shall be deposited continuously in one layer or in layers so that fresh concrete is deposited on in-place concrete that is still plastic. Fresh concrete shall not be deposited on concrete that has hardened sufficiently to cause formation of seams or planes of weakness

within the section. Concrete that has surface dried, partially hardened, or contains foreign material shall not be used. When temporary spreaders are used in the forms, the spreaders shall be removed as their service becomes unnecessary. Concrete shall not be placed in slabs over columns and walls until concrete in columns and walls has been in-place at least two hours or until the concrete begins to lose its plasticity. Concrete for beams, girders, brackets, column capitals, haunches, and drop panels shall be placed at the same time as concrete for adjoining slabs.

3.6.2 Consolidation

Immediately after placing, each layer of concrete shall be consolidated by internal vibrators, except for slabs 4 inches thick or less. The vibrators shall at all times be adequate in effectiveness and number to properly consolidate the concrete; a spare vibrator shall be kept at the jobsite during all concrete placing operations. The vibrators shall have a frequency of not less than 10,000 vibrations per minute, an amplitude of at least 0.025 inch, and the head diameter shall be appropriate for the structural member and the concrete mixture being placed. Vibrators shall be inserted vertically at uniform spacing over the area of placement. The distance between insertions shall be approximately 1-1/2 times the radius of action of the vibrator so that the area being vibrated will overlap the adjacent just-vibrated area by a reasonable amount. The vibrator shall penetrate rapidly to the bottom of the layer and at least 6 inches into the preceding layer if there is such. Vibrator shall be held stationary until the concrete is consolidated and then vertically withdrawn slowly while operating. Form vibrators shall not be used unless specifically approved and unless forms are constructed to withstand their use. Vibrators shall not be used to move concrete within the forms. Slabs 4 inches and less in thickness shall be consolidated by properly designed vibrating screeds or other approved technique. Excessive vibration of lightweight concrete resulting in segration or flotation of coarse aggregate shall be prevented. Frequency and amplitude of vibrators shall be determined in accordance with COE CRD-C 521. Grate tampers ("jitterbugs") shall not be used.

3.6.3 Cold Weather Requirements

Special protection measures, approved by the Contracting Officer, shall be used if freezing temperatures are anticipated before the expiration of the specified curing period. The ambient temperature of the air where concrete is to be placed and the temperature of surfaces to receive concrete shall be not less than 40 degrees F. The temperature of the concrete when placed shall be not less than 50 degrees F nor more than 75 degrees F. Heating of the mixing water or aggregates will be required to regulate the concrete placing temperature. Materials entering the mixer shall be free from ice, snow, or frozen lumps. Salt, chemicals or other materials shall not be incorporated in the concrete to prevent freezing. Upon written approval, an accelerating admixture conforming to ASTM C 494/C 494M, Type C or E may be used, provided it contains no calcium chloride. Calcium chloride shall not be used.

3.6.4 Hot Weather Requirements

When the ambient temperature during concrete placing is expected to exceed 85 degrees F, the concrete shall be placed and finished with procedures previously submitted and as specified herein. The concrete temperature at time of delivery to the forms shall not exceed the temperature shown in the table below when measured in accordance with ASTM C 1064/C 1064M. Cooling of the mixing water or aggregates or placing concrete in the cooler part of

the day may be required to obtain an adequate placing temperature. A retarder may be used, as approved, to facilitate placing and finishing. Steel forms and reinforcements shall be cooled as approved prior to concrete placement when steel temperatures are greater than 120 degrees F. Conveying and placing equipment shall be cooled if necessary to maintain proper concrete-placing temperature.

Maximum Allowable Concrete Placing Temperature

Relative Humidity, Percent, During Time of Concrete Placement	Maximum Allowable Concrete Temperature Degrees
Greater than 60	90 F
40-60	85 F
Less than 40	80 F

3.6.5 Prevention of Plastic Shrinkage Cracking

During hot weather with low humidity, and particularly with appreciable wind, as well as interior placements when space heaters produce low humidity, the Contractor shall be alert to the tendency for plastic shrinkage cracks to develop and shall institute measures to prevent this. Particular care shall be taken if plastic shrinkage cracking is potentially imminent and especially if it has developed during a previous placement. Periods of high potential for plastic shrinkage cracking can be anticipated by use of Fig. 2.1.5 of ACI 305R. In addition the concrete placement shall be further protected by erecting shades and windbreaks and by applying fog sprays of water, sprinkling, ponding or wet covering. Plastic shrinkage cracks that occur shall be filled by injection of epoxy resin as directed, after the concrete hardens. Plastic shrinkage cracks shall never be troweled over or filled with slurry.

3.6.6 Placing Concrete in Congested Areas

Special care shall be used to ensure complete filling of the forms, elimination of all voids, and complete consolidation of the concrete when placing concrete in areas congested with reinforcing bars, embedded items, waterstops and other tight spacing. An appropriate concrete mixture shall be used, and the nominal maximum size of aggregate (NMSA) shall meet the specified criteria when evaluated for the congested area. Vibrators with heads of a size appropriate for the clearances available shall be used, and the consolidation operation shall be closely supervised to ensure complete and thorough consolidation at all points. Where necessary, splices of reinforcing bars shall be alternated to reduce congestion. Where two mats of closely spaced reinforcing are required, the bars in each mat shall be placed in matching alignment to reduce congestion. Reinforcing bars may be temporarily crowded to one side during concrete placement provided they are returned to exact required location before concrete placement and consolidation are completed.

3.6.7 Placing Flowable Concrete

If a plasticizing admixture conforming to ASTM C 1017/C 1017M is used or if a Type F or G high range water reducing admixture is permitted to increase the slump, the concrete shall meet all requirements of paragraph GENERAL REQUIREMENTS in PART 1. Extreme care shall be used in conveying and

placing the concrete to avoid segregation. Consolidation and finishing shall meet all requirements of paragraphs Placing Concrete, Finishing Formed Surfaces, and Finishing Unformed Surfaces. No relaxation of requirements to accommodate flowable concrete will be permitted.

3.7 JOINTS

Joints shall be located and constructed as indicated or approved. Joints not indicated on the drawings shall be located and constructed to minimize the impact on the strength of the structure. In general, such joints shall be located near the middle of the spans of supported slabs, beams, and girders unless a beam intersects a girder at this point, in which case the joint in the girder shall be offset a distance equal to twice the width of the beam. Joints in walls and columns shall be at the underside of floors, slabs, beams, or girders and at the tops of footings or floor slabs, unless otherwise approved. Joints shall be perpendicular to the main reinforcement. All reinforcement shall be continued across joints; except that reinforcement or other fixed metal items shall not be continuous through expansion joints, or through construction or contraction joints in slabs on grade. Reinforcement shall be 2 inches clear from each joint. Except where otherwise indicated, construction joints between interior slabs on grade and vertical surfaces shall consist of 30 pound asphalt-saturated felt, extending for the full depth of the slab. The perimeters of the slabs shall be free of fins, rough edges, spalling, or other unsightly appearance. Reservoir for sealant for construction and contraction joints in slabs shall be formed to the dimensions shown on the drawings by removing snap-out joint-forming inserts, by sawing sawable inserts, or by sawing to widen the top portion of sawed joints. Joints to be sealed shall be cleaned and sealed as indicated and in accordance with Section 07900 JOINT SEALING.

3.7.1 Construction Joints

For concrete other than slabs on grade, construction joints shall be located so that the unit of operation does not exceed 30 feet. Concrete shall be placed continuously so that each unit is monolithic in construction. Fresh concrete shall not be placed against adjacent hardened concrete until it is at least 24 hours old. Construction joints shall be located as indicated or approved. Where concrete work is interrupted by weather, end of work shift or other similar type of delay, location and type of construction joint shall be subject to approval of the Contracting Officer. Unless otherwise indicated and except for slabs on grade, reinforcing steel shall extend through construction joints. Construction joints in slabs on grade shall be keyed or doweled as shown. Concrete columns, walls, or piers shall be in place at least 2 hours, or until the concrete begins to lose its plasticity, before placing concrete for beams, girders, or slabs thereon. In walls having door or window openings, lifts shall terminate at the top and bottom of the opening. Other lifts shall terminate at such levels as to conform to structural requirements or architectural details. Where horizontal construction joints in walls or columns are required, a strip of 1 inch square-edge lumber, bevelled and oiled to facilitate removal, shall be tacked to the inside of the forms at the construction joint. Concrete shall be placed to a point 1 inch above the underside of the strip. The strip shall be removed 1 hour after the concrete has been placed, and any irregularities in the joint line shall be leveled off with a wood float, and all laitance shall be removed. Prior to placing additional concrete, horizontal construction joints shall be prepared as specified in paragraph Previously Placed Concrete.

3.7.2 Contraction Joints in Slabs on Grade

Contraction joints shall be located and detailed as shown on the drawings. Contraction Joints shall be produced by forming a weakened plane in the concrete slab by use of rigid inserts impressed in the concrete during placing operations, use of snap-out plastic joint forming inserts or sawing a continuous slot with a concrete saw. Regardless of method used to produce the weakened plane, it shall be 1/4 the depth of the slab thickness and between 1/8 and 3/16 inch wide. For saw-cut joints, cutting shall be timed properly with the set of the concrete. Cutting shall be started as soon as the concrete has hardened sufficiently to prevent ravelling of the edges of the saw cut. Cutting shall be completed before shrinkage stresses become sufficient to produce cracking. Reservoir for joint sealant shall be formed as previously specified.

3.7.3 Expansion Joints

Installation of expansion joints and sealing of these joints shall conform to the requirements of Section 03150 EXPANSION JOINTS, CONTRACTION JOINTS, AND WATERSTOPS and Section 07900 JOINT SEALING.

3.7.4 Waterstops

Waterstops shall be installed in conformance with the locations and details shown on the drawings using materials and procedures specified in Section 03150 EXPANSION JOINTS, CONTRACTION JOINTS, AND WATERSTOPS and manufacturer's instructions.

3.7.5 Dowels and Tie Bars

Dowels and tie bars shall be installed at the locations shown on the drawings and to the details shown, using materials and procedures specified in Section 03200 CONCRETE REINFORCEMENT and herein. Conventional smooth "paving" dowels shall be installed in slabs using approved methods to hold the dowel in place during concreting within a maximum alignment tolerance of 1/8 inch in 12 inches. "Structural" type deformed bar dowels, or tie bars, shall be installed to meet the specified tolerances. Care shall be taken during placing adjacent to and around dowels and tie bars to ensure there is no displacement of the dowel or tie bar and that the concrete completely embeds the dowel or tie bar and is thoroughly consolidated.

3.8 FINISHING FORMED SURFACES

Forms, form materials, and form construction are specified in Section 03100 STRUCTURAL CONCRETE FORMWORK. Finishing of formed surfaces shall be as specified herein. Unless another type of architectural or special finish is specified, surfaces shall be left with the texture imparted by the forms except that defective surfaces shall be repaired. Unless painting of surfaces is required, uniform color of the concrete shall be maintained by use of only one mixture without changes in materials or proportions for any structure or portion of structure that requires a Class A or B finish. Except for major defects, as defined hereinafter, surface defects shall be repaired as specified herein within 24 hours after forms are removed. Repairs of the so-called "plaster-type" will not be permitted in any location. Tolerances of formed surfaces shall conform to the requirements of ACI 117/117R. These tolerances apply to the finished concrete surface, not to the forms themselves; forms shall be set true to line and grade. Form tie holes requiring repair and other defects whose depth is at least as great as their surface diameter shall be repaired as specified in

paragraph Damp-Pack Mortar Repair. Defects whose surface diameter is greater than their depth shall be repaired as specified in paragraph Repair of Major Defects. Repairs shall be finished flush with adjacent surfaces and with the same surface texture. The cement used for all repairs shall be a blend of job cement with white cement proportioned so that the final color after curing and aging will be the same as the adjacent concrete. Concrete with excessive honeycomb, or other defects which affect the strength of the member, will be rejected. Repairs shall be demonstrated to be acceptable and free from cracks or loose or drummy areas at the completion of the contract and, for Class A and B Finishes, shall be inconspicuous. Repairs not meeting these requirements will be rejected and shall be replaced.

3.8.1 Class A Finish and Class B Finish

Class A finish is required where indicated on the drawings. Class B finish is required where indicated on the drawings. Fins, ravelings, and loose material shall be removed, all surface defects over 1/2 inch in diameter or more than 1/2 inch deep, shall be repaired and, except as otherwise indicated or as specified in Section 03100 STRUCTURAL CONCRETE FORMWORK, holes left by removal of form ties shall be reamed and filled. Defects more than 1/2 inch in diameter shall be cut back to sound concrete, but in all cases at least 1 inch deep. The Contractor shall prepare a sample panel for approval (as specified in PART 1) before commencing repair, showing that the surface texture and color match will be attained. Metal tools shall not be used to finish repairs in Class A surfaces.

3.8.2 Class C and Class D Finish

Class C finish is required where indicated on the drawings. Class D finish is required where indicated on the drawings. Fins, ravelings, and loose material shall be removed, and, except as otherwise indicated or as specified in Section 03100 STRUCTURAL CONCRETE FORMWORK, holes left by removal of form ties shall be reamed and filled. Honeycomb and other defects more than 1/2 inch deep or more than 2 inches in diameter shall be repaired. Defects more than 2 inches in diameter shall be cut back to sound concrete, but in all cases at least 1 inch deep.

3.8.3 Special Finishes

Special finishes shall conform to the requirements specified herein.

3.8.3.1 Smooth Finish

After other concrete construction is complete in each overall separate contiguous area of the structure, smooth finish shall be applied to the areas indicated on the drawings. A mortar mix consisting of one part portland cement and two parts well-graded sand passing a No. 30 sieve, with water added to give the consistency of thick paint, shall be used. Where the finished surface will not receive other applied surface, white cement shall be used to replace part of the job cement to produce an approved color, which shall be uniform throughout the surfaces of the structure. After the surface has been thoroughly wetted and allowed to approach surface dryness, the mortar shall be vigorously applied to the area by clean burlap pads or by cork or wood-floating, to completely fill all surface voids. Excess grout shall be scraped off with a trowel. As soon as it can be accomplished without pulling the mortar from the voids, the area shall be rubbed with burlap pads having on their surface the same sand-cement mix specified above but without any mixing water, until all of

the visible grout film is removed. The burlap pads used for this operation shall be stretched tightly around a board to prevent dishing the mortar in the voids. The finish of any area shall be completed in the same day, and the limits of a finished area shall be made at natural breaks in the surface. The surface shall be continuously moist cured for 48 hours commencing immediately after finishing operations in each area. The temperature of the air adjacent to the surface shall be not less than 50 degrees F for 24 hours prior to, and 48 hours after, the application. In hot, dry weather the smooth finish shall be applied in shaded areas or at night, and shall never be applied when there is significant hot, dry wind.

3.9 REPAIRS

3.9.1 Damp-Pack Mortar Repair

Form tie holes requiring repair and other defects whose depth is at least as great as their surface diameter but not over 4 inches shall be repaired by the damp-pack mortar method. Form tie holes shall be reamed and other similar defects shall be cut out to sound concrete. The void shall then be thoroughly cleaned, thoroughly wetted, brush-coated with a thin coat of neat cement grout and filled with mortar. Mortar shall be a stiff mix of 1 part portland cement to 2 parts fine aggregate passing the No. 16 mesh sieve, and minimum amount of water. Only sufficient water shall be used to produce a mortar which, when used, will stick together on being molded into a ball by a slight pressure of the hands and will not exude water but will leave the hands damp. Mortar shall be mixed and allowed to stand for 30 to 45 minutes before use with remixing performed immediately prior to use. Mortar shall be thoroughly tamped in place in thin layers using a hammer and hardwood block. Holes passing entirely through walls shall be completely filled from the inside face by forcing mortar through to the outside face. All holes shall be packed full. Damp-pack repairs shall be moist cured for at least 48 hours.

3.9.2 Repair of Major Defects

Major defects will be considered to be those more than 1/2 inch deep or, for Class A and B finishes, more than 1/2 inch in diameter and, for Class C and D finishes, more than 2 inches in diameter. Also included are any defects of any kind whose depth is over 4 inches or whose surface diameter is greater than their depth. Major defects shall be repaired as specified below.

3.9.2.1 Surface Application of Mortar Repair

Defective concrete shall be removed, and removal shall extend into completely sound concrete. Approved equipment and procedures which will not cause cracking or microcracking of the sound concrete shall be used. If reinforcement is encountered, concrete shall be removed so as to expose the reinforcement for at least 2 inches on all sides. All such defective areas greater than 12 square inches shall be outlined by saw cuts at least 1 inch deep. Defective areas less than 12 square inches shall be outlined by a 1 inch deep cut with a core drill in lieu of sawing. All saw cuts shall be straight lines in a rectangular pattern in line with the formwork panels. After concrete removal, the surface shall be thoroughly cleaned by high pressure washing to remove all loose material. Surfaces shall be kept continually saturated for the first 12 of the 24 hours immediately before placing mortar and shall be damp but not wet at the time of commencing mortar placement. The Contractor, at his option, may use either hand-placed mortar or mortar placed with a mortar gun. If hand-placed

mortar is used, the edges of the cut shall be perpendicular to the surface of the concrete. The prepared area shall be brush-coated with a thin coat of neat cement grout. The repair shall then be made using a stiff mortar, preshrunk by allowing the mixed mortar to stand for 30 to 45 minutes and then remixed, thoroughly tamped into place in thin layers. If hand-placed mortar is used, the Contractor shall test each repair area for drumminess by firm tapping with a hammer and shall inspect for cracks, both in the presence of the Contracting Officer's representative, immediately before completion of the contract, and shall replace any showing drumminess or cracking. If mortar placed with a mortar gun is used, the gun shall be a small compressed air-operated gun to which the mortar is slowly hand fed and which applies the mortar to the surface as a high-pressure stream, as approved. Repairs made using shotcrete equipment will not be accepted. The mortar used shall be the same mortar as specified for damp-pack mortar repair. If gun-placed mortar is used, the edges of the cut shall be beveled toward the center at a slope of 1:1. All surface applied mortar repairs shall be continuously moist cured for at least 7 days. Moist curing shall consist of several layers of saturated burlap applied to the surface immediately after placement is complete and covered with polyethylene sheeting, all held closely in place by a sheet of plywood or similar material rigidly braced against it. Burlap shall be kept continually wet.

3.9.2.2 Repair of Deep and Large Defects

Deep and large defects will be those that are more than 6 inches deep and also have an average diameter at the surface more than 18 inches or that are otherwise so identified by the Project Office. Such defects shall be repaired as specified herein or directed, except that defects which affect the strength of the structure shall not be repaired and that portion of the structure shall be completely removed and replaced. Deep and large defects shall be repaired by procedures approved in advance including forming and placing special concrete using applied pressure during hardening. Preparation of the repair area shall be as specified for surface application of mortar. In addition, the top edge (surface) of the repair area shall be sloped at approximately 20 degrees from the horizontal, upward toward the side from which concrete will be placed. The special concrete shall be a concrete mixture with low water content and low slump, and shall be allowed to age 30 to 60 minutes before use. Concrete containing a specified expanding admixture may be used in lieu of the above mixture; the paste portion of such concrete mixture shall be designed to have an expansion between 2.0 and 4.0 percent when tested in accordance with ASTM C 940. A full width "chimney" shall be provided at the top of the form on the placing side to ensure filling to the top of the opening. A pressure cap shall be used on the concrete in the chimney with simultaneous tightening and revibrating the form during hardening to ensure a tight fit for the repair. The form shall be removed after 24 hours and immediately the chimney shall be carefully chipped away to avoid breaking concrete out of the repair; the surface of the repair concrete shall be dressed as required.

3.10 FINISHING UNFORMED SURFACES

The finish of all unformed surfaces shall meet the requirements of paragraph Tolerances in PART 1, when tested as specified herein.

3.10.1 General

The ambient temperature of spaces adjacent to unformed surfaces being

finished and of the base on which concrete will be placed shall be not less than 50 degrees F. In hot weather all requirements of paragraphs Hot Weather Requirements and Prevention of Plastic Shrinkage Cracking shall be met. Unformed surfaces that are not to be covered by additional concrete or backfill shall have a float finish, with additional finishing as specified below, and shall be true to the elevation shown on the drawings. Surfaces to receive additional concrete or backfill shall be brought to the elevation shown on the drawings, properly consolidated, and left true and regular. Unless otherwise shown on the drawings, exterior surfaces shall be sloped for drainage, as directed. Where drains are provided, interior floors shall be evenly sloped to the drains. Joints shall be carefully made with a jointing or edging tool. The finished surfaces shall be protected from stains or abrasions. Grate tampers or "jitterbugs" shall not be used for any surfaces. The dusting of surfaces with dry cement or other materials or the addition of any water during finishing shall not be permitted. If bleedwater is present prior to finishing, the excess water shall be carefully dragged off or removed by absorption with porous materials such as burlap. During finishing operations, extreme care shall be taken to prevent over finishing or working water into the surface; this can cause "crazing" (surface shrinkage cracks which appear after hardening) of the surface. Any slabs with surfaces which exhibit significant crazing shall be removed and replaced. During finishing operations, surfaces shall be checked with a 10 foot straightedge, applied in both directions at regular intervals while the concrete is still plastic, to detect high or low areas.

3.10.2 Rough Slab Finish

As a first finishing operation for unformed surfaces and as final finish for slabs to receive mortar setting beds, the surface shall receive a rough slab finish prepared as follows. The concrete shall be uniformly placed across the slab area, consolidated as previously specified, and then screeded with straightedge strikeoffs immediately after consolidation to bring the surface to the required finish level with no coarse aggregate visible. Side forms and screed rails shall be provided, rigidly supported, and set to exact line and grade. Allowable tolerances for finished surfaces apply only to the hardened concrete, not to forms or screed rails. Forms and screed rails shall be set true to line and grade. "Wet screeds" shall not be used.

3.10.3 Floated Finish

Slabs to receive more than a rough slab finish shall next be given a wood float finish. Areas as indicated on the drawings shall be given only a float finish. The screeding shall be followed immediately by darbying or bull floating before bleeding water is present, to bring the surface to a true, even plane. Then, after the concrete has stiffened so that it will withstand a man's weight without imprint of more than 1/4 inch and the water sheen has disappeared, it shall be floated to a true and even plane free of ridges. Floating shall be performed by use of suitable hand floats or power driven equipment. Sufficient pressure shall be used on the floats to bring a film of moisture to the surface. Hand floats shall be made of wood, magnesium, or aluminum. Concrete that exhibits stickiness shall be floated with a magnesium float. Care shall be taken to prevent over-finishing or incorporating water into the surface.

3.10.4 Troweled Finish

Areas as indicated on the drawings shall be given a trowel finish. After

floating is complete and after the surface moisture has disappeared, unformed surfaces shall be steel-troweled to a smooth, even, dense finish, free from blemishes including trowel marks. In lieu of hand finishing, an approved power finishing machine may be used in accordance with the directions of the machine manufacturer. Additional trowelings shall be performed, either by hand or machine until the surface has been troweled 2 times, with waiting period between each. Care shall be taken to prevent blistering and if such occurs, troweling shall immediately be stopped and operations and surfaces corrected. A final hard steel troweling shall be done by hand, with the trowel tipped, and using hard pressure, when the surface is at a point that the trowel will produce a ringing sound. The finished surface shall be thoroughly consolidated and shall be essentially free of trowel marks and be uniform in texture and appearance. The concrete mixture used for troweled finished areas shall be adjusted, if necessary, in order to provide sufficient fines (cementitious material and fine sand) to finish properly.

3.11 FLOOR HARDENER

Areas as indicated on the drawings shall be treated with floor hardener. Floor hardener shall be applied after the concrete has been cured and then air dried for 28 days. Three coats shall be applied, each the day after the preceding coat was applied. For the first application, one pound of the silicofluoride shall be dissolved in one gallon of water. For subsequent applications, the solution shall be two pounds of silicofluoride to each gallon of water. Floor should be mopped with clear water shortly after the preceding application has dried to remove encrusted salts. Proprietary hardeners shall be applied in accordance with the manufacturer's instructions. During application, area should be well ventilated. Precautions shall be taken when applying silicofluorides due to the toxicity of the salts. Any compound that contacts glass or aluminum should be immediately removed with clear water.

3.12 EXTERIOR SLAB AND RELATED ITEMS

Exterior concrete slab and related items shall be constructed on top of 6 inches (minimum) of non-frost susceptible material. The material shall be uniformly graded, washed sand or gravel with a maximum particle diameter of 4 inches and less than 5 percent by weight passing the No. 200 sieve, with no more than 3 percent by weight finer than 0.02 mm.

3.12.1 Pavements

Pavements shall be constructed where shown on the drawings. After forms are set and underlying material prepared as specified, the concrete shall be placed uniformly throughout the area and thoroughly vibrated. As soon as placed and vibrated, the concrete shall be struck off and screeded to the crown and cross section and to such elevation above grade that when consolidated and finished, the surface of the pavement will be at the required elevation. The entire surface shall be tamped with the strike off, or consolidated with a vibrating screed, and this operation continued until the required compaction and reduction of internal and surface voids are accomplished. Care shall be taken to prevent bringing excess paste to the surface. Immediately following the final consolidation of the surface, the pavement shall be floated longitudinally from bridges resting on the side forms and spanning but not touching the concrete. If necessary, additional concrete shall be placed and screeded, and the float operated until a satisfactory surface has been produced. The floating operation shall be advanced not more than half the length of the float and then

continued over the new and previously floated surfaces. After finishing is completed but while the concrete is still plastic, minor irregularities and score marks in the pavement surface shall be eliminated by means of long-handled cutting straightedges. Straightedges shall be 12 feet in length and shall be operated from the sides of the pavement and from bridges. A straightedge operated from the side of the pavement shall be equipped with a handle 3 feet longer than one-half the width of the pavement. The surface shall then be tested for trueness with a 12 foot straightedge held in successive positions parallel and at right angles to the center line of the pavement, and the whole area covered as necessary to detect variations. The straightedge shall be advanced along the pavement in successive stages of not more than one-half the length of the straightedge. Depressions shall be immediately filled with freshly mixed concrete, struck off, consolidated, and refinished. Projections above the required elevation shall also be struck off and refinished. The straightedge testing and finishing shall continue until the entire surface of the concrete is true. Before the surface sheen has disappeared and well before the concrete becomes nonplastic, the surface of the pavement shall be given a nonslip sandy surface texture by belting with approved "belt" and procedures or use of a burlap drag. A strip of clean, wet burlap from 3 to 5 feet wide and 2 feet longer than the pavement width shall be carefully pulled across the surface. Edges and joints shall be rounded with an edger having a radius of 1/8 inch. Curing shall be as specified.

3.12.2 Sidewalks

Concrete shall be 4 inches minimum thickness. Contraction joints shall be provided at 5 feet spaces unless otherwise indicated. Contraction joints shall be cut 1 inch deep with a jointing tool after the surface has been finished. Transverse expansion joints 1/2 inch thick shall be provided at changes in direction and where sidewalk abuts curbs, steps, rigid pavement, or other similar structures. Sidewalks shall be given a lightly broomed finish. A transverse slope of 1/4 inch per foot shall be provided, unless otherwise indicated. Variations in cross section shall be limited to 1/4 inch in 5 feet.

3.12.3 Curbs and Gutters

Concrete shall be formed, placed, and finished by hand using a properly shaped "mule" or constructed using a slipform machine specially designed for this work. Contraction joints shall be cut 3 inches deep with a jointing tool after the surface has been finished. Expansion joints (1/2 inch wide) shall be provided at 100 feet maximum spacing unless otherwise indicated. Exposed surfaces shall be finished using a stiff bristled brush.

3.12.4 Pits and Trenches

Pits and trenches shall be constructed as indicated on the drawings. Bottoms and walls shall be placed monolithically or waterstops and keys, shall be provided as approved.

3.13 CURING AND PROTECTION

3.13.1 General

Concrete shall be cured by an approved method for the period of time given below:

Concrete with Type III cement	3 days

All other concrete 7 days

Immediately after placement, concrete shall be protected from premature drying, extremes in temperatures, rapid temperature change, mechanical injury and damage from rain and flowing water for the duration of the curing period. Air and forms in contact with concrete shall be maintained at a temperature above 50 degrees F for the first 3 days and at a temperature above 32 degrees F for the remainder of the specified curing period. Exhaust fumes from combustion heating units shall be vented to the outside of the enclosure, and heaters and ducts shall be placed and directed so as not to cause areas of overheating and drying of concrete surfaces or to create fire hazards. Materials and equipment needed for adequate curing and protection shall be available and at the site prior to placing concrete. No fire or excessive heat, including welding, shall be permitted near or in direct contact with the concrete at any time. Except as otherwise permitted by paragraph Membrane Forming Curing Compounds, moist curing shall be provided for any areas to receive floor hardener, any paint or other applied coating, or to which other concrete is to be bonded. Concrete containing silica fume shall be initially cured by fog misting during finishing, followed immediately by continuous moist curing. Except for plastic coated burlap, impervious sheeting alone shall not be used for curing.

3.13.2 Moist Curing

Concrete to be moist-cured shall be maintained continuously wet for the entire curing period, commencing immediately after finishing. If water or curing materials used stain or discolor concrete surfaces which are to be permanently exposed, the concrete surfaces shall be cleaned as approved. When wooden forms are left in place during curing, they shall be kept wet at all times. If steel forms are used in hot weather, nonsupporting vertical forms shall be broken loose from the concrete soon after the concrete hardens and curing water continually applied in this void. If the forms are removed before the end of the curing period, curing shall be carried out as on unformed surfaces, using suitable materials. Surfaces shall be cured by ponding, by continuous sprinkling, by continuously saturated burlap or cotton mats, or by continuously saturated plastic coated burlap. Burlap and mats shall be clean and free from any contamination and shall be completely saturated before being placed on the concrete. The Contractor shall have an approved work system to ensure that moist curing is continuous 24 hours per day.

3.13.3 Membrane Forming Curing Compounds

Membrane curing shall not be used on surfaces that are to receive any subsequent treatment depending on adhesion or bonding to the concrete, including surfaces to which a smooth finish is to be applied or other concrete to be bonded. However, a styrene acrylate or chlorinated rubber compound meeting ASTM C 309, Class B requirements, may be used for surfaces which are to be painted or are to receive bituminous roofing or waterproofing, or floors that are to receive adhesive applications of resilient flooring. The curing compound selected shall be compatible with any subsequent paint, roofing, waterproofing or flooring specified. Membrane curing compound shall not be used on surfaces that are maintained at curing temperatures with free steam. Curing compound shall be applied to formed surfaces immediately after the forms are removed and prior to any patching or other surface treatment except the cleaning of loose sand, mortar, and debris from the surface. All surfaces shall be thoroughly moistened with water. Curing compound shall be applied to slab surfaces as

soon as the bleeding water has disappeared, with the tops of joints being temporarily sealed to prevent entry of the compound and to prevent moisture loss during the curing period. The curing compound shall be applied in a two-coat continuous operation by approved motorized power-spraying equipment operating at a minimum pressure of 75 psi, at a uniform coverage of not more than 400 square feet per gallon for each coat, and the second coat shall be applied perpendicular to the first coat. Concrete surfaces which have been subjected to rainfall within 3 hours after curing compound has been applied shall be resprayed by the method and at the coverage specified. Surfaces on which clear compound is used shall be shaded from direct rays of the sun for the first 3 days. Surfaces coated with curing compound shall be kept free of foot and vehicular traffic, and from other sources of abrasion and contamination during the curing period.

3.13.4 Impervious Sheeting

Except for plastic coated burlap, impervious sheeting alone shall not be used for curing. Impervious-sheet curing shall only be used on horizontal or nearly horizontal surfaces. Surfaces shall be thoroughly wetted and be completely covered with the sheeting. Sheeting shall be at least 18 inches wider than the concrete surface to be covered. Covering shall be laid with light-colored side up. Covering shall be lapped not less than 12 inches and securely weighted down or shall be lapped not less than 4 inches and taped to form a continuous cover with completely closed joints. The sheet shall be weighted to prevent displacement so that it remains in contact with the concrete during the specified length of curing. Coverings shall be folded down over exposed edges of slabs and secured by approved means. Sheets shall be immediately repaired or replaced if tears or holes appear during the curing period.

3.13.5 Ponding or Immersion

Concrete shall be continually immersed throughout the curing period. Water shall not be more than 20 degrees F less than the temperature of the concrete.

3.13.6 Cold Weather Curing and Protection

When the daily ambient low temperature is less than 32 degrees F the temperature of the concrete shall be maintained above 40 degrees F for the first seven days after placing. During the period of protection removal, the air temperature adjacent to the concrete surfaces shall be controlled so that concrete near the surface will not be subjected to a temperature differential of more than 25 degrees F as determined by suitable temperature measuring devices furnished by the Contractor, as required, and installed adjacent to the concrete surface and 2 inches inside the surface of the concrete. The installation of the thermometers shall be made by the Contractor as directed.

3.14 SETTING BASE PLATES AND BEARING PLATES

After being properly positioned, column base plates, bearing plates for beams and similar structural members, and machinery and equipment base plates shall be set to the proper line and elevation with damp-pack bedding mortar, except where nonshrink grout is indicated. The thickness of the mortar or grout shall be approximately 1/24 the width of the plate, but not less than 3/4 inch. Concrete and metal surfaces in contact with grout shall be clean and free of oil and grease, and concrete surfaces in contact with grout shall be damp and free of laitance when grout is placed.

3.14.1 Damp-Pack Bedding Mortar

Damp-pack bedding mortar shall consist of 1 part cement and 2-1/2 parts fine aggregate having water content such that a mass of mortar tightly squeezed in the hand will retain its shape but will crumble when disturbed. The space between the top of the concrete and bottom of the bearing plate or base shall be packed with the bedding mortar by tamping or ramming with a bar or rod until it is completely filled.

3.14.2 Nonshrink Grout

Nonshrink grout shall be a ready-mixed material requiring only the addition of water. Water content shall be the minimum that will provide a flowable mixture and completely fill the space to be grouted without segregation, bleeding, or reduction of strength.

3.14.2.1 Mixing and Placing of Nonshrink Grout

Mixing and placing shall be in conformance with the material manufacturer's instructions and as specified therein. Ingredients shall be thoroughly dry-mixed before adding water. After adding water, the batch shall be mixed for 3 minutes. Batches shall be of size to allow continuous placement of freshly mixed grout. Grout not used within 30 minutes after mixing shall be discarded. The space between the top of the concrete or machinery-bearing surface and the plate shall be filled solid with the grout. Forms shall be of wood or other equally suitable material for completely retaining the grout on all sides and on top and shall be removed after the grout has set. The placed grout shall be carefully worked by rodding or other means to eliminate voids; however, overworking and breakdown of the initial set shall be avoided. Grout shall not be retempered or subjected to vibration from any source. Where clearances are unusually small, placement shall be under pressure with a grout pump. Temperature of the grout, and of surfaces receiving the grout, shall be maintained at 65 to 85 degrees F until after setting.

3.14.2.2 Treatment of Exposed Surfaces

For metal-oxidizing nonshrink grout, exposed surfaces shall be cut back 1 inch and immediately covered with a parge coat of mortar consisting of 1 part portland cement and 2-1/2 parts fine aggregate by weight, with sufficient water to make a plastic mixture. The parge coat shall have a smooth finish. For other mortars or grouts, exposed surfaces shall have a smooth-dense finish and be left untreated. Curing shall comply with paragraph CURING AND PROTECTION.

3.15 TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL

The Contractor shall perform the inspection and tests described below and, based upon the results of these inspections and tests, shall take the action required and shall submit specified reports. When, in the opinion of the Contracting Officer, the concreting operation is out of control, concrete placement shall cease and the operation shall be corrected. The laboratory performing the tests shall be onsite and shall conform with ASTM C 1077. Materials may be subjected to check testing by the Contracting Officer from samples obtained at the manufacturer, at transfer points, or at the project site.

3.15.1 Grading and Corrective Action

3.15.1.1 Fine Aggregate

At least once during each shift when the concrete plant is operating, there shall be one sieve analysis and fineness modulus determination in accordance with ASTM C 136 and COE CRD-C 104 for the fine aggregate or for each fine aggregate if it is batched in more than one size or classification. The location at which samples are taken may be selected by the Contractor as the most advantageous for control. However, the Contractor is responsible for delivering fine aggregate to the mixer within specification limits. When the amount passing on any sieve is outside the specification limits, the fine aggregate shall be immediately resampled and retested. If there is another failure on any sieve, the fact shall immediately reported to the Contracting Officer, concreting shall be stopped, and immediate steps taken to correct the grading.

3.15.1.2 Coarse Aggregate

At least once during each shift in which the concrete plant is operating, there shall be a sieve analysis in accordance with ASTM C 136 for each size of coarse aggregate. The location at which samples are taken may be selected by the Contractor as the most advantageous for production control. However, the Contractor shall be responsible for delivering the aggregate to the mixer within specification limits. A test record of samples of aggregate taken at the same locations shall show the results of the current test as well as the average results of the five most recent tests including the current test. The Contractor may adopt limits for control coarser than the specification limits for samples taken other than as delivered to the mixer to allow for degradation during handling. When the amount passing any sieve is outside the specification limits, the coarse aggregate shall be immediately resampled and retested. If the second sample fails on any sieve, that fact shall be reported to the Contracting Officer. Where two consecutive averages of 5 tests are outside specification limits, the operation shall be considered out of control and shall be reported to the Contracting Officer. Concreting shall be stopped and immediate steps shall be taken to correct the grading.

3.15.2 Quality of Aggregates

Thirty days prior to the start of concrete placement, the Contractor shall perform all tests for aggregate quality required by ASTM C 33. In addition, after the start of concrete placement, the Contractor shall perform tests for aggregate quality at least every three months, and when the source of aggregate or aggregate quality changes. Samples tested after the start of concrete placement shall be taken immediately prior to entering the concrete mixer.

3.15.3 Scales, Batching and Recording

The accuracy of the scales shall be checked by test weights prior to start of concrete operations and at least once every three months. Such tests shall also be made as directed whenever there are variations in properties of the fresh concrete that could result from batching errors. Once a week the accuracy of each batching and recording device shall be checked during a weighing operation by noting and recording the required weight, recorded weight, and the actual weight batched. At the same time, the Contractor shall test and ensure that the devices for dispensing admixtures are operating properly and accurately. When either the weighing accuracy or batching accuracy does not comply with specification requirements, the

plant shall not be operated until necessary adjustments or repairs have been made. Discrepancies in recording accuracies shall be corrected immediately.

3.15.4 Batch-Plant Control

The measurement of concrete materials including cementitious materials, each size of aggregate, water, and admixtures shall be continuously controlled. The aggregate weights and amount of added water shall be adjusted as necessary to compensate for free moisture in the aggregates. The amount of air-entraining agent shall be adjusted to control air content within specified limits. A report shall be prepared indicating type and source of cement used, type and source of pozzolan or slag used, amount and source of admixtures used, aggregate source, the required aggregate and water weights per cubic yard, amount of water as free moisture in each size of aggregate, and the batch aggregate and water weights per cubic yard for each class of concrete batched during each day's plant operation.

3.15.5 Concrete Mixture

a. Air Content Testing. Air content tests shall be made when test specimens are fabricated. In addition, at least two tests for air content shall be made on randomly selected batches of each separate concrete mixture produced during each 8-hour period of concrete production. Additional tests shall be made when excessive variation in workability is reported by the placing foreman or Contracting Officer's representative. Tests shall be made in accordance with ASTM C 231 for normal weight concrete and ASTM C 173 for lightweight concrete. Test results shall be plotted on control charts which shall at all times be readily available to the Contracting Officer and shall be submitted weekly. Copies of the current control charts shall be kept in the field by testing crews and results plotted as tests are made. When a single test result reaches either the upper or lower action limit, a second test shall immediately be made. The results of the two tests shall be averaged and this average used as the air content of the batch to plot on both the air content and the control chart for range, and for determining need for any remedial action. The result of each test, or average as noted in the previous sentence, shall be plotted on a separate control chart for each mixture on which an "average line" is set at the midpoint of the specified air content range from paragraph Air Entrainment. An upper warning limit and a lower warning limit line shall be set 1.0 percentage point above and below the average line, respectively. An upper action limit and a lower action limit line shall be set 1.5 percentage points above and below the average line, respectively. The range between each two consecutive tests shall be plotted on a secondary control chart for range where an upper warning limit is set at 2.0 percentage points and an upper action limit is set at 3.0 percentage points. Samples for air content may be taken at the mixer, however, the Contractor is responsible for delivering the concrete to the placement site at the stipulated air content. If the Contractor's materials or transportation methods cause air content loss between the mixer and the placement, correlation samples shall be taken at the placement site as required by the Contracting Officer, and the air content at the mixer controlled as directed.

b. Air Content Corrective Action. Whenever points on the control

chart for percent air reach either warning limit, an adjustment shall immediately be made in the amount of air-entraining admixture batched. As soon as practical after each adjustment, another test shall be made to verify the result of the adjustment. Whenever a point on the secondary control chart for range reaches the warning limit, the admixture dispenser shall be recalibrated to ensure that it is operating accurately and with good reproducibility. Whenever a point on either control chart reaches an action limit line, the air content shall be considered out of control and the concreting operation shall immediately be halted until the air content is under control. Additional air content tests shall be made when concreting is restarted.

c. Slump Testing. In addition to slump tests which shall be made when test specimens are fabricated, at least four slump tests shall be made on randomly selected batches in accordance with ASTM C 143/C 143M for each separate concrete mixture produced during each 8-hour or less period of concrete production each day. Also, additional tests shall be made when excessive variation in workability is reported by the placing foreman or the Contracting Officer's representative. Test results shall be plotted on control charts which shall at all times be readily available to the Contracting Officer and shall be submitted weekly. Copies of the current control charts shall be kept in the field by testing crews and results plotted as tests are made. When a single slump test reaches or goes beyond either the upper or lower action limit, a second test shall immediately be made. The results of the two tests shall be averaged and this average used as the slump of the batch to plot on both the control charts for slump and the chart for range, and for determining need for any remedial action. Limits shall be set on separate control charts for slump for each type of mixture. The upper warning limit shall be set at 1/2 inch below the maximum allowable slump specified in paragraph Slump in PART 1 for each type of concrete and an upper action limit line and lower action limit line shall be set at the maximum and minimum allowable slumps, respectively, as specified in the same paragraph. The range between each consecutive slump test for each type of mixture shall be plotted on a single control chart for range on which an upper action limit is set at 2 inches. Samples for slump shall be taken at the mixer. However, the Contractor is responsible for delivering the concrete to the placement site at the stipulated slump. If the Contractor's materials or transportation methods cause slump loss between the mixer and the placement, correlation samples shall be taken at the placement site as required by the Contracting Officer, and the slump at the mixer controlled as directed.

d. Slump Corrective Action. Whenever points on the control charts for slump reach the upper warning limit, an adjustment shall immediately be made in the batch weights of water and fine aggregate. The adjustments are to be made so that the total water content does not exceed that amount allowed by the maximum w/c ratio specified, based on aggregates which are in a saturated surface dry condition. When a single slump reaches the upper or lower action limit, no further concrete shall be delivered to the placing site until proper adjustments have been made. Immediately after each adjustment, another test shall be made to verify the correctness of the adjustment. Whenever two consecutive individual slump tests, made during a period when there was no

adjustment of batch weights, produce a point on the control chart for range at or above the upper action limit, the concreting operation shall immediately be halted, and the Contractor shall take appropriate steps to bring the slump under control. Additional slump tests shall be made as directed.

e. Temperature. The temperature of the concrete shall be measured when compressive strength specimens are fabricated. Measurement shall be in accordance with ASTM C 1064/C 1064M. The temperature shall be reported along with the compressive strength data.

f. Strength Specimens. At least one set of test specimens shall be made, for compressive or flexural strength as appropriate, on each different concrete mixture placed during the day for each 500 cubic yards or portion thereof of that concrete mixture placed each day. Additional sets of test specimens shall be made, as directed by he Contracting Officer, when the mixture proportions are changed or when low strengths have been detected. A truly random (not haphazard) sampling plan shall be developed by the Contractor and approved by the Contracting Officer prior to the start of construction. The plan shall assure that sampling is done in a completely random and unbiased manner. A set of test specimens for concrete with a 28-day specified strength per paragraph Strength Requirements in PART 1 shall consist of four specimens, two to be tested at 7 days and two at 28 days. Test specimens shall be molded and cured in accordance with ASTM C 31/C 31M and tested in accordance with ASTM C 39/C 39M for test cylinders and ASTM C 78 for test beams. Results of all strength tests shall be reported immediately to the Contracting Officer. Quality control charts shall be kept for individual strength "tests", ("test" as defined in paragraph Strength Requirements in PART 1) moving average of last 3 "tests" for strength, and moving average for range for the last 3 "tests" for each mixture. The charts shall be similar to those found in ACI 214.3R.

3.15.6 Inspection Before Placing

Foundations, construction joints, forms, and embedded items shall be inspected by the Contractor in sufficient time prior to each concrete placement in order to certify to the Contracting Officer that they are ready to receive concrete. The results of each inspection shall be reported in writing.

3.15.7 Placing

The placing foreman shall supervise placing operations, shall determine that the correct quality of concrete or grout is placed in each location as specified and as directed by the Contracting Officer, and shall be responsible for measuring and recording concrete temperatures and ambient temperature hourly during placing operations, weather conditions, time of placement, volume placed, and method of placement. The placing foreman shall not permit batching and placing to begin until it has been verified that an adequate number of vibrators in working order and with competent operators are available. Placing shall not be continued if any pile of concrete is inadequately consolidated. If any batch of concrete fails to meet the temperature requirements, immediate steps shall be taken to improve temperature controls.

3.15.8 Vibrators

The frequency and amplitude of each vibrator shall be determined in accordance with COE CRD-C 521 prior to initial use and at least once a month when concrete is being placed. Additional tests shall be made as directed when a vibrator does not appear to be adequately consolidating the concrete. The frequency shall be determined while the vibrator is operating in concrete with the tachometer being held against the upper end of the vibrator head while almost submerged and just before the vibrator is withdrawn from the concrete. The amplitude shall be determined with the head vibrating in air. Two measurements shall be taken, one near the tip and another near the upper end of the vibrator head, and these results averaged. The make, model, type, and size of the vibrator and frequency and amplitude results shall be reported in writing. Any vibrator not meeting the requirements of paragraph Consolidation, shall be immediately removed from service and repaired or replaced.

3.15.9 Curing Inspection

a. Moist Curing Inspections. At least once each shift, and not less than twice per day on both work and non-work days, an inspection shall be made of all areas subject to moist curing. The surface moisture condition shall be noted and recorded.

b. Moist Curing Corrective Action. When a daily inspection report lists an area of inadequate curing, immediate corrective action shall be taken, and the required curing period for those areas shall be extended by 1 day.

c. Membrane Curing Inspection. No curing compound shall be applied until the Contractor has verified that the compound is properly mixed and ready for spraying. At the end of each operation, the Contractor shall estimate the quantity of compound used by measurement of the container and the area of concrete surface covered, shall compute the rate of coverage in square feet per gallon, and shall note whether or not coverage is uniform.

d. Membrane Curing Corrective Action. When the coverage rate of the curing compound is less than that specified or when the coverage is not uniform, the entire surface shall be sprayed again.

e. Sheet Curing Inspection. At least once each shift and once per day on non-work days, an inspection shall be made of all areas being cured using impervious sheets. The condition of the covering and the tightness of the laps and tapes shall be noted and recorded.

f. Sheet Curing Corrective Action. When a daily inspection report lists any tears, holes, or laps or joints that are not completely closed, the tears and holes shall promptly be repaired or the sheets replaced, the joints closed, and the required curing period for those areas shall be extended by 1 day.

3.15.10 Cold-Weather Protection

At least once each shift and once per day on non-work days, an inspection shall be made of all areas subject to cold-weather protection. Any deficiencies shall be noted, corrected, and reported.

3.15.11 Mixer Uniformity

a. Stationary Mixers. Prior to the start of concrete placing and once every 6 months when concrete is being placed, or once for every 75,000 cubic yards of concrete placed, whichever results in the shortest time interval, uniformity of concrete mixing shall be determined in accordance with ASTM C 94/C 94M.

b. Truck Mixers. Prior to the start of concrete placing and at least once every 6 months when concrete is being placed, uniformity of concrete mixing shall be determined in accordance with ASTM C 94/C 94M. The truck mixers shall be selected randomly for testing. When satisfactory performance is found in one truck mixer, the performance of mixers of substantially the same design and condition of the blades may be regarded as satisfactory.

c. Mixer Uniformity Corrective Action. When a mixer fails to meet mixer uniformity requirements, either the mixing time shall be increased, batching sequence changed, batch size reduced, or adjustments shall be made to the mixer until compliance is achieved.

3.15.12 Reports

All results of tests or inspections conducted shall be reported informally as they are completed and in writing daily. A weekly report shall be prepared for the updating of control charts covering the entire period from the start of the construction season through the current week. During periods of cold-weather protection, reports of pertinent temperatures shall be made daily. These requirements do not relieve the Contractor of the obligation to report certain failures immediately as required in preceding paragraphs. Such reports of failures and the action taken shall be confirmed in writing in the routine reports. The Contracting Officer has the right to examine all contractor quality control records.

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SECTION 04200

MASONRY

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ACI INTERNATIONAL (ACI)

ACI SP-66	(1994) ACI Detailing Manual

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 82	(1997a) Steel Wire, Plain, for Concrete Reinforcement
ASTM A 153/A 153M	(2000) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 615/A 615M	(2000) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM C 90	(2000) Loadbearing Concrete Masonry Units
ASTM C 91	(1999) Masonry Cement
ASTM C 140	(1999b) Sampling and Testing Concrete Masonry Units
ASTM C 270	(2000) Mortar for Unit Masonry
ASTM C 476	(1999) Grout for Masonry
ASTM C 494/C 494M	(1999a) Chemical Admixtures for Concrete
ASTM C 641	(1982; R 1998el) Staining Materials in Lightweight Concrete Aggregates
ASTM C 780	(2000) Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
ASTM C 1019	(2000) Sampling and Testing Grout
ASTM C 1072	(2000) Measurement of Masonry Flexural Bond Strength
ASTM D 2000	(1999) Rubber Products in Automotive Applications
ASTM D 2240	(2000) Rubber Property - Durometer Hardness

ASTM D 2287 (1996a) Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Masonry Work; GA

Drawings including plans, elevations, and details of wall reinforcement; details of reinforcing bars at corners and wall intersections; offsets; tops, bottoms, and ends of walls; control and expansion joints; and wall openings. Bar splice locations shall be shown. Drawings shall be provided showing the location and layout of glass block units. Bent bars shall be identified on a bending diagram and shall be referenced and located on the drawings. Wall dimensions, bar clearances, and wall openings greater than one masonry unit in area shall be shown. No approval will be given to the shop drawings until the Contractor certifies that all openings, including those for mechanical and electrical service, are shown. If, during construction, additional masonry openings are required, the approved shop drawings shall be resubmitted with the additional openings shown along with the proposed changes. Location of these additional openings shall be clearly highlighted. The minimum scale for wall elevations shall be 1/4 inch per foot. Reinforcement bending details shall conform to the requirements of ACI SP-66.

SD-03 Product Data

Manufacturer's descriptive data.

Cold Weather Installation; GA

Cold weather construction procedures.

SD-06 Test Reports

Field Testing of Mortar; GA
Field Testing of Grout; GA
Fire-rated CMU; GA

Test reports from an approved independent laboratory. Test reports on a previously tested material shall be certified as the same as that proposed for use in this project.

SD-07 Certificates

Concrete Masonry Units (CMU); FIO
Anchors, Ties, and Bar Positioners; FIO
Expansion-Joint Materials; FIO
Joint Reinforcement; FIO

Reinforcing Steel Bars and Rods; FIO
Masonry Cement; FIO
Precast Concrete Items; FIO
Mortar Admixtures; FIO
Grout Admixtures; FIO

1.3 DELIVERY, HANDLING, AND STORAGE

Materials shall be delivered, handled, stored, and protected to avoid chipping, breakage, and contact with soil or contaminating material.

1.3.1 Masonry Units

Concrete masonry units shall be covered or protected from inclement weather. In addition, glass block units and prefaced concrete units shall be stored with their finish surfaces covered. Prefabricated lintels shall be marked on top sides to show either the lintel schedule number or the number and size of top and bottom bars.

1.3.2 Reinforcement, Anchors, and Ties

Steel reinforcing bars, coated anchors, ties, and joint reinforcement shall be stored above the ground. Steel reinforcing bars and uncoated ties shall be free of loose mill scale and rust.

1.3.3 Cementitious Materials, Sand and Aggregates

Cementitious and other packaged materials shall be delivered in unopened containers, plainly marked and labeled with manufacturers' names and brands. Cementitious material shall be stored in dry, weathertight enclosures or be completely covered. Cement shall be handled in a manner that will prevent the inclusion of foreign materials and damage by water or dampness. Sand and aggregates shall be stored in a manner to prevent contamination or segregation.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

The source of materials which will affect the appearance of the finished work shall not be changed after the work has started except with Contracting Officer's approval.

2.2 CONCRETE MASONRY UNITS (CMU)

Hollow and solid concrete masonry units shall conform to ASTM C 90. Cement shall have a low alkali content and be of one brand.

2.2.1 Aggregates

Lightweight aggregates and blends of lightweight and heavier aggregates in proportions used in producing the units, shall comply with the following requirements when tested for stain-producing iron compounds in accordance with ASTM C 641: by visual classification method, the iron stain deposited on the filter paper shall not exceed the "light stain" classification.

2.2.2 Kinds and Shapes

Units shall be modular in size and shall include closer, jamb, header,

lintel, and bond beam units and special shapes and sizes to complete the work as indicated. In exposed interior masonry surfaces, units having a bullnose shall be used for vertical external corners except at door, window, and louver jambs. Radius of the bullnose shall be 1 inch. Units used in exposed masonry surfaces in any one building shall have a uniform fine to medium texture and a uniform color.

2.2.3 Fire-Rated CMU

Concrete masonry units used in fire-rated construction shown on the drawings shall be of minimum equivalent thickness for the fire rating indicated and the corresponding type of aggregates indicated in TABLE I. Units containing more than one of the aggregates listed in TABLE I will be rated on the aggregate requiring the greater minimum equivalent thickness to produce the required fire rating.

TABLE I

FIRE-RATED CONCRETE MASONRY UNITS

See note (a) below

Aggregate Type	Minimum equivalent thickness inches for fire rating of: 4 hours	3 hours	2 hours
Pumice	4.7	4.0	3.0
Expanded slag	5.0	4.2	3.3
Expanded clay, shale, or slate	5.7	4.8	3.7
Limestone, scoria, cinders or unexpanded slag	5.9	5.0	4.0
Calcareous gravel	6.2	5.3	4.2
Siliceous gravel	6.7	5.7	4.5

(a) Minimum equivalent thickness shall equal net volume as determined in conformance with ASTM C 140 divided by the product of the actual length and height of the face shell of the unit in inches. Where walls are to receive plaster or be faced with brick, or otherwise form an assembly; the thickness of plaster or brick or other material in the assembly will be included in determining the equivalent thickness.

2.3 ACCESSORIES

2.3.1 Horizontal Joint Reinforcement

Joint reinforcement shall be factory fabricated from steel wire, and shall conform to ASTM A 82. Wire shall be zinc coated after fabrication by the hot-dip process conforming to ASTM A 153/A 153M, Class B-2. Reinforcement shall consist of two or more parallel longitudinal wires not lighter than 9 gauge weld connected with cross wires not lighter than 14 gauge at not

greater than 8 inches on center. At least one longitudinal wire for each face of glass block shall be provided. Out-to-out dimension of the longitudinal wires shall be 1-1/2 inches less than the actual width of the block. Joint reinforcement in flat sections not less than 8 feet long shall be provided, except that corner reinforcements and other special shapes may be shorter.

2.3.2 Strip Anchor

Perforated steel strip shall be not less than 20 gauge, minimum of 1-3/4 inches wide by 24 inches long and galvanized after fabrication.

2.3.3 Wire-Type Anchor

Steel wire shall be not less than 9 gauge of approved design suitable for use with the panel stiffener provided and galvanized after fabrication.

2.3.4 Expansion Strip

Dense fibrous glass batt or material shall be as recommended by the glass block manufacturer.

2.3.5 Packing (Backer Rods)

Polyethylene foam, neoprene, or filler shall be as recommended by the sealant manufacturer.

2.4 PRECAST CONCRETE ITEMS

Trim, lintels, copings, splashblocks and door sills shall be factory-made units from a plant regularly engaged in producing precast concrete units. Unless otherwise indicated, concrete shall be 4,000 psi minimum conforming to Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE using 1/2 inch to No. 4 nominal-size coarse aggregate, and minimum reinforcement shall be the reinforcement required for handling of the units. Clearance of 3/4 inch shall be maintained between reinforcement and faces of units. Unless precast-concrete items have been subjected during manufacture to saturated-steam pressure of at least 120 psi for at least 5 hours, the items, after casting, shall be either damp-cured for 24 hours or steam-cured and shall then be aged under cover for 28 days or longer. Cast-concrete members weighing over 80 pounds shall have built-in loops of galvanized wire or other approved provisions for lifting and anchoring. Units shall have beds and joints at right angles to the face, with sharp true arises and shall be cast with drip grooves on the underside where units overhang walls. Exposed-to-view surfaces shall be free of surface voids, spalls, cracks, and chipped or broken edges. Precast units exposed-to-view shall be of uniform appearance and color. Unless otherwise specified, units shall have a smooth dense finish. Prior to use, each item shall be wetted and inspected for crazing. Items showing evidence of dusting, spalling, crazing, or having surfaces treated with a protective coating will be rejected.

2.4.1 Lintels

Precast lintels, unless otherwise shown, shall be of a thickness equal to the wall and reinforced with two No. 4 bars for the full length. Top of lintels shall be labeled "TOP" or otherwise identified and each lintel shall be clearly marked to show location in the structure.

2.4.2 Sills and Copings

Sills and copings shall be cast with washes. Sills for windows having mullions shall be cast in sections with head joints at mullions and a 1/4 inch allowance for mortar joints. The ends of sills, except a 3/4 inch wide margin at exposed surfaces, shall be roughened for bond. Treads of door sills shall have rounded nosings.

2.4.3 Splash Blocks

Splash blocks shall be as detailed. Reinforcement shall be the manufacturer's standard.

2.5 MORTAR

Mortar shall be Type S in accordance with the proportion specification of ASTM C 270 except Type S cement-lime mortar proportions shall be 1 part cement, 1/2 part lime and 4-1/2 parts aggregate; Type N cement-lime mortar proportions shall be 1 part cement, 1 part lime and 6 parts aggregate; when masonry cement ASTM C 91 is used the maximum air content shall be limited to 12 percent and performance equal to cement-lime mortar shall be verified. Verification of masonry cement performance shall be based on ASTM C 780 and ASTM C 1072. Mortar for prefaced concrete masonry unit wainscots shall contain aggregates with 100 percent passing the No. 8 sieve and 95 percent passing the No. 16 sieve. Pointing mortar in showers and kitchens shall contain ammonium stearate, or aluminum tri-stearate, or calcium stearate in an amount equal to 3 percent by weight of cement used. Cement shall have a low alkali content and be of one brand. Aggregates shall be from one source.

2.5.1 Admixtures

In cold weather, a non-chloride based accelerating admixture may be used subject to approval. Accelerating admixture shall be non-corrosive, shall contain less than 0.2 percent chlorides, and shall conform to ASTM C 494/C 494M, Type C.

2.5.2 Coloring

Mortar coloring shall be added to the mortar used for exposed masonry surfaces to produce a uniform color matching the block work. Mortar coloring shall not exceed 3 percent of the weight of cement for carbon black and ten percent of the weight of cement for all other pigments. Mortar coloring shall be chemically inert, of finely ground limeproof pigment, and furnished in accurately pre-measured and packaged units that can be added to a measured amount of cement.

2.6 GROUT

Grout shall conform to ASTM C 476. Cement used in grout shall have a low alkali content. Grout slump shall be between 8 and 10 inches. Grout shall be used subject to the limitations of Table III. Proportions shall not be changed and materials with different physical or chemical characteristics shall not be used in grout for the work unless additional evidence is furnished that the grout meets the specified requirements.

2.6.1 Admixtures

In cold weather, a non-chloride based accelerating admixture may be used

subject to approval. Accelerating admixture shall be non-corrosive, shall contain less than 0.2 percent chlorides, and shall conform to ASTM C 494/C 494M, Type C.

2.6.2 Grout Barriers

Grout barriers for vertical cores shall consist of fine mesh wire, fiberglass, or expanded metal.

2.7 ANCHORS, TIES, AND BAR POSITIONERS

Anchors and ties shall be fabricated without drips or crimps and shall be zinc-coated in accordance with ASTM A 153/A 153M, Class B-2. Steel wire used for anchors and ties shall be fabricated from steel wire conforming to ASTM A 82. Anchors and ties shall be sized to provide a minimum of 5/8 inch mortar cover from either face.

2.7.1 Wire Mesh Ties

Wire mesh for tying 4 inch thick concrete masonry unit partitions to other intersecting masonry partitions shall be 1/2 inch mesh of minimum 16 gauge steel wire. Minimum lengths shall be not less than 12 inches.

2.7.2 Wall Ties

Wall ties shall be rectangular-shaped or Z-shaped fabricated of 3/16 inch diameter zinc-coated steel wire. Rectangular wall ties shall be no less than 4 inches wide. Wall ties may also be of a continuous type conforming to paragraph JOINT REINFORCEMENT. Adjustable type wall ties, if approved for use, shall consist of two essentially U-shaped elements fabricated of 3/16 inch diameter zinc-coated steel wire. Adjustable ties shall be of the double pintle to eye type and shall allow a maximum of 1/2 inch eccentricity between each element of the tie. Play between pintle and eye opening shall be not more than 1/16 inch. The pintle and eye elements shall be formed so that both can be in the same plane.

2.7.3 Bar Positioners

Bar positioners, used to prevent displacement of reinforcing bars during the course of construction, shall be factory fabricated from 9 gauge steel wire or equivalent, and coated with a hot-dip galvanized finish. Not more than one wire shall cross the cell.

2.8 JOINT REINFORCEMENT

Joint reinforcement shall be factory fabricated from steel wire conforming to ASTM A 82, welded construction. Tack welding will not be acceptable in reinforcement used for wall ties. Wire shall have zinc coating conforming to ASTM A 153/A 153M, Class B-2. All wires shall be a minimum of 9 gauge. Reinforcement shall be ladder type design, having one longitudinal wire in the mortar bed of each face shell for hollow units and one wire for solid units. Joint reinforcement shall be placed a minimum of 5/8 inch cover from either face. The distance between crosswires shall not exceed 16 inches. Joint reinforcement for straight runs shall be furnished in flat sections not less than 10 feet long. Joint reinforcement shall be provided with factory formed corners and intersections. If approved for use, joint reinforcement may be furnished with adjustable wall tie features.

2.9 REINFORCING STEEL BARS AND RODS

Reinforcing steel bars and rods shall conform to ASTM A 615/A 615M, Grade 60.

2.10 CONTROL JOINT KEYS

Control joint keys shall be a factory fabricated solid section of natural or synthetic rubber (or combination thereof) conforming to ASTM D 2000 or polyvinyl chloride conforming to ASTM D 2287. The material shall be resistant to oils and solvents. The control joint key shall be provided with a solid shear section not less than 5/8 inchthick and 3/8 inch thick flanges, with a tolerance of plus or minus 1/16 inch. The control joint key shall fit neatly, but without forcing, in masonry unit jamb sash grooves. The control joint key shall be flexible at a temperature of minus 30 degrees F after five hours exposure, and shall have a durometer hardness of not less than 70 when tested in accordance with ASTM D 2240.

2.11 EXPANSION-JOINT MATERIALS

Backer rod and sealant shall be adequate to accommodate joint compression equal to 50 percent of the width of the joint. The backer rod shall be compressible rod stock of polyethylene foam, polyurethane foam, butyl rubber foam, or other flexible, nonabsorptive material as recommended by the sealant manufacturer. Sealant shall conform to Section 07900 JOINT SEALING.

PART 3 EXECUTION

3.1 ENVIRONMENTAL REQUIREMENTS

3.1.1 Hot Weather Installation

The following precautions shall be taken if masonry is erected when the ambient air temperature is more than 99 degrees F in the shade and the relative humidity is less than 50 percent. All masonry materials shall be shaded from direct sunlight; mortar beds shall be spread no more than 4 feet ahead of masonry; masonry units shall be set within one minute of spreading mortar; and after erection, masonry shall be protected from direct exposure to wind and sun for 48 hours.

3.1.2 Cold Weather Installation

Before erecting masonry when ambient temperature or mean daily air temperature falls below 40 degrees F, a written statement of proposed cold weather construction procedures shall be submitted for approval. The following precautions shall be taken during all cold weather erection.

3.1.2.1 Preparation

Ice or snow formed on the masonry bed shall be thawed by the application of heat. Heat shall be applied carefully until the top surface of the masonry is dry to the touch. Sections of masonry deemed frozen and damaged shall be removed before continuing construction of those sections.

a. Air Temperature 40 to 32 Degrees F. Sand or mixing water shall be heated to produce mortar temperatures between 40 and 120 degrees F.

b. Air Temperature 32 to 25 Degrees F. Sand and mixing water shall be heated to produce mortar temperatures between 40 and 120

degrees F. Temperature of mortar on boards shall be maintained above freezing.

c. Air Temperature 25 to 20 Degrees F. Sand and mixing water shall be heated to provide mortar temperatures between 40 and 120 degrees F. Temperature of mortar on boards shall be maintained above freezing. Sources of heat shall be used on both sides of walls under construction. Windbreaks shall be employed when wind is in excess of 15 mph.

d. Air Temperature 20 Degrees F and below. Sand and mixing water shall be heated to provide mortar temperatures between 40 and 120 degrees F. Enclosure and auxiliary heat shall be provided to maintain air temperature above 32 degrees F. Temperature of units when laid shall not be less than 20 degrees F.

3.1.2.2 Completed Masonry and Masonry Not Being Worked On

a. Mean daily air temperature 40 to 32 degrees F. Masonry shall be protected from rain or snow for 24 hours by covering with weather-resistive membrane.

b. Mean daily air temperature 32 to 25 degrees F. Masonry shall be completely covered with weather-resistant membrane for 24 hours.

c. Mean Daily Air Temperature 25 to 20 degrees F. Masonry shall be completely covered with insulating blankets or equally protected for 24 hours.

d. Mean Daily Temperature 20 degrees F and Below. Masonry temperature shall be maintained above 32 degrees F for 24 hours by enclosure and supplementary heat, by electric heating blankets, infrared heat lamps, or other approved methods.

3.2 LAYING MASONRY UNITS

Masonry units shall be laid in running bond pattern. Facing courses shall be level with back-up courses, unless the use of adjustable ties has been approved in which case the tolerances shall be plus or minus 1/2 inch. Each unit shall be adjusted to its final position while mortar is still soft and plastic. Units that have been disturbed after the mortar has stiffened shall be removed, cleaned, and relaid with fresh mortar. Air spaces, cavities, chases, expansion joints, and spaces to be grouted shall be kept free from mortar and other debris. Units used in exposed masonry surfaces shall be selected from those having the least amount of chipped edges or other imperfections detracting from the appearance of the finished work. Vertical joints shall be kept plumb. Units being laid and surfaces to receive units shall be free of water film and frost. Solid units shall be laid in a nonfurrowed full bed of mortar. Mortar for veneer wythes shall be beveled and sloped toward the center of the wythe from the cavity side. Units shall be shoved into place so that the vertical joints are tight. Vertical joints of brick and the vertical face shells of concrete masonry units, except where indicated at control, expansion, and isolation joints, shall be completely filled with mortar. Mortar will be permitted to protrude up to 1/2 inch into the space or cells to be grouted. Means shall be provided to prevent mortar from dropping into the space below. In double wythe construction, the inner wythe may be brought up not more than 16 inches ahead of the outer wythe. Collar joints shall be filled with mortar or grout during the laying of the facing wythe, and filling shall

not lag the laying of the facing wythe by more than 8 inches.

3.2.1 Surface Preparation

Surfaces upon which masonry is placed shall be cleaned of laitance, dust, dirt, oil, organic matter, or other foreign materials and shall be slightly roughened to provide a surface texture with a depth of at least 1/8 inch. Sandblasting shall be used, if necessary, to remove laitance from pores and to expose the aggregate.

3.2.2 Forms and Shores

Forms and shores shall be sufficiently rigid to prevent deflections which may result in cracking or other damage to supported masonry and sufficiently tight to prevent leakage of mortar and grout. Supporting forms and shores shall not be removed in less than 10 days.

3.2.3 Concrete Masonry Units

Units in piers, pilasters, columns, starting courses on footings, solid foundation walls, lintels, and beams, and where cells are to be filled with grout shall be full bedded in mortar under both face shells and webs. Other units shall be full bedded under both face shells. Head joints shall be filled solidly with mortar for a distance in from the face of the unit not less than the thickness of the face shell. Foundation walls below grade shall be grouted solid. Jamb units shall be of the shapes and sizes to conform with wall units. Solid units may be incorporated in the masonry work where necessary to fill out at corners, gable slopes, and elsewhere as approved. Double walls shall be stiffened at wall-mounted plumbing fixtures by use of strap anchors, two above each fixture and two below each fixture, located to avoid pipe runs, and extending from center to center of the double wall. Walls and partitions shall be adequately reinforced for support of wall-hung plumbing fixtures when chair carriers are not specified.

3.2.3.1 Solid Units

Bed, head, and collar joints shall be completely filled with mortar.

3.2.3.2 Hollow Units

Hollow units shall be laid as specified for concrete masonry units.

3.2.4 Tolerances

Masonry shall be laid plumb, true to line, with courses level. Bond pattern shall be kept plumb throughout. Corners shall be square unless noted otherwise. Except for walls constructed of prefaced concrete masonry units, masonry shall be laid within the following tolerances (plus or minus unless otherwise noted):

TABLE II

TOLERANCES

Variation from the plumb in the lines
and surfaces of columns, walls and arises

TOLERANCES

In adjacent masonry units	1/8 inch
In 10 feet	1/4 inch
In 20 feet	3/8 inch
In 40 feet or more	1/2 inch

Variations from the plumb for external corners, expansion joints, and other conspicuous lines

In 20 feet	1/4 inch
In 40 feet or more	1/2 inch

Variations from the level for exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines

In 20 feet	1/4 inch
In 40 feet or more	1/2 inch

Variation from level for bed joints and top surfaces of bearing walls

In 10 feet	1/4 inch
In 40 feet or more	1/2 inch

Variations from horizontal lines

In 10 feet	1/4 inch
In 20 feet	3/8 inch
In 40 feet or more	1/2 inch

Variations in cross sectional dimensions of columns and in thickness of walls

Minus	1/4 inch
Plus	1/2 inch

3.2.5 Cutting and Fitting

Full units of the proper size shall be used wherever possible, in lieu of cut units. Cutting and fitting, including that required to accommodate the work of others, shall be done by masonry mechanics using power masonry saws. Concrete masonry units may be wet or dry cut. Wet cut units, before being placed in the work, shall be dried to the same surface-dry appearance as uncut units being laid in the wall. Cut edges shall be clean, true and sharp. Openings in the masonry shall be made carefully so that wall plates, cover plates or escutcheons required by the installation will completely conceal the openings and will have bottoms parallel with the masonry bed joints. Reinforced masonry lintels shall be provided above openings over 12 inches wide for pipes, ducts, cable trays, and other wall penetrations, unless steel sleeves are used.

3.2.6 Jointing

Joints shall be tooled when the mortar is thumbprint hard. Horizontal joints shall be tooled last. Joints shall be brushed to remove all loose and excess mortar. Mortar joints shall be finished as follows:

3.2.6.1 Flush Joints

Joints in concealed masonry surfaces and joints at electrical outlet boxes in wet areas shall be flush cut. Flush cut joints shall be made by cutting off the mortar flush with the face of the wall. Joints in unparged masonry walls below grade shall be pointed tight. Flush joints for architectural units, such as fluted units, shall completely fill both the head and bed joints.

3.2.6.2 Tooled Joints

Joints in exposed exterior and interior masonry surfaces shall be tooled slightly concave. Joints shall be tooled with a jointer slightly larger than the joint width so that complete contact is made along the edges of the unit. Tooling shall be performed so that the mortar is compressed and the joint surface is sealed. Jointer of sufficient length shall be used to obtain a straight and true mortar joint.

3.2.6.3 Door and Window Frame Joints

On the exposed interior side of exterior frames, joints between frames and abutting masonry walls shall be raked to a depth of 3/8 inch. On the exterior side of exterior frames, joints between frames and abutting masonry walls shall be raked to a depth of 3/8 inch.

3.2.7 Joint Widths

Joint widths shall be as follows:

3.2.7.1 Concrete Masonry Units

Concrete masonry units shall have 3/8 inch joints, except for prefaced concrete masonry units.

3.2.8 Embedded Items

Spaces around built-in items shall be filled with mortar. Openings around flush-mount electrical outlet boxes in wet locations shall be pointed with mortar. Anchors, ties, wall plugs, accessories, flashing, pipe sleeves and other items required to be built-in shall be embedded as the masonry work progresses. Anchors, ties and joint reinforcement shall be fully embedded in the mortar. Cells receiving anchor bolts and cells of the first course below bearing plates shall be filled with grout.

3.2.9 Unfinished Work

Unfinished work shall be stepped back for joining with new work. Toothing may be resorted to only when specifically approved. Loose mortar shall be removed and the exposed joints shall be thoroughly cleaned before laying new work.

3.2.10 Masonry Wall Intersections

Each course shall be masonry bonded at corners and elsewhere as shown.

Masonry walls shall be anchored or tied together at corners and intersections with bond beam reinforcement and prefabricated corner or tee pieces of joint reinforcement as shown.

3.2.11 Partitions

Partitions shall be continuous from floor to underside of floor or roof deck where shown. Openings in firewalls around joists or other structural members shall be filled as indicated or approved. Where suspended ceilings on both sides of partitions are indicated, the partitions other than those shown to be continuous may be stopped approximately 4 inches above the ceiling level. An isolation joint shall be placed in the intersection between partitions and structural or exterior walls as shown. Interior partitions having 4 inch nominal thick units shall be tied to intersecting partitions of 4 inch units, 5 inches into partitions of 6 inch units, and 7 inches into partitions of 8 inch or thicker units. Cells within vertical plane of ties shall be filled solid with grout for full height of partition or solid masonry units may be used. Interior partitions having masonry walls over 4 inches thick shall be tied together with joint reinforcement. Partitions containing joint reinforcement shall be provided with prefabricated pieces at corners and intersections or partitions.

3.3 MORTAR

Mortar shall be mixed in a mechanically operated mortar mixer for at least 3 minutes, but not more than 5 minutes. Measurement of ingredients for mortar shall be by volume. Ingredients not in containers, such as sand, shall be accurately measured by the use of measuring boxes. Water shall be mixed with the dry ingredients in sufficient amount to provide a workable mixture which will adhere to the vertical surfaces of masonry units. Mortar that has stiffened because of loss of water through evaporation shall be retempered by adding water to restore the proper consistency and workability. Mortar that has reached its initial set or that has not been used within 2-1/2 hours after mixing shall be discarded.

3.4 REINFORCING STEEL

Reinforcement shall be cleaned of loose, flaky rust, scale, grease, mortar, grout, or other coating which might destroy or reduce its bond prior to placing grout. Bars with kinks or bends not shown on the drawings shall not be used. Reinforcement shall be placed prior to grouting. Unless otherwise indicated, vertical wall reinforcement shall extend to within 2 inches of tops of walls.

3.4.1 Positioning Bars

Vertical bars shall be accurately placed within the cells at the positions indicated on the drawings. A minimum clearance of 1/2 inch shall be maintained between the bars and masonry units. Minimum clearance between parallel bars shall be one diameter of the reinforcement. Vertical reinforcing may be held in place using bar positioners located near the ends of each bar and at intermediate intervals of not more than 192 diameters of the reinforcement. Column and pilaster ties shall be wired in position around the vertical steel. Ties shall be in contact with the vertical reinforcement and shall not be placed in horizontal bed joints.

3.4.2 Splices

Bars shall be lapped a minimum of 48 diameters of the reinforcement.

Welded or mechanical connections shall develop at least 125 percent of the specified yield strength of the reinforcement.

3.5 JOINT REINFORCEMENT

Joint reinforcement shall be installed at 16 inches on center or as indicated. Reinforcement shall be lapped not less than 6 inches. Prefabricated sections shall be installed at corners and wall intersections. The longitudinal wires of joint reinforcement shall be placed to provide not less than 5/8 inch cover to either face of the unit.

3.6 PLACING GROUT

Cells containing reinforcing bars shall be filled with grout. Hollow masonry units in walls or partitions supporting plumbing, heating, or other mechanical fixtures, voids at door and window jambs, and other indicated spaces shall be filled solid with grout. Cells under lintel bearings on each side of openings shall be filled solid with grout for full height of openings. Walls below grade, lintels, and bond beams shall be filled solid with grout. Units other than open end units may require grouting each course to preclude voids in the units. Grout not in place within 1-1/2 hours after water is first added to the batch shall be discarded. Sufficient time shall be allowed between grout lifts to preclude displacement or cracking of face shells of masonry units. If blowouts, flowouts, misalignment, or cracking of face shells should occur during construction, the wall shall be torn down and rebuilt.

3.6.1 Vertical Grout Barriers for Fully Grouted Walls

Grout barriers shall be provided not more than 30 feet apart, or as required, to limit the horizontal flow of grout for each pour.

3.6.2 Horizontal Grout Barriers

Grout barriers shall be embedded in mortar below cells of hollow units receiving grout.

3.6.3 Grouting Equipment

3.6.3.1 Grout Pumps

Pumping through aluminum tubes will not be permitted. Pumps shall be operated to produce a continuous stream of grout without air pockets, segregation, or contamination. Upon completion of each day's pumping, waste materials and debris shall be removed from the equipment, and disposed of outside the masonry.

3.6.3.2 Vibrators

Internal vibrators shall maintain a speed of not less than 5,000 impulses per minute when submerged in the grout. At least one spare vibrator shall be maintained at the site at all times. Vibrators shall be applied at uniformly spaced points not further apart than the visible effectiveness of the machine. Duration of vibration shall be limited to time necessary to produce satisfactory consolidation without causing segregation.

3.6.4 Grout Placement

Masonry shall be laid to the top of a pour before placing grout. Grout

shall not be placed in two-wythe solid unit masonry cavity until mortar joints have set for at least 3 days during hot weather and 5 days during cold damp weather. Grout shall not be placed in hollow unit masonry until mortar joints have set for at least 24 hours. Grout shall be placed using a hand bucket, concrete hopper, or grout pump to completely fill the grout spaces without segregation of the aggregates. Vibrators shall not be inserted into lower pours that are in a semi-solidified state. The height of grout pours and type of grout used shall be limited by the dimensions of grout spaces as indicated in Table III. Low-lift grout methods may be used on pours up to and including 5 feet in height. High-lift grout methods shall be used on pours exceeding 5 feet in height.

3.6.4.1 Low-Lift Method

Grout shall be placed at a rate that will not cause displacement of the masonry due to hydrostatic pressure of the grout. Mortar protruding more than 1/2 inch into the grout space shall be removed before beginning the grouting operation. Grout pours 12 inches or less in height shall be consolidated by mechanical vibration or by puddling. Grout pours over 12 inches in height shall be consolidated by mechanical vibration and reconsolidated by mechanical vibration after initial water loss and settlement has occurred. Vibrators shall not be inserted into lower pours that are in a semi-solidified state. Low-lift grout shall be used subject to the limitations of Table III.

3.6.4.2 High-Lift Method

Mortar droppings shall be cleaned from the bottom of the grout space and from reinforcing steel. Mortar protruding more than 1/4 inch into the grout space shall be removed by dislodging the projections with a rod or stick as the work progresses. Reinforcing, bolts, and embedded connections shall be rigidly held in position before grouting is started. CMU units shall not be pre-wetted. Grout, from the mixer to the point of deposit in the grout space shall be placed as rapidly as practical by pumping and placing methods which will prevent segregation of the mix and cause a minimum of grout splatter on reinforcing and masonry surfaces not being immediately encased in the grout lift. The individual lifts of grout shall be limited to 4 feet in height. The first lift of grout shall be placed to a uniform height within the pour section and vibrated thoroughly to fill all voids. This first vibration shall follow immediately behind the pouring of the grout using an approved mechanical vibrator. After a waiting period sufficient to permit the grout to become plastic, but before it has taken any set, the succeeding lift shall be poured and vibrated 12 to 18 inches into the preceding lift. If the placing of the succeeding lift is going to be delayed beyond the period of workability of the preceding, each lift shall be reconsolidated by reworking with a second vibrator as soon as the grout has taken its settlement shrinkage. The waiting, pouring, and reconsolidation steps shall be repeated until the top of the pour is reached. The top lift shall be reconsolidated after the required waiting period. The high-lift grouting of any section of wall between vertical grout barriers shall be completed to the top of a pour in one working day unless a new series of cleanout holes is established and the resulting horizontal construction joint cleaned. High-lift grout shall be used subject to the limitations in Table III.

TABLE III

POUR HEIGHT AND TYPE OF GROUT FOR VARIOUS GROUT SPACE DIMENSIONS

Maximum Grout Pour Height (feet) (4)	Grout Type	Grouting Procedure	Minimum Dimensions of the Total Clear Areas Within Grout Spaces and Cells (in.) (1,2) Multiwythe Masonry (3)	Hollow-unit Masonry
1	Fine	Low Lift	3/4	1-1/2 x 2
5	Fine	Low Lift	2	2 x 3
8	Fine	High Lift	2	2 x 3
12	Fine	High Lift	2-1/2	2-1/2 x 3
24	Fine	High Lift	3	3 x 3
1	Coarse	Low Lift	1-1/2	1-1/2 x 3
5	Coarse	Low Lift	2	2-1/2 x 3
8	Coarse	High Lift	2	3 x 3
12	Coarse	High Lift	2-1/2	3 x 3
24	Coarse	High Lift	3	3 x 4

Notes:

(1) The actual grout space or cell dimension must be larger than the sum of the following items:
a) The required minimum dimensions of total clear areas given in the table above;
b) The width of any mortar projections within the space;
c) The horizontal projections of the diameters of the horizontal reinforcing bars within a cross section of the grout space or cell.

(2) The minimum dimensions of the total clear areas shall be made up of one or more open areas, with at least one area being 3/4 inch or greater in width.

(3) For grouting spaces between masonry wythes.

(4) Where only cells of hollow masonry units containing reinforcement are grouted, the maximum height of the pour shall not exceed the distance between horizontal bond beams.

3.7 BOND BEAMS

Bond beams shall be filled with grout and reinforced as indicated on the drawings. Grout barriers shall be installed under bond beam units to retain the grout as required. Reinforcement shall be continuous, including around corners, except through control joints or expansion joints, unless otherwise indicated on the drawings. Where splices are required for continuity, reinforcement shall be lapped 48 bar diameters. A minimum clearance of 1/2 inch shall be maintained between reinforcement and interior faces of units.

3.8 CONTROL JOINTS

Control joints shall be provided as indicated and shall be constructed by using sash jamb units with control joint key in accordance with the details shown on the drawings. Sash jamb units shall have a 3/4 by 3/4 inch groove

near the center at end of each unit. The vertical mortar joint at control joint locations shall be continuous, including through all bond beams. This shall be accomplished by utilizing half blocks in alternating courses on each side of the joint. The control joint key shall be interrupted in courses containing continuous bond beam steel.

3.9 LINTELS

3.9.1 Precast Concrete and Steel Lintels

Precast concrete and steel lintels shall be as shown on the drawings. Lintels shall be set in a full bed of mortar with faces plumb and true. Steel and precast lintels shall have a minimum bearing length of 8 inches unless otherwise indicated on the drawings.

3.10 SPLASH BLOCKS

Splash blocks shall be located as shown.

3.11 POINTING AND CLEANING

After mortar joints have attained their initial set, but prior to hardening, mortar and grout daubs or splashings shall be completely removed from masonry-unit surfaces that will be exposed or painted. Before completion of the work, defects in joints of masonry to be exposed or painted shall be raked out as necessary, filled with mortar, and tooled to match existing joints. Immediately after grout work is completed, scum and stains which have percolated through the masonry work shall be removed using a high pressure stream of water and a stiff bristled brush. Masonry surfaces shall not be cleaned, other than removing excess surface mortar, until mortar in joints has hardened. Masonry surfaces shall be left clean, free of mortar daubs, dirt, stain, and discoloration, including scum from cleaning operations, and with tight mortar joints throughout. Metal tools and metal brushes shall not be used for cleaning.

3.11.1 Concrete Masonry Unit and Concrete Brick Surfaces

Exposed concrete masonry unit and concrete brick surfaces shall be dry-brushed at the end of each day's work and after any required pointing, using stiff-fiber bristled brushes.

3.12 TEST REPORTS

3.12.1 Field Testing of Mortar

At least three specimens of mortar shall be taken each day. A layer of mortar 1/2 to 5/8 inch thick shall be spread on the masonry units and allowed to stand for one minute. The specimens shall then be prepared and tested for compressive strength in accordance with ASTM C 780.

3.12.2 Field Testing of Grout

Field sampling and testing of grout shall be in accordance with the applicable provisions of ASTM C 1019. A minimum of three specimens of grout per day shall be sampled and tested. Each specimen shall have a minimum ultimate compressive strength of 2000 psi at 28 days.

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SECTION 05120

STRUCTURAL STEEL

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC FCD	(1995a) Quality Certification Program Description
AISC ASD Manual	(1989) Manual of Steel Construction Allowable Stress Design
AISC ASD/LRFD Vol II	(1992) Manual of Steel Construction Vol II: Connections
AISC Design Guide No. 10	(1989) Erection Bracing of Low-Rise Structural Steel Frames
AISC LRFD Vol II	(1995) Manual of Steel Construction Load & Resistance Factor Design, Vol II: Structural Members, Specifications & Codes
AISC Pub No. S303	(1992) Code of Standard Practice for Steel Buildings and Bridges

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 6/A 6M	(1998a) General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A 36/A 36M	(1997a) Carbon Structural Steel
ASTM A 53	(1999) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 242/A 242M	(1998) High-Strength Low-Alloy Structural Steel
ASTM A 307	(1997) Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 325	(1997) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 490	(1997) Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength

ASTM A 500	(1999) Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 502	(1993) Steel Structural Rivets
ASTM A 514/A 514M	(1994a) High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding
ASTM A 563	(1997) Carbon and Alloy Steel Nuts
ASTM A 563M	(1997) Carbon and Alloy Steel Nuts (Metric)
ASTM A 572/A 572M	(1999) High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A 709/A 709M	(1997a) Carbon and High-Strength Low-Alloy Structural Steel Shapes, Plates, and Bars and Quenched-and-Tempered Alloy Structural Steel Plates for Bridges
ASTM A 852/A 852M	(1997) Quenched and Tempered Low-Alloy Structural Steel Plate with 70 ksi (485 MPa) Minimum Yield Strength to 4 in. (100 mm) Thick
ASTM A 992/A 992M	(1998e1) Steel for Structural Shapes For Use in Building Framing
ASTM F 844	(1998) Washers, Steel, Plain (Flat), Unhardened for General Use

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.21.1	(1994) Lock Washers (Inch Series)
ASME B46.1	(1995) Surface Texture (Surface Roughness, Waviness, and Lay)

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(1998) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS D1.1	(1998) Structural Welding Code - Steel

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC Paint 25	(1991) Red Iron Oxide, Zinc Oxide, Raw Linseed Oil and Alkyd Primer (without Lead and Chromate Pigments)

1.2 GENERAL REQUIREMENTS

Structural steel fabrication and erection shall be performed by an organization experienced in structural steel work of equivalent magnitude. The Contractor shall be responsible for correctness of detailing,

fabrication, and for the correct fitting of structural members. Connections, for any part of the structure not shown on the contract drawings, shall be considered simple shear connections and shall be designed and detailed in accordance with pertinent provisions of AISC ASD Manual and AISC LRFD Vol II. Substitution of sections or modification of connection details will not be accepted unless approved by the Contracting Officer. AISC ASD Manual and AISC ASD/LRFD Vol II shall govern the work. Welding shall be in accordance with AWS D1.1.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Structural Steel System; GA.
Structural Connections; GA.

Shop and erection details including members (with their connections) not shown on the contract drawings. Welds shall be indicated by standard welding symbols in accordance with AWS A2.4.

SD-03 Product Data

Erection; GA.

Prior to erection, erection plan of the structural steel framing describing all necessary temporary supports, including the sequence of installation and removal.

Welding; GA.

WPS not prequalified.

WPS prequalified.

SD-07 Certificates

Mill Test Reports; GA.

Certified copies of mill test reports for structural steel, structural bolts, nuts, washers and other related structural steel items, including attesting that the structural steel furnished contains no less than 25 percent recycled scrap steel and meets the requirements specified, prior to the installation.

Welder Qualifications; GA.

Certified copies of welder qualifications test records showing qualification in accordance with AWS D1.1.

Welding Inspector; GA.

Welding Inspector qualifications.

Fabrication; GA.

A copy of the AISC certificate indicating that the fabrication plant meets the specified structural steelwork category.

1.4 STORAGE

Material shall be stored out of contact with the ground and protected from weather in such manner and location as will minimize deterioration.

1.5 WELDING INSPECTOR

Welding Inspector qualifications shall be in accordance with AWS D1.1

PART 2 PRODUCTS

2.1 STRUCTURAL STEEL

2.1.1 Carbon Grade Steel

Carbon grade steel shall conform to ASTM A 36/A 36M.

2.1.2 High-Strength Low-Alloy Steel

High-strength low-alloy steel shall conform to ASTM A 572/A 572M.

2.1.3 Corrosion-Resistant High-Strength Low-Alloy Steel

Corrosion-resistant steel shall conform to ASTM A 242/A 242M.

2.1.4 Quenched and Tempered Alloy Steel

Tempered alloy steel shall conform to ASTM A 514/A 514M.

2.1.5 Carbon and High-Strength Low-Alloy Steel

Carbon and high-strength low-alloy steel shall conform to ASTM A 709/A 709M.

2.1.6 Quenched and Tempered Low-Alloy Steel

Quenched and tempered low-alloy steel shall conform to ASTM A 852/A 852M, 70 ksi.

2.1.7 Structural Shapes for Use in Building Framing

Wide flange shapes in accordance with ASTM A 992/A 992M shall be used where indicated on the drawings.

2.2 STRUCTURAL TUBING

Structural tubing shall conform to ASTM A 500, Grade B.

2.3 STEEL PIPE

Steel pipe shall conform to ASTM A 53, Type S, Grade B.

2.4 RIVETS

Rivets shall conform to ASTM A 502.

2.5 HIGH STRENGTH BOLTS AND NUTS

High strength bolts shall conform to ASTM A 325.

2.6 CARBON STEEL BOLTS AND NUTS

Carbon steel bolts shall conform to ASTM A 307, Grade A with carbon steel nuts conforming to ASTM A 563, Grade A.

2.7 NUTS DIMENSIONAL STYLE

Carbon steel nuts shall be Square style when used with ASTM A 307 bolts or Heavy Hex style when used with ASTM A 325 or ASTM A 490 bolts.

2.8 WASHERS

Plain washers shall conform to ASTM F 844. Other types, when required, shall conform to ASME B18.21.1 type B.

2.9 PAINT

Paint shall conform to SSPC Paint 25.

PART 3 EXECUTION

3.1 FABRICATION

Fabrication shall be in accordance with the applicable provisions of AISC ASD Manual. Fabrication and assembly shall be done in the shop to the greatest extent possible. The fabricating plant shall be certified under the AISC FCD for Category E structural steelwork. Compression joints depending on contact bearing shall have a surface roughness not in excess of 500 micro inches as determined by ASME B46.1, and ends shall be square within the tolerances for milled ends specified in ASTM A 6/A 6M. Structural steelwork, except surfaces of steel to be encased in concrete, surfaces to be field welded, surfaces to be fireproofed, and contact surfaces of friction-type high-strength bolted connections shall be prepared for painting.

3.2 ERECTION

Erection for low-rise structural steel buildings (60 feet tall or less and a maximum of 2 stories), the erection plan shall conform to AISC Pub No. S303 and the structure shall be erected in accordance with AISC Design Guide No. 10.

3.2.1 Structural Connections

Anchor bolts and other connections between the structural steel and foundations shall be provided and shall be properly located and built into connecting work. Field welded structural connections shall be completed before load is applied.

3.2.2 Base Plates and Bearing Plates

Column base plates for columns and bearing plates for beams, girders, and similar members shall be provided. Base plates and bearing plates shall be provided with full bearing after the supported members have been plumbed and properly positioned, but prior to placing superimposed loads. Separate

setting plates under column base plates will not be permitted. The area under the plate shall be damp-packed solidly with bedding mortar, except where nonshrink grout is used. Bedding mortar and grout shall be as specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.

3.2.3 Field Priming

After erection, the field bolt heads and nuts, field welds, and any abrasions in the shop coat shall be cleaned and primed with paint of the same quality as that used for the shop coat.

3.3 WELDING

The Contractor shall develop and submit the Welding Procedure Specifications (WPS) for all welding, including welding done using prequalified procedures. Prequalified procedures may be submitted for information only; however, procedures that are not prequalified shall be submitted for government approval.

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SECTION 05500

MISCELLANEOUS METAL

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF-45	(1997) Designation System for Aluminum Finishes
AA SAA-46	(1978) Standards for Anodized Architectural Aluminum

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC S303	(2000) Code of Standard Practice for Steel Buildings and Bridges

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A14.3	(1992) Ladders - Fixed - Safety Requirements

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123/A 123M	(2001) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 36/A 36M	(2000a) Carbon Structural Steel
ASTM A 467/A 467M	(1998) Machine and Coil Chain
ASTM A 53/A 53M	(2001) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 653/A 653M	(2000) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 924/A 924M	(1999) General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B 429	(2000) Aluminum-Alloy Extruded Structural Pipe and Tube

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	(2000) Structural Welding Code - Steel

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM MBG 531 (1994) Metal Bar Grating Manual

NAAMM MBG 532 (1994) Heavy Duty Metal Bar Grating Manual

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Miscellaneous Metal Items; GA.

Detail drawings indicating material thickness, type, grade, and class; dimensions; and construction details. Drawings shall include catalog cuts, erection details, manufacturer's descriptive data and installation instructions, and templates. Detail drawings for the following items: aluminum platform complete with framing, railings, plates and stairs and access panels; mezzanine design calculations and detailed drawings, concrete slab and mezzanine supports calculations and detailed drawings.

SD-06 Test Reports

Mill Test Reports; FIO

Certified copies of mill test reports for structural steel, structural bolts, nuts, washers and other related structural stell items.

SD-07 Certificates

Welder Qualifications; FIO

Certified copies of welder qualifications test records showing qualifications in accordance with AWS D1.1.

Structural Steel Erector Qualiications; FIO

A copy of the structural steel erector's state license shall be provided.

Fabrication; GA

A copy of the AISC certificate indicating that the fabrication plant meets the specified structural steel category.

SD-08 Manufacturer's Instructions

Erection; FIO.

Erection plan of the structural steel framing required. Erection plan shall conform to the requirements of AISC S303, shall be submitted prior to the sequence of installation and

removal.

1.3 GENERAL REQUIREMENTS

The Contractor shall verify all measurements and shall take all field measurements necessary before fabrication. Welding to or on structural steel shall be in accordance with AWS D1.1. Items specified to be galvanized, when practicable and not indicated otherwise, shall be hot-dip galvanized after fabrication. Galvanizing shall be in accordance with ASTM A 123/A 123M, ASTM A 653/A 653M, or ASTM A 924/A 924M, as applicable. Exposed fastenings shall be compatible materials, shall generally match in color and finish, and shall harmonize with the material to which fastenings are applied. Materials and parts necessary to complete each item, even though such work is not definitely shown or specified, shall be included. Poor matching of holes for fasteners shall be cause for rejection. Fastenings shall be concealed where practicable. Thickness of metal and details of assembly and supports shall provide strength and stiffness. Joints exposed to the weather shall be formed to exclude water.

1.4 DISSIMILAR MATERIALS

Where dissimilar metals are in contact, or where aluminum is in contact with concrete, mortar, masonry, wet or pressure-treated wood, or absorptive materials subject to wetting, the surfaces shall be protected with a coat of bituminous paint or asphalt varnish.

1.5 WORKMANSHIP

Miscellaneous metalwork shall be well formed to shape and size, with sharp lines and angles and true curves. Drilling and punching shall produce clean true lines and surfaces. Welding shall be continuous along the entire area of contact except where tack welding is permitted. Exposed connections of work in place shall not be tack welded. Exposed welds shall be ground smooth. Exposed surfaces of work in place shall have a smooth finish, and unless otherwise approved, exposed riveting shall be flush. Where tight fits are required, joints shall be milled. Corner joints shall be coped or mitered, well formed, and in true alignment. Work shall be accurately set to established lines and elevations and securely fastened in place. Installation shall be in accordance with manufacturer's installation instructions and approved drawings, cuts, and details.

1.6 ANCHORAGE

Anchorage shall be provided where necessary for fastening miscellaneous metal items securely in place. Anchorage not otherwise specified or indicated shall include slotted inserts made to engage with the anchors, expansion shields, and power-driven fasteners when approved for concrete; toggle bolts and through bolts for masonry; machine and carriage bolts for steel; and lag bolts and screws for wood.

1.7 ALUMINUM FINISHES

Unless otherwise specified, aluminum items shall have standard mill finish except that aluminum railings shall have a clear anodized finish conforming to AA SAA-46. The thickness of the coating shall be not less than that specified for protective and decorative type finishes for items used in interior locations or architectural Class I type finish for items used in exterior locations in AA DAF-45. Items to be anodized shall receive a polished satin finish pretreatment and a clear lacquer overcoating.

1.8 SHOP PAINTING

Surfaces of ferrous metal except galvanized surfaces, shall be cleaned and shop coated with the manufacturer's standard protective coating unless otherwise specified. Surfaces of items to be embedded in concrete shall not be painted. Items to be finish painted shall be prepared according to manufacturer's recommendations or as specified.

PART 2 PRODUCTS

2.1 ACCESS DOORS AND PANELS

Doors and panels shall be flush type unless otherwise indicated. Frames for access doors shall be fabricated of not lighter than 16 gauge steel with welded joints and finished with anchorage for securing into construction. Access doors shall be a minimum of 14 by 20 inches and of not lighter than 14 gauge steel, with stiffened edges, complete with attachments. Access doors shall be hinged to frame and provided with a flush face, screw driver operated latch. Exposed metal surfaces shall have a baked enamel finish.

2.2 CORNER GUARDS AND SHIELDS

Corner guards and shields for jambs and sills of openings and edges of platforms shall be steel shapes and plates anchored in masonry or concrete with welded steel straps or end weld stud anchors. Corner guards for use with glazed or ceramic tile finish on walls shall be formed of 0.0625 inch thick corrosion-resisting steel with polished or satin finish, shall extend 5 feet above the top of cove base or to the top of the wainscot, whichever is less, and shall be securely anchored to the supporting wall. Corner guards on exterior shall be galvanized.

2.3 DOOR GUARDS

Door guards shall be constructed of woven steel wire or expanded metal framed with structural steel shapes. Expanded metal guards shall be of 1-1/2 inch No. 10 mesh, welded to 1 by 1 by 1/8 inch angle frame. Woven-wire panel shall be of 10 gauge, 1-1/2 inch mesh secured through weaving to 1 inch channel frame or around a 3/8 inch round bar frame. Corners of frames shall be mitered and welded. Guards shall be sized as indicated.

2.4 PIPE GUARDS

Pipe guards shall be heavy duty steel pipe conforming to ASTM A 53/A 53M, Type E or S, weight STD, black finish.

2.5 DOWNSPOUT BOOTS

Downspout boots shall be cast iron with receiving bells sized to fit downspouts.

2.6 FLOOR GRATINGS AND FRAMES

Stainless steel grating shall be designed in accordance with NAAMM MBG 532 to meet the indicated load requirements. Edges shall be banded with bars 1/4 inch less in height than bearing bars for grating sizes above 3/4 inch. Banding bars shall be flush with the top of bearing grating. Frames shall

be of welded steel construction finished to match the grating. Floor gratings and frames shall be galvanized after fabrication.

2.7 HANDRAILS

Handrails shall be designed to resist a concentrated load of 200 pounds in any direction at any point of the top of the rail or 20 pounds per foot applied horizontally to top of the rail, whichever is more severe.

2.7.1 Aluminum Handrails

Handrails shall consist of 1-1/2 inch IPS, Schedule 80, aluminum pipe alloy 6063-T6 for intermediate rails conforming to ASTM B 429. Railings and pipe collars shall be anodized aluminum clear in color. All fasteners shall be Series 300 stainless steel.

a. Jointing shall be by the following method:

(1) Mitered and welded joints, made by fitting post to top rail and intermediate rail to post and corners, shall be groove welded and ground smooth. Splices, where allowed by the Contracting Officer, shall be butted and reinforced by a tight fitting dowel or sleeve not less than 6 inches in length. Dowel or sleeve shall be connected to one side of the splice by tack welding or by using epoxy cement.

2.8 LADDERS

Ladders shall be steel or aluminum, fixed rail type in accordance with ANSI A14.3.

2.9 METAL GRID WALKWAYS

Metal grid walkways shall be designed to protect rooftops from pedestrian traffic and shall be 14 gauge minimum galvanized steel. The walkway shall consist of metal planks, 2 by 10 or 12 feet, bolted or welded to support stands. Other sizes may be furnished if approved. In addition to end supports, a midspan support shall be provided when required to limit deflection. End supports shall be located to avoid uplift and to provide continuous runs.

2.10 MISCELLANEOUS

Miscellaneous plates and shapes for items that do not form a part of the structural steel framework, such as lintels, sill angles, miscellaneous mountings, and frames, shall be provided to complete the work.

2.11 ROOF SCUTTLES

Roof scuttles shall be of galvanized steel not less than 14 gauge, with 3 inch beaded flange welded and ground at corners. Scuttle shall be sized to provide minimum clear opening of 37 by 30 inches. Cover and curb shall be insulated with 1 inch thick rigid insulation covered and protected by galvanized steel liner not less than 26 gauge. The curb shall be equipped with an integral metal cap flashing of the same gauge and metal as the curb, full welded and ground at corners for weathertightness. Scuttle shall be completely assembled with heavy hinges, compression spring operators enclosed in telescopic tubes, positive snap latch with turn handles on inside and neoprene draft seal. Fasteners shall be provided for

padlocking on the inside. The cover shall be equipped with an automatic hold-open arm complete with handle to permit one hand release.

2.12 SAFETY CHAINS

Safety chains shall be galvanized welded steel, proof coil chain tested in accordance with ASTM A 467/A 467M, Class CS. Safety chains shall be straight link style, 3/16 inch diameter, minimum 12 links per foot and with bolt type snap hooks on each end. Eye bolts for attachment of chains shall be galvanized 3/8 inch bolt with 3/4 inch eye, anchored as indicated. Two chains shall be furnished for each guarded opening.

2.13 STEEL STAIRS

Steel stairs shall be complete with structural or formed channel stringers, slip-resistant metallic treads, landings, columns, handrails, and necessary bolts and other fastenings as indicated. Structural steel shall conform to ASTM A 36/A 36M. Stairs and accessories shall be galvanized. Risers on stairs with metal pan treads shall be deformed to form a sanitary cove to retain the tread concrete. Integral nosings shall have braces extended into the concrete fill. Gratings for treads and landings shall conform to NAAMM MBG 531. Grating treads shall have slip-resistant nosings.

2.14 STEEL DOOR FRAMES

Steel door frames built from structural shapes shall be neatly mitered and securely welded at the corners with all welds ground smooth. Jambs shall be provided with 2 by 1/4 by 12 inch bent, adjustable metal anchors spaced not over 2 feet 6 inches on centers. Provision shall be made to stiffen the top member for all spans over 3 feet. Continuous door stops shall be made of 1-1/2 by 5/8 inch bars.

2.15 TRENCH COVERS, FRAMES, AND LINERS

Trench covers shall be designed to meet the indicated load requirements. Trench frames and anchors shall be all welded steel construction designed to match cover. Covers shall be secured to frame, and shall be cast-iron grating. Grating opening widths shall not exceed 1 inch. Trench liners shall be cast iron with integral frame for cover.

2.16 MEZZANINE (ABOVE CONTROL ROOM AND BATHROOM)

Design, fabrication and construct a mezzanine consisting of cellular steel decks and a 2 inch concrete fill capable of withstanding a uniform live load of 200 psf. Provide structural steel shapes, plates and bolts necessary to support the steel decks on building columns and on masonry walls. Refer to drawings for location of mezzanine and building structure.

2.16.1 Cellular Steel Decks

Cellular steel decks shall be of 18-gauge or heavier as determined by design and comply with ASTM A 653/A 653M.

2.16.2 Concrete

Concrete fill shall be supplied and placed in accordance with the requirements of Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.

2.16.3 Platforms

Fabricate from 1/4-inch, thick tread plate. Support platforms on edges by angles and at midspan by tees. Provide tread and platform plate with acceptance nonskid pattern surface.

2.16.4 Railings

Provide aluminum pipe railings as specified herein.

2.16.5 Ladder

Provide structural aluminum channel supports and brackets necessary to complete ladder. Ladder construction shall be consistent with the requirements specified in 29 CFR 1910.23.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

All items shall be installed according to the manufacturer's recommendations. Items listed below require additional procedures as specified.

3.2 REMOVABLE ACCESS PANELS

A removable access panel not less than 12 by 12 inches shall be installed directly below each valve, flow indicator, damper, or air splitter that is located above the ceiling, other than an acoustical ceiling, and that would otherwise not be accessible.

3.3 DOOR GUARD FRAME

Door guard frame shall be mounted over the glazed opening using 1/4 inch lag bolts on the interior of wood doors or tamperproof through bolts on the interior of metal doors.

3.4 INSTALLATION OF PIPE GUARDS

Pipe guards shall be set vertically in concrete piers. Piers shall be constructed of, and the hollow cores of the pipe filled with, concrete specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.

3.5 INSTALLATION OF DOWNSPOUT BOOTS

Downspouts shall be secured to building through integral lips with appropriate fasteners.

3.6 ATTACHMENT OF HANDRAILS

Toeboards and brackets shall be installed where indicated. Splices, where required, shall be made at expansion joints. Removable sections shall be installed as indicated.

3.6.1 Installation of Aluminum Handrails

Installation shall be by means of base plates or flanges bolted to stringers or structural steel framework. Bolts used to anchor aluminum alloy flanges shall be stainless steel of a size appropriate to the standard product of the manufacturer. Where aluminum or alloy fittings or

extrusions are to be in contact with dissimilar metals or portland cement concrete, the contact surface shall be given a heavy coating of bituminous paint or asphalt varnish.

3.7 INSTALLATION OF METAL GRID WALKWAYS

Walkways shall be installed after final flood coat and aggregate surfacing. Each stand shall be set on a protective pad; the pad may be adhesively attached to the bottom of the stand or set loose under the stand. The area where the supports are to be located shall be swept clear of loose aggregate. Protective pad shall be placed on the roof membrane except on inverted roofs where the protective pad shall be set on the rigid insulation.

3.8 MOUNTING OF SAFETY CHAINS

Safety chains shall be mounted 3 feet 6 inches and 2 feet above the floor.

3.9 INSTALLATION OF SAFETY NOSINGS

Nosing shall be completely embedded in concrete before the initial set of the concrete occurs and shall finish flush with the top of the concrete surface.

3.10 DOOR FRAMES

Door frames shall be secured to the floor slab by means of angle clips and expansion bolts. Continuous door stops shall be welded to the frame or tap screwed with countersunk screws at no more than 18 inchcenters, assuring in either case full contact with the frame. Any necessary reinforcements shall be made and the frames shall be drilled and tapped as required for hardware.

3.11 TRENCH FRAMES AND COVERS

Trench frames and covers shall finish flush with the floor.

-- End of Section --

DIVISION 06 – WOODS & PLASTICS
NOT IN USE

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DIVISION 07 - THERMAL & MOISTURE PROTECTION

SECTION 07840

FIRESTOPPING

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SECTION 07840

FIRESTOPPING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 84	(1999) Surface Burning Characteristics of Building Materials
ASTM E 119	(1998) Fire Tests of Building Construction and Materials
ASTM E 814	(1997) Fire Tests of Through-Penetration Fire Stops
ASTM E 1399	(1997) Cyclic Movement and Measuring the Minimum and Maximum Joint Widths of Architectural Joint Systems

UNDERWRITERS LABORATORIES (UL)

UL 723	(1996; Rev thru Dec 1998) Test for Surface Burning Characteristics of Building Materials
UL 1479	(1994; Rev thru Feb 1998) Fire Tests of Through-Penetration Firestops
UL 2079	(1998) Tests for Fire Resistance of Building Joint Systems
UL Fire Resist Dir	(1999) Fire Resistance Directory (2 Vol.)

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Firestopping Materials; GA.

Detail drawings including manufacturer's descriptive data, typical details conforming to UL Fire Resist Dir or other details

certified by another nationally recognized testing laboratory, installation instructions or UL listing details for a firestopping assembly in lieu of fire-test data or report. For those firestop applications for which no UL tested system is available through a manufacturer, a manufacturer's engineering judgement, derived from similar UL system designs or other tests, shall be submitted for review and approval prior to installation. Submittal shall indicate the firestopping material to be provided for each type of application. When more than 5 penetrations or construction joints are to receive firestopping, drawings shall indicate location and type of application.

SD-07 Certificates

Firestopping Materials; GA.

Certificates attesting that firestopping material complies with the specified requirements. In lieu of certificates, drawings showing UL classified materials as part of a tested assembly may be provided. Drawings showing evidence of testing by an alternate nationally recognized independent laboratory may be substituted.

Installer Qualifications; GA.

Documentation of training and experience.

Inspection; GA.

Manufacturer's representative certification stating that firestopping work has been inspected and found to be applied according to the manufacturer's recommendations and the specified requirements.

1.3 GENERAL REQUIREMENTS

Firestopping shall consist of furnishing and installing tested and listed firestop systems, combination of materials, or devices to form an effective barrier against the spread of flame, smoke and gases, and maintain the integrity of fire resistance rated walls, partitions, floors, and ceiling-floor assemblies, including through-penetrations and construction joints and gaps. Through-penetrations include the annular space around pipes, tubes, conduit, wires, cables and vents. Construction joints include those used to accommodate expansion, contraction, wind, or seismic movement; firestopping material shall not interfere with the required movement of the joint. Gaps requiring firestopping include gaps between the curtain wall and the floor slab and between the top of the fire-rated walls and the roof.

1.4 STORAGE AND DELIVERY

Materials shall be delivered in the original unopened packages or containers showing name of the manufacturer and the brand name. Materials shall be stored off the ground and shall be protected from damage and exposure to elements. Damaged or deteriorated materials shall be removed from the site.

1.5 INSTALLER QUALIFICATIONS

The Contractor shall engage an experienced Installer who is certified,

licensed, or otherwise qualified by the firestopping manufacturer as having the necessary staff, training, and a minimum of 3 years experience in the installation of manufacturer's products per specified requirements. A manufacturer's willingness to sell its firestopping products to the Contractor or to an installer engaged by the Contractor does not in itself confer qualification on the buyer. The Installer shall have been trained by a direct representative of the manufacturer (not distributor or agent) in the proper selection and installation procedures.

1.6 COORDINATION

The specified work shall be coordinated with other trades. Firestopping materials, at penetrations of pipes and ducts, shall be applied prior to insulating, unless insulation meets requirements specified for firestopping. Firestopping materials at building joints and construction gaps shall be applied prior to completion of enclosing walls or assemblies. Cast-in-place firestop devices shall be located and installed in place before concrete placement. Pipe, conduit or cable bundles shall be installed through cast-in-place device after concrete placement but before area is concealed or made inaccessible.

PART 2 PRODUCTS

2.1 FIRESTOPPING MATERIALS

Firestopping materials shall consist of commercially manufactured, asbestos-free products complying with the following minimum requirements:

2.1.1 Fire Hazard Classification

Material shall have a flame spread of 25 or less, and a smoke developed rating of 50 or less, when tested in accordance with ASTM E 84 or UL 723. Material shall be an approved firestopping material as listed in UL Fire Resist Dir or by a nationally recognized testing laboratory.

2.1.2 Toxicity

Material shall be nontoxic to humans at all stages of application.

2.1.3 Fire Resistance Rating

Firestopping will not be required to have a greater fire resistance rating than that of the assembly in which it is being placed.

2.1.3.1 Through-Penetrations

Firestopping materials for through-penetrations, as described in paragraph GENERAL REQUIREMENTS, shall provide "F" and "T" fire resistance ratings in accordance with ASTM E 814 or UL 1479. Fire resistance ratings shall be as follows:

a. Penetrations of Fire Resistance Rated Walls and Partitions: F Rating = 2 hour.

b. Penetrations of Fire Resistance Rated Floors, Roof-Ceiling Assemblies and Ceiling-Floor Assemblies: F Rating = 2 hour, T Rating = 2 hour.

2.1.3.2 Construction Joints and Gaps

Fire resistance ratings of construction joints, as described in paragraph GENERAL REQUIREMENTS, and gaps such as those between floor slab and curtain walls shall be the same as the construction in which they occur. Construction joints and gaps shall be provided with firestopping materials and systems that have been tested per ASTM E 119 or UL 2079 to meet the required fire resistance rating. Systems installed at construction joints shall meet the cycling requirements of ASTM E 1399 or UL 2079.

PART 3 EXECUTION

3.1 PREPARATION

Areas to receive firestopping shall be free of dirt, grease, oil, or loose materials which may affect the fitting or fire resistance of the firestopping system. For cast-in-place firestop devices, formwork or metal deck to receive device prior to concrete placement shall be sound and capable of supporting device.

3.2 INSTALLATION

Firestopping material shall completely fill void spaces regardless of geometric configuration, subject to tolerance established by the manufacturer. Firestopping systems for filling floor voids 4 inches or more in any direction shall be capable of supporting the same load as the floor is designed to support or shall be protected by a permanent barrier to prevent loading or traffic in the firestopped area. Firestopping shall be installed in accordance with manufacturer's written instructions. Tested and listed firestop systems shall be provided in the following locations, except in floor slabs on grade:

a. Penetrations of duct, conduit, tubing, cable and pipe through floors and through fire-resistance rated walls, partitions, and ceiling-floor assemblies.

b. Penetrations of vertical shafts such as pipe chases and utility chutes.

c. Gaps at the intersection of floor slabs and curtain walls, including inside of hollow curtain walls at the floor slab.

d. Gaps at perimeter of fire-resistance rated walls and partitions, such as between the top of the walls and the roof.

e. Construction joints in floors and fire rated walls and partitions.

f. Other locations where required to maintain fire resistance rating of the construction.

3.2.1 Insulated Pipes and Ducts

Thermal insulation shall be cut and removed where pipes or ducts pass through firestopping, unless insulation meets requirements specified for firestopping. Thermal insulation shall be replaced with a material having equal thermal insulating and firestopping characteristics.

3.2.2 Fire Dampers

Fire dampers shall be installed and firestopped in accordance with Section

15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

3.3 INSPECTION

Firestopped areas shall not be covered or enclosed until inspection is complete and approved. A manufacturer's representative shall inspect the applications initially to ensure adequate preparations (clean surfaces suitable for application, etc.) and periodically during the work to assure that the completed work has been accomplished according to the manufacturer's written instructions and the specified requirements.

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SECTION 07900

JOINT SEALING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 509	(1994) Elastomeric Cellular Preformed Gasket and Sealing Material
ASTM C 570	(1995) Oil- and Resin-Base Caulking Compound for Building Construction
ASTM C 734	(1993) Low-Temperature Flexibility of Latex Sealants After Artificial Weathering
ASTM C 834	(1995) Latex Sealants
ASTM C 920	(1998) Elastomeric Joint Sealants
ASTM C 1085	(1991) Butyl Rubber-Based Solvent-Release Sealants
ASTM C 1184	(1995el) Structural Silicone-Sealants
ASTM D 217	(1997) Cone Penetration of Lubricating Grease (IP50/88)
ASTM D 1056	(1998) Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM E 84	(1999) Surface Burning Characteristics of Building Materials

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Backing; GA.

Bond-Breaker; GA.

Sealant; GA.

Manufacturer's descriptive data including storage requirements, shelf life, curing time, instructions for mixing and application, and primer data (if required). A copy of the Material Safety Data Sheet shall be provided for each solvent, primer or sealant material.

SD-07 Certificates

Sealant; FIO.

Certificates of compliance stating that the materials conform to the specified requirements.

1.3 ENVIRONMENTAL REQUIREMENTS

The ambient temperature shall be within the limits of 40 to 90 degrees F when the sealants are applied.

1.4 DELIVERY AND STORAGE

Materials shall be delivered to the job in the manufacturer's original unopened containers. The container label or accompanying data sheet shall include the following information as applicable: manufacturer, name of material, formula or specification number, lot number, color, date of manufacture, mixing instructions, shelf life, and curing time at the standard conditions for laboratory tests. Materials shall be handled and stored to prevent inclusion of foreign materials. Materials shall be stored at temperatures between 40 and 90 degrees F unless otherwise specified by the manufacturer.

PART 2 PRODUCTS

2.1 BACKING

Backing shall be 25 to 33 percent oversize for closed cell and 40 to 50 percent oversize for open cell material, unless otherwise indicated.

2.1.1 Rubber

Cellular rubber sponge backing shall be ASTM D 1056, Type 2, closed cell, Class A.

2.1.2 Synthetic Rubber

Synthetic rubber backing shall be ASTM C 509, Option I, Type I preformed rods or tubes.

2.1.3 Neoprene

Neoprene backing shall be ASTM D 1056, closed cell expanded neoprene cord Type 2, Class C, Grade 2C2.

2.2 BOND-BREAKER

Bond-breaker shall be as recommended by the sealant manufacturer to prevent adhesion of the sealant to backing or to bottom of the joint.

2.3 PRIMER

Primer shall be non-staining type as recommended by sealant manufacturer for the application.

2.4 CAULKING

Oil- and resin-based caulking shall be ASTM C 570.

2.5 SEALANT

2.5.1 LATEX

Latex Sealant shall be ASTM C 834.

2.5.2 ELASTOMERIC

Elastomeric sealants shall conform to ASTM C 920 and the following:

a. Polysulfide Sealant: Type M, Grade NS , Class 25 , Use NT, M, G, A and O.

b. Polyurethane sealant: Type S, Grade NS , Class 25 , Use NT, M, T, A and O.

c. Silicone sealant: Type S , Grade NS , Class 25 , Use NT, G and A.

d. Structural silicone sealant: ASTM C 1184, Type S , Grade NS, Class 25, Use NT, G and A.

2.5.3 ACOUSTICAL

Rubber or polymer-based acoustical sealant shall have a flame spread of 25 or less and a smoke developed rating of 50 or less when tested in accordance with ASTM E 84. Acoustical sealant shall have a consistency of 250 to 310 when tested in accordance with ASTM D 217, and shall remain flexible and adhesive after 500 hours of accelerated weathering as specified in ASTM C 734, and shall be non-staining. See ASTM C 919 for use of acoustical sealant. The acoustical sealant described here is to be used only in non-moving joints protected from abuse. Other specified sealants may be used in acoustical applications when appropriate.

2.5.4 BUTYL

Butyl sealant shall be ASTM C 1085.

2.5.5 PREFORMED

Preformed sealant shall be polybutylene or isoprene-butylene based pressure sensitive weather resistant tape or bead sealant capable of sealing out moisture, air and dust when installed as recommended by the manufacturer. At temperatures from minus 30 to plus 160 degrees F, the sealant shall be non-bleeding and shall have no loss of adhesion.

2.5.5.1 Tape

Tape sealant: cross-section dimensions shall be determined by the Contractor.

2.5.5.2 Bead

Bead sealant: cross-section dimensions shall be determined by the Contractor.

2.5.5.3 Foam Strip

Foam strip shall be polyurethane foam. Foam strip shall be capable of sealing out moisture, air, and dust when installed and compressed as recommended by the manufacturer. Service temperature shall be minus 40 to plus 275 degrees F. Untreated strips shall be furnished with adhesive to hold them in place. Adhesive shall not stain or bleed into adjacent finishes. Treated strips shall be saturated with butylene waterproofing or impregnated with asphalt.

2.6 SOLVENTS AND CLEANING AGENTS

Solvents, cleaning agents, and accessory materials shall be provided as recommended by the manufacturer.

PART 3 EXECUTION

3.1 GENERAL

3.1.1 Surface Preparation

The surfaces of joints to receive sealant or caulk shall be free of all frost, condensation and moisture. Oil, grease, dirt, chalk, particles of mortar, dust, loose rust, loose mill scale, and other foreign substances shall be removed from surfaces of joints to be in contact with the sealant. Oil and grease shall be removed with solvent and surfaces shall be wiped dry with clean cloths. For surface types not listed below, the sealant manufacturer shall be contacted for specific recommendations.

3.1.2 Steel Surfaces

Steel surfaces to be in contact with sealant shall be sandblasted or, if sandblasting would not be practical or would damage adjacent finish work, the metal shall be scraped and wire brushed to remove loose mill scale. Protective coatings on steel surfaces shall be removed by sandblasting or by a solvent that leaves no residue.

3.1.3 Aluminum Surfaces

Aluminum surfaces to be in contact with sealants shall be cleaned of temporary protective coatings. When masking tape is used for a protective cover, the tape and any residual adhesive shall be removed just prior to applying the sealant. Solvents used to remove protective coating shall be as recommended by the manufacturer of the aluminum work and shall be non-staining.

3.1.4 Wood Surfaces

Wood surfaces to be in contact with sealants shall be free of splinters and sawdust or other loose particles.

3.2 APPLICATION

3.2.1 Masking Tape

Masking tape may be placed on the finish surface on one or both sides of a

joint cavity to protect adjacent finish surfaces from primer or sealant smears. Masking tape shall be removed within 10 minutes after joint has been filled and tooled.

3.2.2 Backing

Backing shall be installed to provide the indicated sealant depth. The installation tool shall be shaped to avoid puncturing the backing.

3.2.3 Bond-Breaker

Bond-breaker shall be applied to fully cover the bottom of the joint without contaminating the sides where sealant adhesion is required.

3.2.4 Primer

Primer shall be used on concrete masonry units, wood, or other porous surfaces in accordance with instructions furnished with the sealant. Primer shall be applied to the joint surfaces to be sealed. Surfaces adjacent to joints shall not be primed.

3.2.5 Sealant

Sealant shall be used before expiration of shelf life. Multi-component sealants shall be mixed according to manufacturer's printed instructions. Sealant in guns shall be applied with a nozzle of proper size to fit the width of joint. Joints shall be sealed as detailed in the drawings. Sealant shall be forced into joints with sufficient pressure to expel air and fill the groove solidly. Sealant shall be installed to the indicated depth without displacing the backing. Unless otherwise indicated, specified, or recommended by the manufacturer, the installed sealant shall be dry tooled to produce a uniformly smooth surface free of wrinkles and to ensure full adhesion to the sides of the joint; the use of solvents, soapy water, etc., will not be allowed. Sealants shall be installed free of air pockets, foreign embedded matter, ridges and sags. Sealer shall be applied over the sealant when and as specified by the sealant manufacturer.

3.3 CLEANING

The surfaces adjoining the sealed joints shall be cleaned of smears and other soiling resulting from the sealant application as work progresses.

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DIVISION 08 - DOORS & WINDOWS

SECTION 08110

STEEL DOORS AND FRAMES

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SECTION 08110

STEEL DOORS AND FRAMES

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A250.6	(1997) Hardware on Steel Doors (Reinforcement - Application)
ANSI A250.8	(1998) Standard Steel Doors and Frames

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 236	(1989; R 1993) Steady-State Thermal Performance of Building Assemblies by Means of a Guarded Hot Box
ASTM C 976	(1990; R 1996) Thermal Performance of Building Assemblies by Means of a Calibrated Hot Box
ASTM D 2863	(1997) Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)

DOOR AND HARDWARE INSTITUTE (DHI)

DHI A115.1G	(1994) Installation Guide for Doors and Hardware

STEEL DOOR INSTITUTE (SDOI)

SDOI SDI-106	(1999) Standard Door Type Nomenclature

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Doors and Frames; GA

Drawings using standard door type nomenclature in accordance with SDOI SDI-106 indicating the location of each door and frame, elevation of each model of door and frame, details of

construction, method of assembling sections, location and extent of hardware reinforcement, hardware locations, type and location of anchors for frames, and thicknesses of metal. Drawings shall include catalog cuts or descriptive data for the doors, frames, and weatherstripping including air infiltration data and manufacturers printed instructions.

SD-07 Certificates

Thermal Insulated Doors; FIO

Certification of Thermal Insulating Rating: Certification or test report for thermal insulated doors shall show compliance with the specified requirements. The certification, or test report, shall list the parameters and the type of hardware and perimeter seals used to achieve the rating.

1.3 DELIVERY AND STORAGE

During shipment, welded unit type frames shall be strapped together in pairs with heads at opposite ends or shall be provided with temporary steel spreaders at the bottom of each frame; and knockdown type frames shall be securely strapped in bundles. Materials shall be delivered to the site in undamaged condition, and stored out of contact with the ground and under a weathertight covering permitting air circulation. Doors and assembled frames shall be stored in an upright position in accordance with DHI A115.1G. Whenever damage becomes evident, abraded, scarred, or rusty areas shall be cleaned and touched up with matching finishes.

1.4 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period shall be provided.

PART 2 PRODUCTS

2.1 DOORS AND FRAMES

Doors and frames shall be factory fabricated in accordance with ANSI A250.8 and the additional requirements specified herein. Door Level shall be heavy duty (Grade II) unless otherwise indicated on the door and door frame schedules. Exterior doors and frames shall be galvanized. Interior doors and frames shall be galvanized. Doors and frames shall be prepared to receive hardware conforming to the templates and information provided under Section 08700 BUILDERS' HARDWARE. Rubber silencers shall be furnished for installation into factory predrilled holes in door frames; adhesively applied silencers are not acceptable. Where frames are installed in plaster or masonry walls, plaster guards shall be provided on door frames at hinges and strikes. The Contractor shall coordinate between the hardware and door suppliers to assure that reinforcing of door assemblies for closures and other required hardware shall conform to ANSI A250.8 and the conditions of the fire door assembly listing when applicable. Exterior doors shall have top edges closed flush and sealed against water penetration. Door sizes shall be 3 ft. wide by 7 ft. high by 1-3/4-in. thick.

2.2 THERMAL INSULATED DOORS

The interior of thermal insulated doors shall be completely filled with

rigid plastic foam permanently bonded to each face panel. The thermal conductance (U-value) through the door shall not exceed 0.41 Btu/hr-ft^2-F when tested as an operational assembly in accordance with ASTM C 236 or ASTM C 976. Doors with cellular plastic cores shall have a minimum oxygen index rating of 22 percent when tested in accordance with ASTM D 2863.

2.3 WEATHERSTRIPPING

Unless otherwise specified in Section 08700 BUILDERS' HARDWARE, weatherstripping shall be as follows: Weatherstripping for head and jamb shall be manufacturer's standard elastomeric type of synthetic rubber, vinyl, or neoprene and shall be installed at the factory or on the jobsite in accordance with the door frame manufacturer's recommendations. Weatherstripping for bottom of doors shall be in accordance with the door frame manufacturer's recommendations.

2.4 LOUVERS

Doors at the control room shall be provided with full louvers or louver sections. Louvers shall be sight proof type inserted into the door. Pierced louvers shall not be used on exterior doors. Inserted louvers shall be stationary. Louvers shall be nonremovable from the outside of exterior doors or the secure side of interior doors. Insect screens shall be a removable type with 18 by 16 mesh aluminum or bronze cloth. Full louver doors shall be SDOI SDI 100, Grade III, Model 5, fitted with louvers.

2.6 FIELD PAINTED FINISH

Steel doors and frames shall be field painted in accordance with Section 09900 PAINTING, GENERAL. Weatherstrips shall be protected from paint. Finish shall be free of scratches or other blemishes.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

Installation shall not begin until temperature and humidity conditions closely approximate interior conditions which will exist when area is complete and occupied; heating and air conditioning shall be operating prior to, during, and after installation. The Contractor shall coordinate the work with that of other trades and shall verify opening dimensions with contract and shop drawings. Each frame shall be installed plumb and square using door as template; the frame shall be secured to the wall in accordance with the manufacturer's instructions. All damaged or defective frames shall be repaired/replaced prior to final inspection.

3.2 INSTALLATION

Installation shall be in accordance with DHI A115.1G. Steel doors and frames shall be reinforced, drilled, and tapped to receive mortised hinges, locks, latches, flush bolts, and closers as required. Preparation for surface applied hardware shall be in accordance with ANSI A250.6. Adhesively applied silencers are not acceptable. Weatherstripping shall be installed at exterior door openings to provide a weathertight installation.

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DIVISION 08 - DOORS & WINDOWS

SECTION 08330

OVERHEAD ROLLING DOORS

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PART 3 EXECUTION

3.1 INSTALLATION
3.2 FIELD PAINTED FINISH

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SECTION 08330

OVERHEAD ROLLING DOORS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 84	(1999) Surface Burning Characteristics of Building Materials
ASTM E 330	(1997el) Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE HDBK-IP	(1997) Handbook, Fundamentals I-P Edition
ASHRAE HDBK-SI	(1997) Handbook, Fundamentals SI Edition

1.2 DESCRIPTION

Overhead rolling doors shall be spring counterbalanced, rolling type, with interlocking slats, complete with guides, fastenings, hood, brackets, and operating mechanisms, and shall be designed for use on openings as indicatedon the drawings. Each door shall be provided with a permanent label showing the manufacturer's name and address and the model/serial number of the door. Doors in excess of the labelled size shall be deemed oversize and shall be provided with a listing agency oversize label, or a listing agency oversize certificate, or a certificate signed by an official of the manufacturing company certifying that the door and operator have been designed to meet the specified requirements.

1.2.1 Wind Load Requirements

Doors and components shall be designed to withstand the minimum design wind load of 20 psf. Doors shall be constructed to sustain a superimposed load, both inward and outward, equal to 1-1/2 times the minimum design wind load. Test data showing compliance with design windload requirements for the specific door design tested in accordance with the uniform static air pressure difference test procedures of ASTM E 330 shall be provided. Recovery shall be at least 3/4 of the maximum deflection within 24 hours after the test load is removed. Sound engineering principles may be used to interpolate or extrapolate test results to door sizes not specifically tested

1.2.2 Operational Cycle Life

All portions of the door and door operating mechanism that are subject to movement, wear, or stress fatigue shall be designed to operate through a minimum number of 10 cycles per day. One complete cycle of door operation is defined as when the door is in the closed position, moves to the full open position, and returns to the closed position.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Overhead Rolling Door Unit; GA.

Drawings showing the location of each door including schedules. Drawings shall include elevations of each door type, details and method of anchorage, details of construction, location and installation of hardware, shape and thickness of materials, details of joints and connections, and details of guides, power operators, controls, and other fittings.

SD-03 Product Data

Overhead Rolling Door Unit; GA.

Manufacturer's catalog data, test data, and summary of forces and loads on the walls/jambs.

Manufacturer's preprinted installation instructions.

SD-10 Operation and Maintenance Data

Operation Manual; GA.

Maintenance and Repair Manual; FIO.

Six copies of the system operation manual and system maintenance and repair manual for each type of door and control system.

1.4 DELIVERY AND STORAGE

Doors shall be delivered to the jobsite wrapped in a protective covering with the brands and names clearly marked thereon. Doors shall be stored in a dry location that is adequately ventilated and free from dirt and dust, water, and other contaminants, and in a manner that permits easy access for inspection and handling.

1.5 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 1-year period shall be provided.

1.6 OPERATION AND MAINTENANCE MANUALS

Operating instructions outlining the step-by-step procedures required for

manual hand-chain operation for the overhead rolling door unit shall be provided. The instructions shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, troubleshooting guides, and simplified diagrams for the equipment as installed shall be provided. A complete list of parts and supplies, source of supply, and a list of the high mortality maintenance parts shall be provided.

PART 2 PRODUCTS

2.1 OVERHEAD ROLLING DOORS

Doors shall be surface-mounted type with guides at jambs set back a sufficient distance to clear the opening. Exterior doors shall be mounted as indicated on the drawings.

2.1.1 Curtains

The curtains shall roll up on a barrel supported at the head of the opening on brackets, and shall be balanced by helical torsion springs. Stainless steel slats for doors less than 15 feet wide shall be minimum bare metal thickness of 0.0281 inch. Slats for doors from 15 to 21 feet wide shall be minimum bare metal thickness of 0.0344 inch. Stainless steel slats shall be of the minimum bare metal decimal thickness required for the width indicated and the wind pressure specified above.

2.1.1.1 Insulated Curtains

The slat system shall supply a minimum R-value of 6 when calculated in accordance with ASHRAE HDBK-IP ASHRAE HDBK-SI. Slats shall be of the flat type as standard with the manufacturer. Slats shall consist of a solid polyurethane core not less than 11/16 inch thick, completely enclosed within metal facings. Exterior face of slats shall be gauge as specified for curtains. Interior face shall be not lighter than 0.0219 inch. The insulated slat assembly shall have a flame spread rating of not more than 25 and a smoke development factor of not more than 50 when tested in accordance with ASTM E 84.

2.1.2 Endlocks and Windlocks

The ends of each alternate slat for interior doors shall have steel endlocks of manufacturer's stock design. In addition to endlocks, non-rated exterior doors shall have the manufacturer's standard windlocks as required to withstand the wind load. Windlocks shall prevent the curtain from leaving guides because of deflection from specified wind pressure.

2.1.3 Bottom Bar

The curtain shall have a standard bottom bar consisting of two stainless steel angles for steel doors. A sensing edge shall be attached to the bottom bar of doors that are electric-power operated.

2.1.4 Guides

Guides shall be stainless steel structural shapes or formed stainless steel shapes, of a size and depth to provide proper clearance for operation and

resistance under the design windload. Guides shall be attached to adjoining construction with fasteners recommended by the manufacturer. Spacing of fasteners shall be as required to meet the minimum design windload. Doors and guides in hazardous areas shall have static grounding.

2.1.5 Barrel

The barrel shall be stainless steel pipe or commercial welded stainless steel tubing of proper diameter for the size of curtain. Deflection shall not exceed 0.03 inch per foot of span. Ends of the barrel shall be closed with metal plugs, machined to fit the pipe.

2.1.6 Springs

Oil tempered helical steel counter-balance torsion springs shall be installed within the barrel and shall be capable of producing sufficient torque to assure easy operation of the door curtain. Access shall be provided for spring tension adjustment from outside of the bracket without removing the hood.

2.1.7 Brackets

Brackets shall be of steel plates to close the ends of the roller-shaft housing, and to provide mounting surfaces for the hood. An operation bracket hub and shaft plugs shall have sealed prelubricated ball bearings.

2.1.8 Hoods

Hoods shall be stainless steel with minimum bare metal thickness of 0.0219 inch formed to fit contour of the end brackets, and shall be reinforced with stainless steel rods, rolled beads, or flanges at top and bottom edges. Multiple segment and single piece hoods shall be provided with support brackets of the manufacturer's standard design as required for adequate support.

2.1.9 Weatherstripping

Exterior doors shall be fully weatherstripped. A compressible and replaceable weather seal shall be attached to the bottom bar. Weather seal at door guides shall be continuous vinyl or neoprene, bulb or leaf type, or shall be nylon-brush type. A weather baffle shall be provided at the lintel or inside the hood. Weatherstripping shall be easily replaced without special tools.

2.1.10 Slat Openings

2.1.10.1 Vision Lites

Vision lites shall be those standard for the manufacturer. The lite assembly shall consist of 3 separate lites across and 5 slats high. Opening shall have manufacturer's standard acrylic coverings.

2.1.10.2 Ventilation/Vision Perforations

Perforations shall be manufacturer's standard design and size. Weather stripping for door guides and hoods shall be omitted from perforated doors.

2.1.11 Operation

Doors shall be operated by means of hand-chain with provision made for future installation of electric power. Equipment shall be designed and manufactured for usage in non-hazardous areas.

2.1.11.1 Manual Hand-Chain Operation

Operation shall be by means of a galvanized endless chain extending to within 3 feet of floor. Reduction shall be provided by use of roller chain and sprocket drive or suitable gearing, to reduce the pull required on hand chain to not over 35 lbf. Gears shall be high grade gray cast iron.

2.1.12 Inertia Brake

Overhead rolling door shall have a mechanical inertia brake device which will stop the door from free fall in any position, should there be a failure in the motor operator brake or roller chain drive. The unit shall be capable of being reset with a back drive action.

2.1.13 Locking

Locking shall consist of interior slide bolts, suitable for padlock by others, for manual push-up doors.

2.1.14 Finish

Stainless steel slats and hoods shall receive a #2 B or #4 finish. Surfaces other than slats, hood, and faying surfaces shall be cleaned and treated to assure maximum paint adherence and shall be given a factory dip or spray coat of rust inhibitive metallic oxide or synthetic resin primer.

PART 3 EXECUTION

3.1 INSTALLATION

Doors shall be installed in accordance with approved detail drawings and manufacturer's instructions. Anchors and inserts for guides, brackets, hardware, and other accessories shall be accurately located. Upon completion, doors shall be free from warp, twist, or distortion. Doors shall be lubricated, properly adjusted, and demonstrated to operate freely.

3.2 FIELD PAINTED FINISH

Steel doors and frames shall be field painted in accordance with Section 09900 PAINTING, GENERAL. Weatherstrips shall be protected from paint. Finish shall be free of scratches or other blemishes.

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SECTION 08510

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SECTION 08510

STEEL WINDOWS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123/A 123M	(1997ael) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 569/A 569M	(1998) Commercial Steel (CS) Sheet and Strip, Carbon (0.15 Maximum Percent), Hot-Rolled
ASTM A 653/A 653M	(1999) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 924/A 924M	(1999) General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B 633	(1985; R 1998) Electrodeposited Coatings of Zinc on Iron and Steel
ASTM B 766	(1998) Electrodeposited Coatings of Cadmium
ASTM D 3656	(1997) Insect Screening and Louver Cloth Woven from Vinyl-Coated Glass Yarns
ASTM E 283	(1991) Determining the Rate of Air Leakage through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E 330	(1997el) Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference
ASTM E 331	(1996) Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7	(1995) Minimum Design Loads For Buildings and Other Structures

ASME INTERNATIONAL (ASME)

ASME B18.6.3	(1972; R 1997) Machine Screws and Machine Screw Nuts
ASME B18.6.4	(1981; R 1997) Thread Forming and Thread Cutting Tapping Screws and Metallic Drive Screws (Inch Series)

COMMONWEALTH OF MASSACHUSETTS

780 CMR	(2001) Massachusetts State Building Code

INSECT SCREENING WEAVERS ASSOCIATION (ISWA)

ISWA IWS 089	(1990) Recommended Standards and Specifications for Insect Wire Screening (Wire Fabric)

NATIONAL FENESTRATION RATING COUNCIL (NFRC)

NFRC 100	(1997) Procedure for Determining Fenestration Product U-factors
NFRC 200	(1997) Procedure for Determining Fenestration Product Solar Heat Gain Coefficients at Normal Incidence

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80	(1999) Fire Doors and Fire Windows
NFPA 101	(1997; Errata 97-1; TIA-97-1) Life Safety Code

SCREEN MANUFACTURERS ASSOCIATION (SMA)

SMA ANSI/SMA 1004	(1987) Aluminum Tubular Frame Screens for Windows

STEEL WINDOW INSTITUTE (SWI)

SWI Specifier's Guide	(1995) The Specifier's Guide to Steel Windows

1.2 WINDOW PERFORMANCE

Steel windows shall be designed to meet the following performance requirements, and shall be of the type and size indicated.

1.2.1 Structural Performance

Windows shall be designed to withstand windloads determined by procedures in ASCE 7, 780 CMR, and a minimum design wind load of 20 psf. Structural test pressures on window units shall be for positive load (inward) and negative load (outward) equal to 1-1/2 times the minimum design windload when tested in accordance with ASTM E 330. After testing, there shall be no glass breakage, permanent damage to main frame, sash or ventilator member, fasteners, hardware parts, support arms or actuating mechanisms or

any other damage which could cause window to be inoperable. There shall be no permanent deformation in excess of the requirements established by SWI Specifier's Guide for the window types specified in this section.

1.2.2 Air Infiltration

Air infiltration shall not exceed the amount established by SWI Specifier's Guide for weatherstripped window types when tested in accordance with ASTM E 283.

1.2.3 Water Penetration

Water penetration shall not exceed the amount established by SWI Specifier's Guide for weatherstripped window types when tested in accordance with ASTM E 331.

1.2.4 Thermal Performance

Thermal transmittance for steel windows with insulating glass shall not exceed a U-factor of 0.35 Btu/hr-ft^2-F determined according to NFRC 100. Window units shall comply with the U.S. Department of Energy, Energy Star Window Program for the Northern Climate Zone.

1.2.5 Condensation Index Rating

The condensation index rating shall be 85 as determined using National Fenestration Rating Council approved software THERM.

1.2.6 Life Safety Criteria

Windows shall conform to NFPA 101 when rescue and/or second means of escape are indicated.

1.3 **SUBMITTALS**

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Steel Windows; GA
Insect Screens; FIO

Drawings indicating elevations of windows, rough-opening dimensions for each type and size of windows, full-size sections, thicknesses of metal, fastenings, methods of installation and anchorage, connections with other work, type of wall construction, size and spacing of anchors, method of glazing, types and locations of operating hardware, mullion details, weatherstripping details, screen details including method of attachment, and window schedules showing locations of each window type and indicating compliance with fire safety code, where required.

SD-03 Product Data

Steel Windows; FIO

Manufacturer's descriptive data and catalog cut sheets.

Manufacturer's preprinted installation instructions and cleaning instructions.

SD-04 Samples

Steel Windows; FIO

Manufacturer's standard color samples of painted finishes.

SD-07 Certificates

Steel Windows; FIO

Certificates stating that the steel windows conform to requirements of this section. Product ratings determined using NFRC 100 and NFRC 200 shall be authorized for certification and properly labeled by the manufacturer.

SD-10 Operation and Maintenance Data

Steel Windows; FIO

Manufacturer's preprinted instructions for operating and maintaining hardware for each type of window specified, including finish.

1.4 QUALIFICATION

Window manufacturer shall specialize in designing and manufacturing the type of steel windows specified, and shall have a minimum of 3 years of documented successful experience. Manufacturer shall have the facilities capable of meeting contract requirements, single-source responsibility and warranty.

1.5 DELIVERY AND STORAGE

Steel windows shall be delivered to project site and stored in accordance with manufacturer's recommendations. Damaged windows shall be replaced with new windows.

1.6 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period shall be provided.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Steel Bars

Steel bars shall be solid one-piece sections hot-rolled from new billet steel in accordance with SWI Specifier's Guide.

2.1.2 Sheet Steel

Hot-rolled sheet steel shall conform to ASTM A 569/A 569M, commercial

quality with a minimum of 0.15 percent carbon. Cold-rolled sheet steel shall conform to ASTM A 653/A 653M. Sheet steel shall be zinc coated (galvanized) by the hot-dip process in accordance with ASTM A 653/A 653M or ASTM A 924/A 924M.

2.1.3 Screws and Bolts

Screws and bolts shall conform to ASTM B 766, ASME B18.6.3 and ASME B18.6.4.

2.2 STEEL WINDOW TYPES

Steel windows shall be designed for outside field glazing, and for glass types scheduled on the Contractor's drawings and specified in Section 08810 GLASS AND GLAZING. Units shall be complete with glass and glazing provisions to meet requirements of paragraph WINDOW PERFORMANCE and SWI Specifier's Guide. Glazing material shall be compatible with steel, and shall not require painting.

2.2.1 Projected Windows

Steel projected windows shall conform to SWI Specifier's Guide Standard Intermediate type. Hinges for projected windows shall be concealed four-bar friction type. Sash locks for project-out ventilators shall be cam-action sweep-lock handle with surface-mounted strike. Sash locks for project-in ventilators shall be thru-rail spring catch with concealed strike. Limit stops shall be provided for project-out ventilators that open onto traffic areas. Ventilator operation shall permit cleaning the outside face of glass from inside the building.

2.3 FIRE-RATED WINDOWS

Fire-rated windows shall conform to local code and shall be labeled with a 3/4-hour fire test rating. Units shall be designed and fabricated from one-piece hot-rolled steel members to meet glass sizes, window sizes and opening dimensions established by NFPA 80. Hardware shall conform to NFPA 80 requirements. Fire-rated windows shall bear the Underwriters Laboratories, Warnock Hersey, Factory Mutual or other nationally recognized testing laboratory label for the indicated rating.

2.4 WEATHERSTRIPPING

Weatherstripping for steel window ventilating sections shall be manufacturer's standard designed to meet water penetration and air infiltration requirements specified under paragraph WINDOW PERFORMANCE in accordance with SWI Specifier's Guide, and shall be manufactured of material compatible with steel and shall be resistant to weather. Weatherstrips shall be factory-applied and shall be easily replaced in the field. Neoprene or polyvinylchloride weatherstripping are not acceptable where exposed to direct sunlight.

2.5 INSECT SCREENS

Insect screens shall be steel window manufacturer's standard design, and shall be provided where scheduled on the Contractor's drawings. Insect screens shall be fabricated of roll-formed aluminum or extruded aluminum frames conforming to SMA ANSI/SMA 1004, or roll-formed corrosion resistant steel frames. Plastic-coated (18 x 16) glass fiber mesh screening shall conform to ASTM D 3656. Aluminum mesh (18 x 14) screening shall conform to ISWA IWS 089.

2.6 ACCESSORIES

2.6.1 Fasteners

Fastening devices shall be window manufacturer's standard design made from non-magnetic stainless steel, cadmium-plated steel, zinc-plated steel, nickel/chrome-plated steel or magnetic stainless steel in compliance with SWI Specifier's Guide. Self-tapping sheet metal screws are not acceptable for material thicker than 1/16 inch.

2.6.2 Window Anchors

Anchors for installing windows shall be as a minimum, finished steel or hot-dip to match the prime window.

2.7 FINISHES

2.7.1 Prime Coat

Steel windows, fins, mullions, cover plates and associated parts shall be cleaned, treated and factory primed with manufacturer's standard primer coat in a dry film thickness of not less than 1.0 mil. Primer coat shall be free of scratches and other blemishes. Paint finish shall be in accordance with paragraph FIELD PAINTED FINISH.

2.7.2 Baked Enamel

Finish Steel windows shall be coated with a baked-on silicon polyester enamel in a dry film thickness of not less than 1.0 mil. Finish shall be free of scratches and other blemishes.

2.7.3 Galvanized Finish

Steel windows, fins, mullions, cover plates and associated parts shall be electrodeposited with zinc in accordance with ASTM B 633 or hot-dip galvanized in accordance with ASTM A 123/A 123M. Ventilators containing dovetail weatherstrip grooves shall be finished with an electrodeposited coating of zinc in accordance with ASTM B 633.

PART 3 EXECUTION

3.1 INSTALLATION

Steel windows shall be installed in accordance with approved shop drawings and manufacturer's approved recommendations. Fire-rated windows shall be installed in compliance with NFPA 80 and NFPA 101. Steel surfaces in close proximity with masonry, concrete, wood, and dissimilar metals other than stainless steel, zinc, cadmium, or small areas of white bronze shall be protected from direct contact. The completed window installation shall be watertight and shall be in accordance with Section 07900 JOINT SEALING. Glazing shall be installed in accordance with requirements of this section and 780 CMR and Section 08810 GLASS AND GLAZING. Fire-rated windows shall be glazed in accordance with NFPA 80.

3.2 ADJUSTMENTS AND CLEANING

3.2.1 Hardware Adjustments

Final operating adjustments shall be made after glazing work is complete. When adjustments are completed, operating sash or ventilators shall operate smoothly, and shall be weathertight when locked in closed position.

3.2.2 Cleaning

Steel window finish and glass shall be cleaned on interior and exterior sides in accordance with window manufacturer's recommendations. Alkaline or abrasive agents shall not be used.

3.3 FIELD PAINTED FINISH

Steel windows shall be field painted in accordance with Section 09900 PAINTING, GENERAL. Weatherstrips shall be protected from paint. Finish shall be free of scratches and other blemishes.

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SECTION 08700

BUILDERS' HARDWARE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

BHMA L & R Directory	(Effective thru Jun 1999) Directory of Certified Locks & Latches
BHMA Closer Directory	(Effective thru Jul (1999) Directory of Certified Door Closers
BHMA Exit Devices Directory	(Effective thru Aug 1998) Directory of Certified Exit Devices
BHMA A156.1	(1997) Butts and Hinges
BHMA A156.2	(1996) Bored and Preassembled Locks and Latches
BHMA A156.3	(1994) Exit Devices
BHMA A156.4	(1992) Door Controls - Closers
BHMA A156.5	(1992) Auxiliary Locks & Associated Products
BHMA A156.7	(1997) Template Hinge Dimensions
BHMA A156.13	(1994) Mortise Locks & Latches
BHMA A156.17	(1993) Self Closing Hinges & Pivots
BHMA A156.18	(1993) Materials and Finishes
BHMA A156.21	(1996) Thresholds

DOOR AND HARDWARE INSTITUTE (DHI)

DHI Keying Systems	(1989) Keying Systems and Nomenclature
DHI Locations for CSD	(1997) Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames
DHI Locations for SSD	(1990) Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames

DHI ANSI/DHI A115.1G (1994) Installation Guide for Doors and Hardware

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Exit Device Accessories; GA

Manufacturer's descriptive data, technical literature, catalog cuts, and installation instructions. Spare parts data for locksets, exit devices, closers, electric locks, electric strikes, electro-magnetic closer holder release devices, and electric exit devices, after approval of the detail drawings, and not later than 1 month prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

Hardware Schedule; GA

Hardware schedule listing all items to be furnished. The schedule shall include for each item: the quantities; manufacturer's name and catalog numbers; the ANSI number specified, sizes; detail information or catalog cuts; finishes; door and frame size and materials; location and hardware set identification cross-references to drawings; corresponding reference standard type number or function number from manufacturer's catalog if not covered by ANSI or BHMA; and list of abbreviations and template numbers.

Keying; GA

Keying schedule developed in accordance with DHI Keying Systems, after the keying meeting with the user.

SD-07 Certificates

Hardware and Accessories; GA

The hardware manufacturer's certificates of compliance stating that the supplied material or hardware item meets specified requirements. Each certificate shall be signed by an official authorized to certify in behalf of the product manufacturer and shall identify quantity and date or dates of shipment or delivery to which the certificates apply. A statement that the proposed hardware items appear in BHMA L & R Directory, BHMA Closer Directory and BHMA Exit Devices Directory directories of certified products may be submitted in lieu of certificates.

1.3 PREDELIVERY CONFERENCE

Upon approval of the Hardware Schedule, the construction Contractor shall arrange a conference with the hardware supplier, Contracting Officer and

the using agency to determine keying system requirements. Location of the key control storage system, set-up and key identification labeling will also be determined.

1.4 DELIVERY, STORAGE, AND HANDLING

Hardware shall be delivered to the project site in the manufacturer's original packages. Each article of hardware shall be individually packaged in the manufacturer's standard commercial carton or container, and shall be properly marked or labeled to be readily identifiable with the approved hardware schedule. Each change key shall be tagged or otherwise identified with the door for which its cylinder is intended. Where double cylinder functions are used or where it is not obvious which is the key side of a door, appropriate instructions shall be included with the lock and on the hardware schedule. Manufacturer's printed installation instructions, fasteners, and special tools shall be included in each package.

1.5 SPECIAL TOOLS

Special tools, such as those supplied by the manufacturer, unique wrenches, and dogging keys, shall be provided as required to adjust hardware items.

1.6 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one year period shall be provided.

1.7 OPERATION AND MAINTENANCE MANUALS

Six complete copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides shall be provided. The instructions for electric locks, electric strikes, electro-magnetic closer holder release devices, and electric exit devices shall include simplified diagrams as installed.

PART 2 PRODUCTS

2.1 GENERAL HARDWARE REQUIREMENTS

Hardware shall conform to the requirements specified herein. Hardware set numbers correspond to the set numbers shown on the Contractor's drawings.

2.2 TEMPLATES

Requirements for hardware to be mounted on metal doors or metal frames shall be coordinated between hardware manufacturer and door or frame manufacturer by use of templates and other information to establish location, reinforcement required, size of holes, and similar details. Templates of hinges shall conform to BHMA A156.7.

2.3 HINGES

Hinges shall conform to BHMA A156.1. Hinges used on metal doors and frames shall also conform to BHMA A156.7. Except as otherwise specified, hinge sizes shall conform to the hinge manufacturer's printed recommendations. For outswinging exterior doors and for interior doors subject to high humidity and/or corrosive conditions, nonferrous hinges or stainless steel hinges should be used. Hinges with loose pins on outswinging exterior doors will be specified with nonremovable pins or safety stud.

2.3.1 Hinges for Reverse Bevel Doors with Locks

Hinges for reverse bevel doors with locks shall have pins that are made nonremovable by means such as a set screw in the barrel, or safety stud, when the door is in the closed position.

2.3.2 Contractor's Option

Hinges with antifriction bearings may be furnished in lieu of ball bearing hinges.

2.3.3 Pivot Hinges

Pivot hinges shall conform to BHMA A156.4.

2.3.4 Spring Hinges

Spring hinges shall conform to BHMA A156.17.

2.4 LOCKS AND LATCHES

To the maximum extent possible, locksets, latchsets and deadlocks, and all components thereof, including cylinders and removable cores, shall be the products of a single manufacturer. Lock fronts for double-acting doors shall be rounded.

2.4.1 Mortise Lock and Latchsets

Mortise lock, latchsets, and strikes shall be series 1000 and shall conform to BHMA A156.13, operational Grade 1. Mortise type locks and latches for doors 1-3/4 inches thick and over shall have adjustable bevel fronts or otherwise conform to the shape of the door. Mortise locks shall have armored fronts.

2.4.2 Bored Lock and Latchsets

Bored lock, latchsets, and strikes shall be series 4000 and shall conform to BHMA A156.2, Grade 1. Bored type locks and latches for doors 1-3/8 inches thick and over shall have adjustable bevel fronts or otherwise conform to the shape of the door.

2.4.3 Auxiliary Locks and Associated Products

Bored and mortise dead locks and dead latches, narrow style dead locks and dead latches, rim latches, dead latches, and dead bolts, and electric strikes shall conform to BHMA A156.5. Strike boxes shall be furnished with dead bolt and latch strikes for Grade 1.

2.4.4 Lock Cylinders (Mortise, Rim and Bored)

Lock cylinders shall comply with BHMA A156.5. Lock cylinder shall have not less than six pins. A construction master keying system shall be provided.

2.4.5 Lock Trim

Lock trim shall be cast, forged, or heavy wrought construction of commercial plain design. In addition to meeting the test requirement of BHMA A156.2 or BHMA A156.13, knobs, lever handles, roses, and escutcheons

shall be 0.050 inch thick, if unreinforced. If reinforced, the outer shell shall be 0.035 inch thick and the combined thickness shall be 0.070 inch except that knob shanks shall be 0.060 inch thick. Knob diameter shall be 2-1/8 to 2-1/4 inches. Lever handles shall be of plain design with ends returned to no more than 1/2 inch from the door face.

2.5 EXIT DEVICES AND EXIT DEVICE ACCESSORIES

Exit devices and exit device accessories shall conform to BHMA A156.3, Grade 1.

2.5.1 Exit Devices and Auxiliary Items

Trim shall be of wrought construction and commercial plain design with straight, beveled, or smoothly rounded sides, corners, and edges. Adjustable strikes shall be provided for rim type and vertical rod devices. Open back strikes shall be provided for pairs of doors with mortise and vertical rod devices; except open back strikes shall be used on labeled doors only where specifically provided for in the published listings. Touch bars may be provided in lieu of conventional crossbars and arms.

2.6 KEYING

Locks shall be keyed in sets or subsets as scheduled. Locks shall be furnished with the manufacturer's standard construction key system. Change keys for locks shall be stamped with change number and the inscription "U.S. Property - Do Not Duplicate." Keys shall be supplied as follows:

Locks:	2 change keys each lock.
Master keyed sets:	2 keys each set.
Grand master keys:	2 total.
Construction keys:	4 total.

The keys shall be furnished to the Contracting Officer arranged in a container in sets or subsets as scheduled.

2.7 DOOR CLOSING DEVICES

Door closing devices shall conform to BHMA A156.4, Grade 1. Closing devices shall be products of one manufacturer for each type specified. The opening resistance of closing devices shall not exceed 15 lbf applied at the latch stile or exceed 5 lbf where low opening resistance is scheduled.

2.7.1 Surface Type Closers

Surface type closers shall be Grade 1, Series C02000 Full Cover with options PT-4H and Size 1 or 2 through Size 6. Except as otherwise specified, sizes shall conform to the manufacturer's published recommendations. Closers for outswinging exterior doors shall have parallel arms or shall be top jamb mounted. Closers for doors close to a wall shall be of narrow projection so as not to strike the wall at the 90-degree open position.

2.8 MISCELLANEOUS

2.8.1 Metal Thresholds

Thresholds shall conform to BHMA A156.21. Thresholds for exterior doors shall be extruded aluminum of the type indicated and shall provide proper

clearance and an effective seal with specified weather stripping. Thresholds for doors accessible to the handicapped shall be beveled with slopes not exceeding 1:2 and with heights not exceeding 1/2 inch.

2.8.2 Key Control Storage System

Key control storage system shall conform to BHMA A156.5, Type E8331, capacity 25 hook, and shall be properly labeled for key identification. Set up, identification labeling and location of the key control storage shall be as directed at the Predelivery Conference.

2.9 FASTENINGS

Fastenings of proper type, size, quantity, and finish shall be supplied with each article of hardware. Machine screws and expansion shields shall be used for attaching hardware to concrete or masonry. Fastenings exposed to the weather in the finished work shall be stainless steel. Sex bolts, through bolts, or machine screws and grommet nuts, where used on reverse-bevel exterior doors equipped with half-surface or full-surface hinges, shall employ one-way screws or other approved tamperproof screws. Screws for the jamb leaf of half-mortise and full-surface hinges attached to structural steel frames shall be one-way or other approved tamperproof type.

2.10 FINISHES

Unless otherwise specified, finishes shall conform to those identified in BHMA A156.18. Where painting of primed surfaces is required, painting is specified in Section 09900 PAINTING, GENERAL. Finishes 612 or 630 should be considered for outswinging exterior doors in lieu of finish 600 where corrosion may be a problem. Mixing finishes should be avoided whenever possible.

PART 3 EXECUTION

3.1 APPLICATION

Hardware shall be located in accordance with DHI Locations for CSD and DHI Locations for SSD, except that deadlocks shall be mounted 48 inches above finish floor. When approved, slight variations in locations or dimensions will be permitted. Application shall be in accordance with DHI ANSI/DHI A115.1G. Door control devices for exterior doors such as closers and holders, shall be attached to doors with thru bolts and nuts or sex bolts. Alternate fastening methods may be approved by the Contracting Officer when manufacturers' documentation is submitted to verify that the fastening devices and door reinforcements are adequate to resist wind induced stresses.

3.1.1 Door-Closing Devices

Door-closing devices shall be installed and adjusted in accordance with the templates and printed instructions supplied by the manufacturer of the devices. Insofar as practicable, doors opening to or from halls and corridors shall have the closer mounted on the room side of the door.

3.1.2 Key Control Storage Systems

Key control storage system shall be installed where directed.

3.1.3 Thresholds

Thresholds shall be secured with a minimum of three fasteners per single door width and six fasteners per double door width with a maximum spacing of 12 inches. Exterior thresholds shall be installed in a bed of sealant with expansion anchors and stainless steel screws. Minimum screw size shall be No. 10 length, dependent on job conditions, with a minimum of 3/4 inch thread engagement into the floor or anchoring device used.

3.1.4 Weatherseals

Weatherseals shall be located as indicated for all exterior doors, snug to door face and fastened in place with color matched metal screws after door and frames have been finish painted. Screw spacing shall be as recommended by manufacturer.

3.2 HARDWARE SETS

Hardware sets shall be determined by the Contractor and submitted for approval by the Contracting Officer.

-- End of Section --

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SECTION 08810

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SECTION 08810

GLASS AND GLAZING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z97.1	(1984; R 1994) Safety Performance Specifications and Methods of Test for Safety Glazing Materials Used in Buildings

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 1036	(2001) Standard Specification for Flat Glass
ASTM E 774	(1997) Classification of the Durability of Sealed Insulating Glass Units
ASTM E 1300	(1998) Determining the Minimum Thickness and Type of Glass Required to Resist a Specified Load

GLASS ASSOCIATION OF NORTH AMERICA (GANA)

GANA Glazing Manual	(1997) Glazing Manual

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80	(1999) Fire Doors and Fire Windows

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation; GA

Drawings showing complete details of the proposed setting methods, mullion details, edge blocking, size of openings, frame details, materials, and types and thickness of glass.

SD-03 Product Data

Insulating Glass; GA
Glazing Accessories; GA

Manufacturer's descriptive product data, handling and storage recommendations, installation instructions, and cleaning instructions.

SD-04 Samples

Insulating Glass; GA

Two 8 x 10 inch samples of insulating glass units.

SD-07 Certificates

Insulating Glass; GA

Certificates stating that the glass meets the specified requirements. Labels or manufacturers marking affixed to the glass will be accepted in lieu of certificates.

Glazing Accessories; GA

Certificates from the manufacturer attesting that the units meet the luminous and solar radiant transmission requirements.

1.3 SYSTEM DESCRIPTION

Glazing systems shall be fabricated and installed watertight and airtight to withstand thermal movement and wind loading without glass breakage, gasket failure, deterioration of glazing accessories, and defects in the work. Glazed panels shall comply with the safety standards, as indicated in accordance with ANSI Z97.1. Glazed panels shall comply with indicated wind/snow loading in accordance with ASTM E 1300.

1.4 DELIVERY, STORAGE AND HANDLING

Glazing compounds shall be delivered to the site in the manufacturer's unopened containers. Glass shall be stored indoors in a safe, well ventilated dry location in accordance with manufacturer's instructions, and shall not be unpacked until needed for installation. Glass shall not be stored on site over 1 month.

1.5 PROJECT/SITE CONDITIONS

Glazing work shall not be started until outdoor temperature is above 40 degrees F and rising, unless procedures recommended by glass manufacturer and approved by Contracting Officer are made to warm the glass and rabbet surfaces. Ventilation shall be provided to prevent condensation of moisture on glazing work during installation. Glazing work shall not be performed during damp or raining weather.

1.6 WARRANTY

1.6.1 Insulating Glass

Manufacturer shall warrant the insulating glass to be free of fogging or film formation on the internal glass surfaces caused by failure of the hermetic seal for a period of 10 years from Date of Substantial Completion.

Warranty shall be signed by manufacturer.

PART 2 PRODUCTS

2.1 MATERIALS

Each piece of glass shall bear the manufacturer's label showing the strength, grade, thickness, type and quality of glass and all labels shall remain in place until the glass has been set and inspected by the Contracting Officer except that safety and insulating glass shall have permanently etched labels. When glass is not cut to size by the manufacturer and is furnished from local stock, the glass and glazing Contractor shall submit an affidavit stating the strength, grade, thickness, type, quality and manufacturer of the glass furnished.

2.2 INSULATING GLASS

Insulating glass for use in glazed exterior openings shall be Insulating Glass Certification Council certified and shall meet ASTM E 774, Class CBA. Units shall carry the manufacturer's ten year guarantee. The units shall consist of two lights of float glass, conforming to ASTM C 1036, permanently and hermetically sealed together at edges with continuous spacers and dual sealant to maintain a factory dehydrated air space.

Provide thickness consisting of 2 lights, 1/4 inch float glass with a 1/2 inch air space, except 1/4 inch air space at doors. Provide outside light bronze or gray tinted (chosen for compatibility with selected building color) and inside light clear.

Provide insulating glass with factory low-emissivity coating, PPG Sungate 100, equal by L.O.F., Spectrum or approved equal which does not change the appearance of the glass and which provides a winter night time U-value of 0.31 and a shading coefficient of 0.45 in the specified insulating unit. Coat inside of outside light.

Provide dual perimeter seal, inner (primary) seal of polyisobutylene butyl and outer (secondary) seal of structural silicone.

Provide aluminum spacer between lights with folded and permanently joined corners as approved to provide continuity around perimeter of each unit. Primary seal shall completely cover sides and corners of spacers between spacers and glass, both sides.

Provide approved molecular sieve, silica gel or blend or both for dissicant, sealed into spacers.

All non-labelled door glass shall be clear (except as specified below) tempered glass, 1/4 inch thick Herculite by PPG Industries, equal by L.O.F.; A.F.G. or approved equal. Exterior doors shall be tempered insulating glass as specified above, with outside light tinted as selected.

All labelled door glass shall be 1/4 inch thick clear, polished, diamond welded, wired glass, UL listed.

2.3 ACCESSORIES

2.3.1 Glazing Compounds

Glazing compounds shall be 999-A Glazing silicone by DOW, equal by General

Electric or approved equal.

Glazing compound for labelled construction glazing shall meet NFPA requirements for a hardsetting glazing compound with 90 percent inert and non-flammable components as approved.

2.3.2 Glazing Tape

Glazing tape for use with the glazing compound shall be Tremco No. 440; Percora Extru-Seal Butyl Rubber Tape or Dap Inc. Butyl Rubber Sealing Tape or approved equal. Tape shall be compatible with the glazing compound.

2.3.3 Setting Block

Setting blocks, 85 plus or minus 5 durometer and spacer blocks, 50 durometer, shall be closed cell neoprene.

2.3.4 Glazing Strips

Glazing strips for hollow metal door and bead glazing, shall be adhesive faced, closed cell, PVC foam strip, 1/8 inch thick, 32 durometer hardness.

PART 3 EXECUTION

3.1 PREPARATION

Openings and framing systems scheduled to receive glass shall be examined for compliance with approved shop drawings, GANA Glazing Manual and glass manufacturer's recommendations including size, squareness, offsets at corners, presence and function of weep system, face and edge clearance requirements and effective sealing between joints of glass-framing members. Detrimental materials shall be removed from glazing rabbet and glass surfaces and wiped dry with solvent. Glazing surfaces shall be dry and free of frost.

3.2 INSTALLATION

Glass and glazing work shall be performed in accordance with approved shop drawings, GANA Glazing Manual, glass manufacturer's instructions and warranty requirements. Glass shall be installed with factory labels intact and removed only when instructed. Wired glass and fire/safety rated glass shall be installed in accordance with NFPA 80. Edges and corners shall not be ground, nipped or cut after leaving factory. Springing, forcing or twisting of units during installation will not be permitted.

3.3 CLEANING

Upon completion of project, outside surfaces of glass shall be washed clean and the inside surfaces of glass shall be washed and polished in accordance with glass manufacturer's recommendations.

3.4 PROTECTION

Glass work shall be protected immediately after installation. Glazed openings shall be identified with suitable warning tapes, cloth or paper flags, attached with non-staining adhesives. Reflective glass shall be protected with a protective material to eliminate any contamination of the reflective coating. Protective material shall be placed far enough away from the coated glass to allow air to circulate to reduce heat buildup and

moisture accumulation on the glass. Glass units which are broken, chipped, cracked, abraded, or otherwise damaged during construction activities shall be removed and replaced with new units.

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SECTION 09250

GYPSUM WALLBOARD

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A108.11	(1992) Interior Installation of Cementitious Backup Units
ANSI A118.9	(1992) Test Methods and Specifications for Cementitious Backer Units

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 580/A 580M	(1998) Stainless Steel Wire
ASTM A 853	(1993) Steel Wire, Carbon, for General Use
ASTM C 36	(1997) Gypsum Wallboard
ASTM C 475	(1994) Joint Compound and Joint Tape for Finishing Gypsum Board
ASTM C 514	(1996) Nails for the Application of Gypsum Board
ASTM C 557	(1993a) Adhesive for Fastening Gypsum Wallboard to Wood Framing
ASTM C 630/C 630M	(1996a) Water-Resistant Gypsum Backing Board
ASTM C 645	(1998) Nonstructural Steel Framing Members
ASTM C 754	(1997) Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products
ASTM C 840	(1998) Application and Finishing of Gypsum Board
ASTM C 955	(1998) Load-Bearing (Transverse and Axial) Steel Studs, Runners (Tracks), and Bracing or Bridging for Screw Application of Gypsum Panel Products and Metal Plaster Bases

ASTM C 1002	(1998) Steel Drill Screws for the Application of Gypsum Board or Metal Plaster Bases
ASTM C 1047	(1998) Accessories for Gypsum Wallboard and Gypsum Veneer Base
ASTM C 1178/C 1178M	(1996) Glass Mat Water-Resistant Gypsum Backing Panel

GYPSUM ASSOCIATION (GA)

GA 216	(1996) Application and Finishing of Gypsum Board
GA 600	(1997) Fire Resistance Design Manual

UNDERWRITERS LABORATORIES (UL)

UL Fire Resist Dir	(1998) Fire Resistance Directory (2 Vol.)

1.2 SYSTEM DESCRIPTION

1.2.1 Fire-Rated Construction

Joints of fire-rated gypsum board enclosures shall be closed and sealed in accordance with UL test requirements or GA requirements, and as required to meet pressurization requirements. Penetrations through rated partitions and ceilings shall be sealed tight in accordance with tested systems. Fire ratings shall be as indicated.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Steel Framing; FIO
Control Joints; FIO
Fire-Resistant Assemblies; FIO

Drawings and installation details for ceiling framing, furring, special wall framing, and framed openings in walls and ceilings.

SD-07 Certificates

Gypsum Wallboard; FIO
Water-Resistant Gypsum Board; FIO
Steel Framing; FIO
Fire-Rated Gypsum Board; FIO
Cementitious Backer Units; FIO

Certificates stating that the steel framing and gypsum wallboard meet the specified requirements.

1.4 QUALIFICATIONS

Manufacturer shall specialize in manufacturing the types of material specified and shall have a minimum of 5 years of documented successful experience. Installer shall specialize in the type of gypsum board work required and shall have a minimum of 3 years of documented successful experience.

1.5 DELIVERY, STORAGE AND HANDLING

Materials shall be delivered in original containers bearing the name of manufacturer, contents, and brand name. Materials shall be stored off the ground in a weathertight structure for protection. Gypsum boards shall be stacked flat, off floor and supported to prevent sagging and warpage. Adhesives and joint materials shall be stored in accordance with manufacturer's printed instructions. Damaged or deteriorated materials shall be removed from jobsite.

1.6 ENVIRONMENTAL CONDITIONS

Environmental conditions for application and finishing of gypsum board shall be in accordance with ASTM C 840. During the application of gypsum board without adhesive, a room temperature of not less than 40 degrees F shall be maintained. During the application of gypsum board with adhesive, a room temperature of not less than 50 degrees F shall be maintained for 48 hours prior to application and continuously afterwards until completely dry. Building spaces shall be ventilated to remove water not required for drying joint treatment materials. Drafts shall be avoided during dry hot weather to prevent materials from drying too rapidly.

PART 2 MATERIALS

2.1 NON-LOADBEARING STUD WALLS

2.1.1 Studs

Studs for non-loadbearing walls shall conform to ASTM C 645. Studs shall be C-shaped, roll formed steel with minimum uncoated design thickness of 0.0329 in made from G40 hot-dip galvanized coated sheet.

2.1.2 Runner Tracks

Floor and ceiling runner tracks shall conform to ASTM C 645. Tracks shall be prefabricated, U-shaped with minimum 1 inch flanges, unpunched web, thickness to match studs, made from G40 hot-dip galvanized coated sheet.

2.2 LOADBEARING STUD WALLS

2.2.1 Studs

Studs for loadbearing walls shall conform to ASTM C 955. Studs shall be C-shaped roll formed steel made from minimum G60 hot-dip galvanized coated sheet. Stud sizes and base metal design thickness shall be as shown.

2.2.2 Runner Tracks

Floor and ceiling runner tracks shall conform to ASTM C 955. Runners shall be prefabricated, U-shaped with minimum 3/4 inch flanges, unpunched web, thickness to match studs, made from G60 hot-dip galvanized coated sheet.

2.2.3 Bridging

Bridging for loadbearing walls shall conform to ASTM C 955. Bridging shall be minimum 3/4 x 3/4 inch cold-rolled steel channel with weld attachment clips at each stud or V-bar type weld or screw attached to each stud flange. Bridging shall be adequate to provide lateral support for the stud.

2.3 SUSPENDED CEILING FRAMING

Suspended ceiling framing system shall have the capability to support the finished ceiling, light fixtures, air diffusers, and accessories, as shown. The suspension system shall have a maximum deflection of L/240. Carrying channels shall be formed from minimum 0.0548 in thick cold-rolled steel, 1-1/2 x 3/4 inch. Furring members shall be formed from cold-rolled steel, 7/8 x 2-9/16 inch. Carrying channels and furring members shall be made from hot-dip galvanized coated sheet.

2.4 GYPSUM BOARD

Gypsum board shall have square-cut ends, tapered or beveled edges and shall be maximum possible length. Gypsum board thickness shall be as shown.

2.4.1 Standard Gypsum Board

Regular gypsum board shall conform to ASTM C 36, and shall be 48 inches wide.

2.4.2 Fire-Rated Gypsum Board

Fire-rated gypsum board shall conform to ASTM C 36, and shall be Type X or Type C as required, 48 inches wide.

2.4.3 Water-Resistant Gypsum Board

Water-resistant gypsum board shall conform to ASTM C 630/C 630M, regular, with water-resistant paper faces, paintable surfaces, and shall be 48 inch width and maximum permissible length.

2.4.4 Water-Resistant Gypsum Backing Panel

Glass mat water-resistant gypsum backing panels shall conform to ASTM C 1178/C 1178M, shall have a water-resistant cove with water and mold/mildew resistant fiberglass faces imbedded into the cove and shall have square edges 48 inches wide by 1/2 inch thick.

2.5 TRIM, MOLDINGS, AND ACCESSORIES

2.5.1 Taping and Embedding Compound

Taping and embedding compound shall conform to ASTM C 475. Compound shall be specifically formulated and manufactured for use in embedding tape at gypsum wallboard joints and fastener heads, and shall be compatible with tape and substrate.

2.5.2 Finishing or Topping Compound

Finishing or topping compound shall conform to ASTM C 475. Compound shall be specifically formulated and manufactured for use as a finishing compound

for gypsum board.

2.5.3 All-Purpose Compound

All-purpose compound shall be specifically formulated and manufactured to use as a taping and finishing compound, and shall be compatible with tape and substrate.

2.5.4 Joint Tape

Joint tape shall conform to ASTM C 475 and shall be as recommended by gypsum board manufacturer.

2.5.5 Trim, Control Joints, Beads, Stops and Nosings

Items used to protect edges, corners, and to provide architectural features shall be in accordance with ASTM C 1047.

2.6 FASTENINGS AND ADHESIVES

2.6.1 Nails

Nails shall conform to ASTM C 514. Nails shall be hard-drawn low or medium-low carbon steel, suitable for intended use.

2.6.2 Screws

Screws shall conform to ASTM C 1002. Screws shall be self-drilling and self-tapping steel, Type S for wood or light-gauge steel framing.

2.6.3 Adhesives

Adhesives shall conform to ASTM C 557. Adhesives shall be formulated to bond gypsum board to wood framing members. For securing gypsum board to metal framing, adhesive shall be as recommended by gypsum board manufacturer.

2.6.4 Hangers

Suspended ceiling runner channel hangers shall be soft, annealed steel wire not less than No. 8 SWG, conforming to ASTM A 853.

2.6.5 Wire and Clip Type Fastenings

Tie wire, clips, rings, and other fastenings shall be corrosion-resisting steel conforming to ASTM A 580/A 580M, composition 302, 304, or 316, Condition A, except that walls, partitions, and other vertical surfaces not incorporated in ceiling construction may be erected with soft, annealed steel conforming to ASTM A 853.

2.6.5.1 Tie Wire

Tie wire for constructing partitions and vertical furring, for securing metal lath to supports, and for lacing shall be not less than No. 18 SWG. Tie wire for other applications shall be not less than No. 16 SWG.

2.6.5.2 Clips

Clips used in lieu of tie wire for securing the furring channels to the

runner channels in ceiling construction shall be made from strip not less than 1/8 inch thick or shall be hairpin clip, formed of wire not less than 0.01620 inch nominal diameter. Other clips and rings or fastenings of similar materials shall be equivalent in holding power to that provided by tie wire for the specific application.

2.7 CEMENTITIOUS BACKER UNITS

Cementitious backer units shall comply with ANSI A118.9.

PART 3 EXECUTION

3.1 INTERIOR WALL FRAMING

Steel framing and furring members shall be installed in accordance with ASTM C 754. Members shall be in alignment with spacings not to exceed the maximum spacings indicated on drawings. Runners shall be aligned accurately at the floor and ceiling and securely anchored.

3.1.1 Wall Openings

The framing system shall provide for the installation and anchorage of the required subframes or finish frames for wall openings at doors, pass-through openings, and access panels. Partitions abutting continuous suspended ceilings shall be strengthened for rigidity at rough openings of more than 30 inches wide. Studs at openings shall be 0.0329 in minimum bare metal thickness and spot grouted at jamb anchor inserts. Double studs shall be fastened together with screws and secured to floor and overhead runners. Two studs shall be used for framing solid-core doors, doors over 36 inches wide and extra-heavy doors such as X-ray room doors.

3.1.2 Wall Control Joints

Control joints for expansion and contraction in the walls shall be constructed with double studs installed 1/2 inch apart in interior walls or wall furrings where indicated on drawings. Control joint spacing shall not exceed 30 feet. Ceiling-height door frames may be used as vertical control joints. Door frames of less than ceiling height may be used as control joints only if standard control joints extend to ceiling from both corners of top of door frame. Control joints between studs shall be filled with firesafing insulation in fire rated partitions.

3.1.3 Blocking

Blocking shall be provided as necessary for mounted equipment. Blocking shall be metal or wood and shall be cut to fit between framing members. Blocking shall be rigidly anchored to the framing members. Under no circumstances will accessories or other wall mounted equipment be anchored directly to gypsum wallboard.

3.2 SHAFT WALL FRAMING

The shaft wall system shall be installed in accordance with the system manufacturer's published instructions. Bucks, anchors, blocking and other items placed in or behind shaft wall framing shall be coordinated with electrical and mechanical work. Fireproofing materials which are damaged or removed during shaft wall construction shall be patched or replaced.

3.3 SUSPENDED CEILING FRAMING

Suspended ceiling system framing shall be installed in accordance with ASTM C 754.

3.3.1 Hangers

Hangers shall be spaced not more than 48 inches along runner channels and 36 inches in the other direction or 42 inches in both directions unless otherwise indicated. Locations of hanger wires shall be coordinated with other work. Hangers at ends of runner channels shall be located not more than 6 inches from wall. Hanger wire shall be looped around bottom chord of open-web steel joists, or secured to structural elements with suitable fasteners. Sags or twists which develop in the suspended system shall be adjusted. Damaged or faulty parts shall be replaced.

3.3.2 Main Runners

Main runner channels shall be installed in accordance with ASTM C 754. Hanger wires shall be double strand saddle-tied to runner channels and the ends of hanger wire shall be twisted three times around itself. Main runners shall be located to within 6 inches of the paralleling wall to support the ends of cross furring. Main runners shall not come in contact with abutting masonry or concrete walls. Where main runners are spliced, ends shall be overlapped 12 inches with flanges of channels interlocked, and shall be securely tied at each end of splice with wire looped twice around the channels.

3.3.3 Furring Channels

Furring channels shall be spaced in accordance with ASTM C 754. Furring channels shall be secured to the runner channels and to structural supports at each crossing with tie wire, hairpin clips, or equivalent fastenings. Furring channels shall be located within 2 inches of parallel walls and beams, and shall be cut 1/2 inch short of abutting walls.

3.3.4 Ceiling Openings

Support members shall be provided as required at ceiling openings for access panels, recessed light fixtures, and air supply or exhaust. Support members shall be not less than 1-1/2 inch main runner channels and vertically installed suspension wires or straps shall be located to provide at least the minimum support specified herein for furring and wallboard attachment. Intermediate structural members not a part of the structural system, shall be provided for attachment or suspension of support members.

3.3.5 Light Fixtures and Air Diffusers

Light fixtures and air diffusers shall be supported directly from suspended ceiling runners. Wires shall be provided at appropriate locations to carry the weight of recessed or surface mounted light fixtures and air diffusers.

3.3.6 Control Joints

Ceiling control joints for expansion and contraction shall be located where indicated on drawings. A control joint or intermediate blocking shall be installed where ceiling framing members change direction. Control joints shall be installed so that linear dimensions between control joints shall not exceed 50 feet in either direction nor more than 2500 square feet.

3.4 APPLICATION OF GYPSUM BOARD

Gypsum board shall be installed in accordance with ASTM C 840 and GA 216 and as specified. Paragraph 17.3.1 GENERAL of ASTM C 840 which permits usage of water resistant gypsum board as a base for adhesive application of ceramic or plastic tile on ceilings, does not apply. Edges and ends of gypsum boards shall be cut to obtain neat fitting joints. End joints of adjoining boards shall be staggered, and shall be staggered on opposite sides of wall. Boards shall be applied with moderate contact without forcing in place. Holes for pipes, fixtures or other small openings shall be cut with a tool which will provide a neat fit. Screws shall be driven so that the heads are slightly below the plane of paper face. Fracturing the paper face or damaging the core shall be avoided. Trim shall be installed at external and internal angles formed by the intersecting gypsum board surfaces with other surfaces. Corner beads shall be installed to vertical and horizontal corners in accordance with manufacturer's published instructions.

3.4.1 Water-Resistant Gypsum Board

Water-resistant gypsum board shall be installed at the locations indicated.

3.4.2 Adhesively-Applied Gypsum Board

Walls scheduled to receive adhesively-applied gypsum board shall be dry, free of dust, oil, or form release agents, protrusions or voids, or foreign matter that would affect a proper bond.

3.5 TRIM, MOLDINGS, AND ACCESSORIES INSTALLATION

Trim, moldings and accessories shall be installed in accordance with GA 216.

3.6 TAPING AND FINISHING

Gypsum board taping and finishing shall be performed in accordance with ASTM C 840. Boards shall be kept free of dirt, oil and other foreign matter that could cause a lack of bond. Screw heads, dents, gouges, and cut-outs shall be filled with joint compound and sanded. Accessories at exposed joints, edges, corners, openings, and similar locations shall be taped, floated with joint compound, and sanded to produce surfaces ready for gypsum board finishes.

3.7 APPLICATION OF CEMENTITIOUS BACKER UNITS

Cementitious backer units shall be installed in accordance with ANSI A108.11. Fasteners shall be the type designed for cement board application.

3.8 FIRE-RESISTANT ASSEMBLIES

Gypsum wallboard construction for fire-rated assemblies shall be in accordance with UL Fire Resist Dir, or GA 600 for the design number indicated on drawings.

3.9 PATCHING

Surface defects and damage shall be corrected as required to leave gypsum board smooth, uniform in appearance, and ready to receive finish as specified.

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SECTION 09510

ACOUSTICAL CEILINGS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 635	(2000) Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings
ASTM C 636	(1996) Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels
ASTM E 119	(2000) Fire Tests of Building Construction and Materials
ASTM E 580	(2000) Application of Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels in Areas Requiring Moderate Seismic Restraint
ASTM E 1264	(1998) Standard Classification for Acoustical Ceiling Products

U.S. ARMY CORPS OF ENGINEERS (USACE)

TI 809-04	(1998) Seismic Design for Buildings

UNDERWRITERS LABORATORIES (UL)

UL Fire Resist Dir	(1999) Fire Resistance Directory (2 Vol.)

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Approved Detail Drawings; GA

Drawings showing suspension system, method of anchoring and fastening, details, and reflected ceiling plan.

SD-03 Product Data

Acoustical Ceiling Systems; FIO

Manufacturer's descriptive data, catalog cuts, and installation instructions. Submittals which do not provide adequate data for the product evaluation will be rejected.

SD-06 Test Reports

Fire Resistive Ceilings; FIO
Ceiling Attenuation Class and Test; FIO

Reports by an independent testing laboratory attesting that acoustical ceiling systems meet specified fire endurance and sound transmission requirements. Data attesting to conformance of the proposed system to Underwriters Laboratories requirements for the fire endurance rating listed in UL Fire Resist Dir may be submitted in lieu of test reports.

SD-07 Certificates

Acoustical Units; FIO

Certificate attesting that the mineral based acoustical units furnished for the project contain recycled material and showing an estimated percent of such material.

1.3 GENERAL REQUIREMENTS

Acoustical treatment shall consist of sound controlling units mechanically mounted on a ceiling suspension system. The unit size, texture, finish, and color shall be as specified. The location and extent of acoustical treatment shall be as shown on the approved detail drawings.

1.4 DELIVERY AND STORAGE

Materials shall be delivered to the site in the manufacturer's original unopened containers with brand name and type clearly marked. Materials shall be carefully handled and stored in dry, watertight enclosures. Immediately before installation, acoustical units shall be stored for not less than 24 hours at the same temperature and relative humidity as the space where they will be installed in order to assure proper temperature and moisture acclimation.

1.5 ENVIRONMENTAL REQUIREMENTS

A uniform temperature of not less than 60 degrees F nor more than 85 degrees F and a relative humidity of not more than 70 percent shall be maintained before, during, and after installation of acoustical units.

1.6 SCHEDULING

Interior finish work such as plastering, concrete and terrazzo work shall be complete and dry before installation. Mechanical, electrical, and other work above the ceiling line shall be completed and heating, ventilating, and air conditioning systems shall be installed and operating in order to maintain temperature and humidity requirements.

1.7 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one year period shall be provided. Standard performance guarantee or warranty shall contain an agreement to repair or replace acoustical panels that fail within the warranty period. Failures include, but are not limited to, sagging and warping of panels; rusting and manufacturers defects of grid system.

1.8 EXTRA MATERIALS

Spare tiles of each color shall be furnished at the rate of 10 tiles for each 1000 tiles installed. Tiles shall be from the same lot as those installed.

PART 2 PRODUCTS

2.1 ACOUSTICAL UNITS

Acoustical units shall conform to ASTM E 1264, Class A, and the following requirements:

2.1.1 Units for Exposed-Grid System

Type: III (mineral fiber with painted finish).

Minimum NRC: 0.55 when tested on mounting No. E-400.

Pattern: D.

Nominal size: 24 by 48 inches.

Edge detail: Trimmed and butt.

Finish: Factory-applied white finish.

Minimum LR coefficient: 0.70.

Minimum CAC: 40.

2.2 SUSPENSION SYSTEM

Suspension system shall be exposed-grid, and shall conform to ASTM C 635 for intermediate-duty systems. Surfaces exposed to view shall be aluminum with colored factory-applied vinyl paint finish. Wall molding shall have a flange of not less than 15/16 inch. Inside and outside corner caps shall be provided. Suspended ceiling framing system shall have the capability to support the finished ceiling, light fixtures, air diffusers, and accessories, as shown. The suspension system shall have a maximum deflection of 1/360 of span length. Seismic details shall conform to the guidance in TI 809-04 and ASTM E 580.

2.3 HANGERS

Hangers shall be galvanized steel wire. Hangers and attachment shall support a minimum 300 pound ultimate vertical load without failure of supporting material or attachment.

2.4 FIRE RESISTIVE CEILINGS

Acoustical ceiling systems indicated as fire resistant shall be rated for fire endurance as indicated when tested in accordance with ASTM E 119. Suspended ceiling shall have been tested with a specimen roof assembly representative of the indicated construction, including mechanical and electrical work within ceiling space openings for light fixtures, and air outlets, and access panels. Ceiling assembly rating shall be 2 hour exposed grid system.

2.5 FINISHES

Acoustical units and suspension system members shall have manufacturer's standard textures, patterns and finishes as specified. Ceiling suspension system components shall be treated to inhibit corrosion.

PART 3 EXECUTION

3.1 INSTALLATION

Acoustical work shall be provided complete with necessary fastenings, clips, and other accessories required for a complete installation. Mechanical fastenings shall not be exposed in the finished work. Hangers shall be laid out for each individual room or space. Hangers shall be placed to support framing around beams, ducts, columns, grilles, and other penetrations through ceilings. Main runners and carrying channels shall be kept clear of abutting walls and partitions. At least two main runners shall be provided for each ceiling span. Wherever required to bypass an object with the hanger wires, a subsuspension system shall be installed, so that all hanger wires will be plumb.

3.1.1 Suspension System

Suspension system shall be installed in accordance with ASTM C 636 and as specified herein. There shall be no hanger wires or other loads suspended from underside of steel decking.

3.1.1.1 Plumb Hangers

Hangers shall be plumb and shall not press against insulation covering ducts and pipes.

3.1.2 Wall Molding

Wall molding shall be provided where ceilings abut vertical surfaces. Wall molding shall be secured not more than 3 inches from ends of each length and not more than 16 inches on centers between end fastenings. Wall molding springs shall be provided at each acoustical unit in semi-exposed or concealed systems.

3.1.3 Acoustical Units

Acoustical units shall be installed in accordance with the approved installation instructions of the manufacturer. Edges of acoustical units shall be in close contact with metal supports, with each other, and in true alignment. Acoustical units shall be arranged so that units less than one-half width are minimized. Units in exposed-grid system shall be held in place with manufacturer's standard hold-down clips, if units weigh less than 1 psf or if required for fire resistance rating.

3.2 CEILING ACCESS PANELS

Ceiling access panels shall be located directly under the items which require access.

3.3 CLEANING

Following installation, dirty or discolored surfaces of acoustical units shall be cleaned and left free from defects. Units that are damaged or improperly installed shall be removed and new units provided as directed.

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SECTION 09650

RESILIENT FLOORING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 4078	(1992; R 1996) Water Emulsion Floor Polish
ASTM E 648	(1999) Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source
ASTM E 662	(1997) Specific Optical Density of Smoke Generated by Solid Materials
ASTM F 1066	(1999) Vinyl Composition Floor Tile

1.2 FIRE RESISTANCE REQUIREMENTS

Flooring in corridors and exits shall have a minimum average critical radiant flux of 0.22 watts per square centimeter when tested in accordance with ASTM E 648. The smoke density rating shall be less than 450 when tested in accordance with ASTM E 662.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Resilient Flooring and Accessories; FIO

Manufacturer's descriptive data and installation instructions including cleaning and maintenance instructions.

SD-04 Samples

Flooring; FIO

Three samples of each indicated color and type of flooring and base. Sample size shall be minimum 2-1/2 x 4 inches.

SD-06 Test Reports

Moisture Test; FIO

Copies of test reports showing that representative product samples of the flooring proposed for use have been tested by an independent testing laboratory within the past three years or when formulation change occurred and conforms to the requirements specified.

1.4 DELIVERY AND STORAGE

Materials shall be delivered to the building site in original unopened containers bearing the manufacturer's name, project identification, and handling instructions. Materials shall be stored in a clean dry area with temperature maintained above 70 degrees F for 2 days prior to installation, and shall be stacked according to manufacturer's recommendations. Materials shall be protected from the direct flow of heat from hot-air registers, radiators and other heating fixtures and appliances.

1.5 ENVIRONMENTAL REQUIREMENTS

Areas to receive resilient flooring shall be maintained at a temperature above 70 degrees F and below 100 degrees F for 2 days before application, during application and 2 days after application. A minimum temperature of 55 degrees F shall be maintained thereafter.

1.6 SCHEDULING

Resilient flooring application shall be scheduled after the completion of other work which would damage the finished surface of the flooring.

1.7 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one year period shall be provided.

1.8 EXTRA MATERIALS

Extra flooring material of each color and pattern shall be furnished at the rate of 10 tiles for each 1000 tiles installed. Extra materials shall be from the same lot as those installed. Extra base material composed of 20 linear feet of each color shall be furnished.

PART 2 PRODUCTS

2.1 VINYL-COMPOSITION TILE

Vinyl-composition tile shall conform to ASTM F 1066, Class 1, (solid color tile), Composition 1, asbestos-free, and shall be 12 inches square and 1/8 inch thick. Tile shall have the color and pattern uniformly distributed throughout the thickness of the tile. Flooring in any one continuous area shall be from the same lot and shall have the same shade and pattern.

2.2 RESILIENT BASE

Base shall be manufacturers standard rubber or vinyl, coved style (installed with resilient flooring). Base shall be 4 inches high and a minimum 1/8 inch thick. Job Formed corners shall be furnished.

2.3 FEATURE STRIP

Feature strips shall be vinyl, 1 inch wide, and of thickness to match the flooring. Color shall be as indicated.

2.4 ADHESIVE

Adhesive for flooring and wall base shall be as recommended by the flooring manufacturer.

2.5 POLISH

Polish shall conform to ASTM D 4078.

2.6 CAULKING AND SEALANTS

Caulking and sealants shall be in accordance with Section 07900 JOINT SEALING.

2.7 MANUFACTURER'S COLOR AND TEXTURE

Color and texture shall be as directed by the Contracting Officer upon review of samples.

PART 3 EXECUTION

3.1 EXAMINATION/VERIFICATION OF CONDITIONS

The Contractor shall examine and verify that site conditions are in agreement with the design package and shall report all conditions that will prevent a proper installation. The Contractor shall not take any corrective action without written permission from the Government.

3.2 SURFACE PREPARATION

Flooring shall be in a smooth, true, level plane, except where indicated as sloped. Before any work under this section is begun, all defects such as rough or scaling concrete, low spots, high spots, and uneven surfaces shall have been corrected, and all damaged portions of concrete slabs shall have been repaired as recommended by the flooring manufacturer. Concrete curing compounds, other than the type that does not adversely affect adhesion, shall be entirely removed from the slabs. Paint, varnish, oils, release agents, sealers, waxers, and adhesives shall be removed, as recommended by the flooring manufacturer.

3.3 MOISTURE TEST

The suitability of the concrete subfloor for receiving the resilient flooring with regard to moisture content shall be determined by a moisture test as recommended by the flooring manufacturer.

3.4 INSTALLATION OF VINYL-COMPOSITION TILE AND SOLID VINYL TILE

Tile flooring shall be installed with adhesive in accordance with the manufacturer's installation instructions. Tile lines and joints shall be kept square, symmetrical, tight, and even. Edge width shall vary as necessary to maintain full-size tiles in the field, but no edge tile shall be less than one-half the field tile size, except where irregular shaped rooms make it impossible. Flooring shall be cut to, and fitted around, all

permanent fixtures, built-in furniture and cabinets, pipes, and outlets. Edge tile shall be cut, fitted, and scribed to walls and partitions after field flooring has been applied.

3.5 INSTALLATION OF FEATURE STRIPS

Feature strips shall be secured with adhesive as recommended by the manufacturer. Feature strips shall be provided at locations where flooring termination is higher than the adjacent finished flooring, except at doorways where thresholds are provided.

3.6 INSTALLATION OF RESILIENT BASE

Wall base shall be installed with adhesive in accordance with the manufacturer's written instructions. Base joints shall be tight and base shall be even with adjacent resilient flooring.

3.7 CLEANING

Immediately upon completion of installation of tile in a room or an area, flooring and adjacent surfaces shall be cleaned to remove all surplus adhesive. After installation, flooring shall be washed with a cleaning solution, rinsed thoroughly with clear cold water, and, except for raised pattern rubber flooring, rubber tile and sheet rubber flooring, rubber stair treads, and static control vinyl tile, given two coats of polish in accordance with manufacturers written instructions. After each polish coat, floors shall be buffed to an even luster with an electric polishing machine. Raised pattern rubber flooring, rubber tile and sheet rubber flooring, rubber stair treads, and static control vinyl tile shall be cleaned and maintained as recommended by the manufacturer.

3.8 PROTECTION

From the time of laying until acceptance, flooring shall be protected from damage as recommended by the flooring manufacturer. Flooring which becomes damaged, loose, broken, or curled shall be removed and replaced.

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SECTION 09900

PAINTING, GENERAL

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

ACGIH Limit Values	(1999) Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 150	(1998a) Portland Cement
ASTM D 3273	(1994) Resistance to Growth of Mold on the Surface of Interior Coating in an Environmental Chamber
ASTM D 3274	(1995) Evaluating Degree of Surface Disfigurement of Paint Films by Microbial (Fungal or Algal) Growth or Soil and Dirt Accumulation
ASTM D 4214	(1998) Evaluating Degree of Chalking of Exterior Paint Films
ASTM D 4258	(1999) Surface Cleaning Concrete for Coating

COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-1500	(Rev A; Notice 1) Sealer, Surface (Latex Block Filler)
CID A-A-2246	(Rev B) Paint, Latex
CID A-A-2247	(Basic) Paint, Latex (Semigloss, Interior)
CID A-A-2248	(Basic) Paint, Latex, (Flat, Interior)
CID A-A-2867	Coating, Polyurethane, Single Component Moisture Cure, Alipathic
CID A-A-2962	(Rev A) Enamel, Alkyd (Metric)
CID A-A-2994	Primer Coating, Interior, for Walls and Wood

FEDERAL SPECIFICATIONS (FS)

FS TT-E-2784	(Rev A) Enamel (Acrylic-Emulsion, Exterior Gloss and Semigloss) (Metric)

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 5	(1995) Zinc Dust, Zinc Oxide and Phenolic Varnish Paint
SSPC Paint 20	(1991) Zinc-Rich Primers (Type I - "Inorganic" and Type II - "Organic")
SSPC Paint 23	(1991) Latex Primer for Steel surfaces
SSPC Paint 25	(1991) Red Iron Oxide, Zinc Oxide, Raw Linseed Oil and Alkyd Primer (Without Lead and Chromate Pigments)
SSPC SP 1	(1982) Solvent Cleaning
SSPC SP 2	(1995) Hand Tool Cleaning
SSPC SP 3	(1995) Power Tool Cleaning
SSPC SP 7/NACE 4	(1994) Brush-Off Blast Cleaning

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Paint; GA.

The names, quantity represented, and intended use for the proprietary brands of materials proposed to be substituted for the specified materials when the required quantity of a particular batch is 50 gallons or less.

SD-04 Samples

Moisture-Curing Polyurethane; FIO.

A complete moisture-curing polyurethane system applied to a panel of the same material as that on which the coating will be applied in the work and for each color specified. The sample panels will be used for quality control in applying the system.

Paint; FIO.

While the material is at the site or source of supply, and at a time agreeable to the Contractor and the Contracting Officer, a 1 quart sample of each color and batch, except for quantities of 50 gallons or less, shall be taken by random selection from the sealed containers by the Contractor in the presence of a

representative of the Contracting Officer. The contents of the containers to be sampled shall be thoroughly mixed to ensure that the sample is representative. Samples shall be identified by designated name, specification number, manufacturer name and address, batch number, project contract number, intended use, and quantity involved.

SD-06 Test Reports

Paint; FIO.

A statement as to the quantity represented and the intended use, plus the following test report for batches in excess of 50 gallons:

a. A test report showing that the proposed batch to be used meets specified requirements.

b. A test report showing that a previous batch of the same formulation as the batch to be used met specified requirements, plus, on the proposed batch to be used, a report of test results for properties of weight per gallon, viscosity, fineness of grind, drying time, color, and gloss.

SD-07 Certificates

Lead; FIO.
Mildewcide and Insecticide; FIO.
Volatile Organic Compound (VOC) Content; FIO.

Certificate stating that paints for interior use contain no mercurial mildewcide or insecticide. Certificate stating that paints proposed for use contain not more than 0.06 percent lead by weight of the total nonvolatile. Certificate stating that paints proposed for use meet Federal VOC regulations and those of the of the local Air Pollution Control Districts having jurisdiction over the geographical area in which the project is located.

SD-08 Manufacturer's Instructions

Mixing and Thinning; FIO.
Application; FIO.

Manufacturer's current printed product description, material safety data sheets (MSDS) and technical data sheets for each coating system. Detailed mixing, thinning and application instructions, minimum and maximum application temperature, and curing and drying times between coats for epoxy, moisture-curing polyurethane, and liquid glaze coatings. Detailed application instructions for textured coatings shall be provided.

1.3 PACKAGING, LABELING, AND STORING

Paints shall be in sealed containers that legibly show the designated name, formula or specification number, batch number, color, quantity, date of manufacture, manufacturer's formulation number, manufacturer's directions including any warnings and special precautions, and name of manufacturer. Pigmented paints shall be furnished in containers not larger than 5 gallons. Paints and thinner shall be stored in accordance with the manufacturer's written directions and as a minimum stored off the ground, under cover,

with sufficient ventilation to prevent the buildup of flammable vapors and at temperatures between 40 and 95 degrees F. Paints shall be stored on the project site or segregated at the source of supply sufficiently in advance of need to allow 30 days for testing.

1.4 APPROVAL OF MATERIALS

When samples are tested, approval of materials will be based on tests of the samples; otherwise, materials will be approved based on test reports furnished with them. If materials are approved based on test reports furnished, samples will be retained by the Government for testing should the materials appear defective during or after application. In addition to any other remedies under the contract the cost of retesting defective materials will be at the Contractor's expense.

1.5 ENVIRONMENTAL CONDITIONS

Unless otherwise recommended by the paint manufacturer, the ambient temperature shall be between 45 and 95 degrees F when applying coatings other than water-thinned, epoxy, and moisture-curing polyurethane coatings. Water-thinned coatings shall be applied only when ambient temperature is between 50 and 90 degrees F. Epoxy, and moisture-curing polyurethane coatings shall be applied only within the minimum and maximum temperatures recommended by the coating manufacturer. Moisture-curing polyurethane shall not be applied when the relative humidity is below 30 percent.

PART 2 PRODUCTS

2.1 PAINT

The term "paint" as used herein includes emulsions, enamels, paints, stains, varnishes, sealers, cement-emulsion filler, and other coatings, whether used as prime, intermediate, or finish coat. Paint shall conform to the requirements listed in the painting schedules at the end of this section, except when the required amount of a material of a particular batch is 50 gallons or less, an approved first-line proprietary paint material with similar intended formulation, usage and color to that specified may be used. Additional requirements are as follows:

2.1.1 Colors and Tints

Colors shall be as selected from manufacturer's standard colors. The Government shall approve all final color choices based on the color options provided by the Contractor. Manufacturer's standard color is for identification of color only. Tinting of epoxy and urethane paints shall be done by the manufacturer. Stains shall conform in shade to manufacturer's standard color. The color of the undercoats shall vary slightly from the color of the next coat.

2.1.2 Mildewcide and Insecticide

Paint specified for all coats applied to fabrics and vapor barrier jackets over insulation shall contain a mildewcide that will not adversely affect the color, texture, or durability of the coating. The mildewcide shall be incorporated into the paint by the manufacturer and shall attain a surface disfigurement rating of 8 or greater when tested in accordance with ASTM D 3273 and evaluated in accordance with ASTM D 3274. Mercurial mildewcide shall not be used in interior paint. Insecticides shall not be used in paint.

2.1.3 Lead

Paints containing lead in excess of 0.06 percent by weight of the total nonvolatile content (calculated as lead metal) shall not be used.

2.1.4 Chromium

Paints containing zinc chromate or strontium chromate pigments shall not be used.

2.1.5 Volatile Organic Compound (VOC) Content

Paints shall comply with applicable federal, state and local laws enacted to insure compliance with Federal Clean Air Standards and shall conform to the restrictions of the local air pollution control authority.

PART 3 EXECUTION

3.1 PROTECTION OF AREAS NOT TO BE PAINTED

Items not to be painted which are in contact with or adjacent to painted surfaces shall be removed or protected prior to surface preparation and painting operations. Items removed prior to painting shall be replaced when painting is completed. Following completion of painting, workmen skilled in the trades involved shall reinstall removed items. Surfaces contaminated by coating materials shall be restored to original condition.

3.2 SURFACE PREPARATION

Surfaces to be painted shall be clean and free of foreign matter before application of paint or surface treatments. Oil and grease shall be removed prior to mechanical cleaning. Cleaning shall be programmed so that dust and other contaminants will not fall on wet, newly painted surfaces. Exposed ferrous metals such as nail heads on or in contact with surfaces to be painted with water-thinned paints, shall be spot-primmed with a suitable corrosion-inhibitive primer capable of preventing flash rusting and compatible with the coating specified for the adjacent areas.

3.2.1 Concrete Surfaces

Concrete, stucco and masonry surfaces shall be allowed to dry at least 30 days before painting, except concrete slab on grade which shall be allowed to cure 90 days before painting. Surfaces shall be cleaned in accordance with ASTM D 4258. Glaze, efflorescence, laitance, dirt, grease, oil, asphalt, surface deposits of free iron and other foreign matter shall be removed prior to painting. Surfaces to receive polyurethane or epoxy coatings shall be acid-etched or mechanically abraded as specified by the coating manufacturer, rinsed with water, allowed to dry, and treated with the manufacturer's recommended conditioner prior to application of the first coat.

3.2.2 Ferrous Surfaces

Ferrous surfaces including those that have been shop-coated, shall be solvent-cleaned or detergent-washed in accordance with SSPC SP 1. Surfaces that contain loose rust, loose mill scale, and other foreign substances shall be cleaned mechanically with hand tools according to SSPC SP 2, power tools according to SSPC SP 3 or by sandblasting according to SSPC SP 7/NACE

4. Shop-coated ferrous surfaces shall be protected from corrosion by treating and touching up corroded areas immediately upon detection.

3.2.3 Nonferrous Metallic Surfaces

Galvanized, aluminum and aluminum-alloy, lead, copper, and other nonferrous metal surfaces shall be solvent-cleaned or detergent-washed in accordance with SSPC SP 1.

3.2.4 Previously Painted Surfaces

Previously painted surfaces specified to be repainted shall be thoroughly cleaned of all grease, dirt, dust or other foreign matter. Blistering, cracking, flaking and peeling or other deteriorated coatings shall be removed. Slick surfaces shall be roughened. Damaged areas such as, but not limited to, nail holes, cracks, chips, and spalls shall be repaired with suitable material to match adjacent undamaged areas. Edges of chipped paint shall be feather edged and sanded smooth. Rusty metal surfaces shall be cleaned as per SSPC requirements. Solvent, mechanical, or chemical cleaning methods shall be used to provide surfaces suitable for painting. Chalk shall be removed so that when tested in accordance with ASTM D 4214, the chalk resistance rating is no less than 8. New, proposed coatings shall be compatible with existing coatings. If existing surfaces are glossy, the gloss shall be reduced.

3.3 MIXING AND THINNING

When thinning is approved as necessary to suit surface, temperature, weather conditions, or application methods, paints may be thinned in accordance with the manufacturer's directions. When thinning is allowed, paints shall be thinned immediately prior to application with not more than 1 pint of suitable thinner per gallon. The use of thinner shall not relieve the Contractor from obtaining complete hiding, full film thickness, or required gloss. Thinning shall not cause the paint to exceed limits on volatile organic compounds. Paints of different manufacturers shall not be mixed.

3.3.1 Two-Component Systems

Two-component systems shall be mixed in accordance with manufacturer's instructions. Any thinning of the first coat to ensure proper penetration and sealing shall be as recommended by the manufacturer for each type of substrate.

3.4 APPLICATION

Painting practices shall comply with applicable federal, state and local laws enacted to insure compliance with Federal Clean Air Standards. Unless otherwise specified or recommended by the paint manufacturer, paint may be applied by brush, roller, or spray. At the time of application, paint shall show no signs of deterioration. Uniform suspension of pigments shall be maintained during application. Each coat of paint shall be applied so dry film shall be of uniform thickness and free from runs, drops, ridges, waves, pinholes or other voids, laps, brush marks, and variations in color, texture, and finish. Hiding shall be complete. Rollers for applying paints and enamels shall be of a type designed for the coating to be applied and the surface to be coated. Special attention shall be given to insure that all edges, corners, crevices, welds, and rivets receive a film thickness equal to that of adjacent painted surfaces. Paints, except

water-thinned types, shall be applied only to surfaces that are completely free of moisture as determined by sight or touch.

3.4.1 Ventilation

Affected areas shall be ventilated during paint application so that workers exposure to chemical substances shall not exceed limits as established by ACGIH Limit Values, or as required by a more stringent applicable regulation. Interior work zones having a volume of 10,000 cubic feet or less shall be ventilated at a minimum of 2 air exchanges per hour. Ventilation in larger work zones shall be maintained by means of mechanical exhaust. Solvent vapors shall be exhausted outdoors, away from air intakes and workers. Return air inlets in the work zone shall be temporarily sealed before start of work until the coatings have dried.

3.4.2 Respirators

Operators and personnel in the vicinity of operating paint sprayers shall wear respirators.

3.4.3 First Coat

The first coat on plaster, gypsum wallboard, and other surfaces shall include repeated touching up of suction spots or overall application of primer or sealer to produce uniform color and gloss. Excess sealer shall be wiped off after each application. The first coat on both faces of wood doors shall be applied at essentially the same time. Glazed doors and sashes shall be given the specified coating system within 3 weeks of the time they are glazed, but not before the glazing material has set; paint shall overlay glass about 70 mils all around. Each varnish coat shall be sanded lightly prior to application of subsequent coats.

3.4.4 Timing

Surfaces that have been cleaned, pretreated, and otherwise prepared for painting shall be given a coat of the specified first coat as soon as practical after such pretreatment has been completed, but prior to any deterioration of the prepared surface. Sufficient time shall elapse between successive coats to permit proper drying. This period shall be modified as necessary to suit weather conditions. Oil-based or oleoresinous solvent-type paints shall be considered dry for recoating when the paint feels firm, does not deform or feel sticky under moderate pressure of the thumb, and the application of another coat of paint does not cause the undercoat to lift or lose adhesion. Manufacturer's instructions for application, curing and drying time between coats of two-component systems shall be followed.

3.4.5 Fillers

Concrete and masonry surface voids shall be filled; however, surface irregularities need not be completely filled. The dried filler shall be uniform and free of pinholes. Filler shall not be applied over caulking compound.

3.4.5.1 Cement-Emulsion Filler

Immediately before filler application, surfaces shall be dampened uniformly and thoroughly, with no free surface water visible, by several applications of potable water with a fog spray, allowing time between the sprayings for

water to be absorbed. Cement-emulsion filler shall be scrubbed into the surface vigorously with a stiff-bristled brush having tampico or palmyra bristles not longer than 2-1/2 inches. At least 24 hours shall elapse before applying exterior emulsion paint over cement-emulsion filler. When the ambient temperature is over 85 degrees F, cement-emulsion filler surfaces shall be dampened lightly with a fog spray of potable water immediately prior to application of the subsequent paint coat.

3.4.5.2 Latex Filler

Latex filler, CID A-A-1500, shall be applied according to the manufacturer's instructions. Surface voids shall be filled and excess filler shall be removed from the surface with a rubber squeegee. The filler shall be allowed to dry the length of time specified by the manufacturer prior to applying successive coats of paint.

3.4.6 Ferrous-Metal Primer

Primer for ferrous-metal shall be applied to ferrous surfaces to receive paint other than asphalt varnish prior to deterioration of the prepared surface. The semitransparent film applied to some pipes and tubing at the mill is not to be considered a shop coat, but shall be overcoated with the specified ferrous-metal primer prior to application of finish coats.

3.5 PIPE COLOR CODE MARKING

Pipes in exposed areas and in accessible pipe spaces shall be provided with color band and titles adjacent to all valves, except those provided at plumbing fixtures, at not more than 40 foot spacing on straight pipe runs, adjacent to change in direction, and on both sides where pipes pass through walls or floors. Color code marking shall be of the color listed in TABLE I and the size listed in TABLE II. The arrows shall be installed adjacent to each band to indicate the direction of flow in the pipe. The legends shall be printed in upper-case black letters as listed in TABLE I. Letter sizes shall be as listed in TABLE II. Marking shall be painted or applied using colored, pressure-sensitive adhesive markers of standard manufacture. Paint shall be as specified for insulated and uninsulated piping.

TABLE I. COLOR CODES FOR MARKING PIPE

Material	Band	Letters and Arrow*	Legend
Cold water (potable)	Green	White	POTABLE WATER
Fire protection water	Red	White	FIRE PR. WATER
Fire Sprinkler Water	Red	White	FIRE SPR. WATER
Hot water (domestic)	Green	White	H.W.
Hot water recirculating (domestic)	Green	White	H.W.R.
High temp. water supply	Yellow	Black	H.T.W.S.
High temp. water return	Yellow	Black	H.T.W.R.
Boiler feed water	Yellow	Black	B.F.
Low temp. water supply (heating)	Yellow	Black	L.T.W.S.
Low temp. water return (heating)	Yellow	Black	L.T.W.R.
Condenser water supply	Green	White	COND. W.S.
Condenser water return	Green	White	COND. W.R.
Chilled water supply	Green	White	C.H.W.S.
Chilled water return	Green	White	C.H.W.R.
Treated water	Green	White	TR. WATER
Chemical feed	Yellow	Black	CH. FEED

TABLE I. COLOR CODES FOR MARKING PIPE

Material	Band	Letters and Arrow*	Legend
Compressed air	Blue	White	COMP. AIR
Natural gas	Yellow	Black	NAT. GAS
Propane Gas	Yellow	Black	PROP. GAS
Refrigerants	Blue	White	REFRIGERANT
Fuel oil	Yellow	Black	FUEL OIL
Steam	Yellow	Black	STEAM
Condensate	Yellow	Black	CONDENSATE

TABLE II. COLOR CODE MARKING SIZES

Outside Diameter of Pipe Covering (Inches)	Length of Color Band (inches)	Arrow Length x Width (Inches)	Size of Legend Letters and Numerals (Inches)
Less than 1-1/2	8	8 x 2-1/4	1/2
1-1/2 to 2-3/8	8	8 x 2-1/4	3/4
2-1/2 to 7-7/8	12	8 x 2-1/4	1-1/4
8 to 10	24	12 x 4-1/2	2-1/2
Over 10	32	12 x 4-1/2	3-1/2

3.6 MISCELLANEOUS PAINTING

3.6.1 Lettering

Lettering shall be provided as scheduled on the drawings, shall be block type, and shall be black enamel. Samples shall be approved before application.

3.7 SURFACES TO BE PAINTED

Surfaces listed in the painting schedules at the end of this section, other than those listed in paragraph SURFACES NOT TO BE PAINTED, shall be painted as scheduled.

3.8 SURFACES NOT TO BE PAINTED

Surfaces in the following areas shall not to be painted: Concrete (unless otherwise specified); aluminum; stainless steel, copper and plastic components (except bands, arrows and legends for pipe or where codes require full pipe painting); metal building wall and roof panels and liners. In addition, surfaces of hardware, fittings, and other factory finished items shall not be painted.

3.9 CLEANING

Cloths, cotton waste and other debris that might constitute a fire hazard shall be placed in closed metal containers and removed at the end of each day. Upon completion of the work, staging, scaffolding, and containers shall be removed from the site or destroyed in an approved manner. Paint and other deposits on adjacent surfaces shall be removed and the entire job left clean and acceptable.

3.10 PAINTING SCHEDULES

The following painting schedules identify the surfaces to be painted and prescribe the paint to be used and the number of coats of paint to be applied. Contractor options are indicated by ------or------ between optional systems or coats.

For paint classifications, the following data will aid in understanding the specifications in these schedules:

a. CID A-A-1500: Surface Sealer (Latex Block Filler)

b. CID A-A-2246: Latex Paint (Interior Gloss)

c. CID A-A-2962: Alkyd Enamel
Type I - Bulk
Type II - Aerosol
Class A - Maximum VOC 420 g/L (Type I); 82% (Type II)
Class B - Maximum VOC 340 g/L (Type I); 65% (Type II)
Grade A - Flat, 60 degrees Specular Gloss of not over 4
Grade B - Semigloss, 60 degrees Specular Gloss of greater than 15 but not over 25
Grade C - Gloss, 20 degrees Specular Gloss of greater than 70

d. CID A-A-2994: Interior Primer Coating for Walls and Wood
Type I - Alkyd Primer
Type II - Latex Primer

e. FS TT-E-2784: Enamel (Exterior Acrylic-Emulsion)
Type I - Gloss
Type II - Semigloss
Type III - Flat

EXTERIOR PAINTING SCHEDULE

Surface	First Coat	Second Coat	Third Coat
Concrete masonry units.	Cement-emulsion filler	FS TT-E-2784 Type III	None
	CID A-A-1500	FS TT-E-2784 Type III	None
	FS TT-E-2784 Type III	FS TT-E-2784 Type III	None

NOTE: Cement-emulsion filler coat shall be acrylic-based and shall consist of the following ingredients in the proportion stated: white portland cement, ASTM C 150, Type I, 16.5 pounds; aggregate 33.5 pounds; mixing liquid, factory-prepared acrylic containing 46 to 47 percent solids, 0.75 gallon; potable water 1.0 gallon maximum; exterior emulsion paint, FS TT-E-2784 Type III 1.0 gallon. Aggregate shall consist of Washed silica sand of the following gradation:

Percent Sand (by Weight)

EXTERIOR PAINTING SCHEDULE

Surface	First Coat	Second Coat	Third Coat
	U.S. Sieve Size	Passing Individual Sieve	
	0.850 mm (20)	100	
	0.600 mm (30)	95 - 100	
	0.300 mm (50)	30 - 65	
	0.150 mm (100)	0 - 10	
	0.075 mm (200)	0 - 1	
Concrete, as specified.	FS TT-E-2784 Type III	FS TT-E-2784 Type III	None
Ferrous metal unless otherwise specified	SSPC Paint 5	CID A-A-2962 Type I Class B Grade C	CID A-A-2962 Type 1 Class B Grade C
	SSPC Paint 25	CID A-A-2962 Type I Class B Grade C	CID A-A-2962 Type 1 Class B Grade C
	SSPC Paint 23	FS TT-E-2784 Type I	FS TT-E-2784 Type I
Ferrous metal: subject to high temperature, up to 232 degrees C (450 degrees F).	SSPC Paint 20 Type I	None	None
Galvanized metal.	FS TT-E-2784 Type III	FS TT-E-2784 Type I	FS TT-E-2784 Type I

INTERIOR PAINTING SCHEDULE

Surface	First Coat	Second Coat	Third Coat
Plaster, gypsum board, concrete, and concrete masonry units not requiring a not requiring a	CID A-A-2994 Type II	CID A-A-2246	CID A-A-2246 on gypsum board faced with recycled paper
		----------or----------	
		CID A-A-2247	CID A-A-2247 on

INTERIOR PAINTING SCHEDULE

Surface	First Coat	Second Coat	Third Coat
smooth finish, unless otherwise specified			gypsum board faced with recycled paper ----------or---------- CID A-A-2248 on gypsum board faced with recycled paper
		CID A-A-2248	
Concrete masonry units requiring a smooth finish	CID A-A-1500	CID A-A-2994 Type II	CID A-A-2246 -----or----- CID A-A-2247 -----or----- CID A-A-2248
Ferrous Metal unless otherwise specified	SSPC Paint 25	CID A-A-2962 Type I Class B Grade C	CID A-A-2962 Type I Class B Grade C
	SSPC Paint 23	FS TT-E-2784 Type I	FS TT-E-2784 Type I
	CID A-A-2867	CID A-A-2867	None
Ferrous metal factory-primed mechanical and electrical equipment.	Two coats of paint as recommended by the equipment manufacturer		None
Galvanized metal:	FS TT-E-2784 Type III	FS TT-E-2784 Type I	None
	SSPC Paint 5	CID A-A-2962 Type I Class B Grade C	CID A-A-2962 Type I Class B Grade C
	SSPC Paint 25	CID A-A-2962 Type I Class B	CID A-A-2962 Type I Class B

INTERIOR PAINTING SCHEDULE

Surface	First Coat	Second Coat Grade C	Third Coat Grade C
	SSPC Paint 23	FS TT-E-2784 Type I	FS TT-E-2784 Type I
Ferrous Metal: Convector enclosures, electrical conduit runs: metallic tubing uninsulated ducts and pipes, pipe hangers, louvers, grilles, and air outlets, in areas having painted adjacent surfaces.	SSPC Paint 23	None	None
Aluminum and Galvanized Surface Metal: Convector enclosures, electrical conduit runs metallic tubing uninsulated ducts and pipes, pipe hangers, louvers, grilles, and air outlets, in areas having painted adjacent surfaces.	FS TT-E-2784	CID A-A-2246 ----------or---------- CID A-A-2247 ----------or---------- CID A-A-2248	CID A-A-2246 CID A-A-2247 CID A-A-2248
Metal: surfaces subject to high temperature, up to 232 degrees C (450 degrees F).	SSPC Paint 20 Type I	None	None
Facing of vapor barrier jackets of presized or adhesive finished cloth cover insulation on pipes, ducts, and equipment.	Two coats of paint to match adjacent areas		None

INTERIOR PAINTING SCHEDULE

Surface	First Coat	Second Coat	Third Coat

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SECTION 09910

HIGH-SOLIDS THIN FILM EPOXY FLOORING SYSTEM

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SECTION 09910

HIGH SOLIDS THIN FILM EPOXY FLOORING SYSTEM

PART 1 GENERAL

1.1 REFERENCES

The publication listed below forms a part of this specification to the extent referenced. The publication is referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 4259	(1988; R 1999) Standard Practice for Abrading Concrete
ASTM D 4263	(1983; R 1999) Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
ASTM D 4414	(1995; R 2001) Standard Practice for Measurement of Wet Film Thickness by Notched Gages
ASTM F 1869	(1998) Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride

INTERNATIONAL CONCRETE REPAIR INSTITUTE (ICRI)

ICRI Technical Guideline 03732	(1997) Selecting and Specifying Surface Preparation for Sealers, Coatings, and Membranes

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 13/NACE No. 6	(1997) Surface Preparation of Concrete

1.2 DEFINITIONS

1.2.1 Wet Film Thickness

The primer or coating film's actual thickness immediately following application. Wet film thickness is measured in mils or thousandths of an inch (0.001 inch).

1.2.2 Dry Film Thickness

The primer or coating film's actual thickness following curing and drying. Dry film thickness is measured in mils or thousandths of an inch (0.001 inch).

1.3 LOCATION

High solids thin film epoxy flooring system shall be applied to the concrete floor slab in the process room.

1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

High Solids Thin Film Epoxy Flooring System; GA.

Manufacturer's current printed recommendations and product data sheets for all high solids thin film epoxy flooring system products, including performance criteria, surface preparation, installation instructions, volatile organic compound (VOC) data, storage requirements (temperature, humidity, and ventilation), and safety requirements. Cleaning and maintenance instructions shall be included.

Material Safety Data Sheets (MSDSs); FIO.

Contractor shall submit MSDSs for any materials brought onsite, including all flooring system materials, solvents, and abrasive blast media.

Cleaning and Thinner Solutions; FIO.

List of cleaning and thinner solutions allowed by the manufacturer.

SD-04 Samples

High Solids Thin Film Epoxy Flooring System; GA.

Three samples of each color of high solids thin film epoxy flooring system.

SD-07 Certificates

Qualifications of Applicator; GA.

Contractor shall furnish written qualifications of the applicator.

1.5 QUALIFICATIONS OF APPLICATOR

Installation shall be performed by an applicator having satisfactory experience in the application of these or similar materials, or with onsite consultation by a qualified field service representative of the manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver the materials to the project site in new, unopened containers clearly labeled with the name of the product, name of the manufacturer, manufacturer's batch number, generic type of material, application and

mixing instructions, hazardous material identification label, and shelf life. All containers shall be clearly marked indicating any personnel safety hazards associated with the use of or exposure to the materials. All materials shall be handled and stored to prevent damage or loss of label. Do not use or retain contaminated, outdated, prematurely opened, or diluted materials or materials which have exceeded their shelf life.

Materials shall be stored indoors, protected from damage, moisture, direct sunlight, and temperatures below 40 degrees F or above 90 degrees F or in accordance with the manufacturer's requirements. Store all materials only in area or areas designated by the Contracting Officer solely for this purpose. Confine mixing, thinning, cleanup and associated operations, as well as storage of coating materials related debris before approved disposal, to these areas. All materials shall be stored on pallets or similar storage/handling skids off the ground.

1.7 PROTECTION

Protect adjacent surfaces not scheduled to receive the floor coating by masking or by other means to maintain these surfaces free of the coating materials. Provide adequate ventilation and fire protection at all mixing and placing operations. Prohibit smoking and the use of spark or flame producing devices within any mixing or placing operations areas. Provide safety equipment required and recommended by the manufacturer of the floor coating materials. The Contractor shall take all additional precautions and implement all measures necessary to avert potential hazards associated with the high solids thin film epoxy flooring system materials as described on the pertinent MSDSs or container labels.

1.8 ENVIRONMENTAL CONDITIONS

Surfaces and surrounding air temperatures must exceed 55 degrees F, but must be less than 90 degrees F, with materials at not less than 70 degrees F at application or as specified by manufacturer. Do not apply coating materials when dust is being generated. If existing facility lighting is not adequate for flooring system application, the Contractor shall provide all temporary lighting equivalent to one 200 watt explosion proof incandescent lamp per 100 square feet of work area.

PART 2 PRODUCTS

2.1 MATERIALS AND MANUFACTURERS

1. Primer: Tnemec Series 201 Epoxoprime as manufactured by Tnemec Company, Inc.

2. Topcoat (as directed by Contracting Officer): Tnemec Series 201 Epoxoprime as manufactured by Tnemec Company, Inc.

3. Or approved equal.

2.2 DESCRIPTION

High solids thin film epoxy flooring system shall consist of a high solids (100 percent solids by volume), two-component, moisture tolerant, penetrating modified polyamine cured epoxy primer/sealer.

PART 3 EXECUTION

3.1 PREPARATION

Allow new concrete to cure for 28 days. For every 500 square feet of surface to be coated, verify dryness by testing for moisture with a plastic film tapedown test in accordance with ASTM D 4263. If moisture is indicated, perform calcium chloride moisture tests in accordance with ASTM F 1869 once for every 1000 square feet of surface area to be coated. The moisture vapor emissions rate shall not exceed 3 pounds per 1000 square feet in a 24 hour period.

Shot blast or mechanically abrade concrete surface to remove laitance, curing compounds, sealers, and other contaminants and to provide surface profile in accordance with SSPC SP 13/NACE No. 6, ASTM D 4259, or ICRI Technical Guideline 03732, as appropriate, and manufacturer's written installation instructions. Vacuum clean concrete to remove dirt, dust, and other loose materials. Fill large voids, bugholes, and other cavities with recommended filler or surfacer. After mechanically abrading, all surfaces shall be clean, dry, and free of oil, grease, and other contaminants which could adversely affect the adhesion of the flooring system. If between final surface preparation work and flooring system application, contamination of the prepared and cleaned substrates occurs, recleaning shall be required.

3.2 MOCK-UP

Prior to commencing installation, the Contractor shall install, with the Contracting Officer's approval, a mutually agreed upon mock-up test sample to show final color and appearance of the high solids thin film epoxy flooring system.

3.3 INSTALLATION

The high solids thin film epoxy floor primer/sealer shall be mechanically mixed, applied, and cured in strict accordance with the manufacturer's approved written instructions. Apply primer coat uniformly at a dry film thickness of 6 to 12 mils. Apply topcoat (as directed by Contracting Officer) uniformly at a dry film thickness of 6 to 12 mils. Cracks and control joints, construction joints, expansion joints, and all high solids thin film epoxy flooring system terminations shall be installed as indicated on the drawings.

3.4 CLEANUP

Remove waste materials, rubbish, and debris and dispose of them at the Contracting Officer's direction. Do not use drain piping for disposal of flooring materials. Leave work area in a clean and tidy condition.

3.5 PROTECTION

Protect the completed work from water, airborne particles, or other surface contaminants until cured for a minimum of 24 hours after application. Protect from traffic, physical abuse, immersion, and chemical exposure until the complete system has thoroughly cured for a minimum of 24 hours at 75 degrees F. For different temperatures, consult the manufacturer's representative about curing times.

3.6 FIELD TESTS AND INSPECTION

The Contractor shall record weather conditions, document job site

occurrences, and report conditions and occurrences potentially detrimental to the flooring system. At the start of coating operations and every two hours following until daily work is complete, record ambient air temperature, substrate temperature, and relative humidity. Inspect correct mixing of floor coating materials in accordance with the manufacturer's written instructions. Inspect and record that the pot life of each floor coating material used is not exceeded during installation. Following each coat application, inspect surfaces for improperly cured material, blisters, inadequate and/or excessive coating thickness, and other defects. Measure and record the wet film thickness of the flooring system using a notched gage in accordance with ASTM D 4414 and at a frequency recommended by the manufacturer and approved by the Contracting Officer. Document each inspection, test, non-compliant area, and location of each non-compliant area.

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SECTION 09930

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SECTION 09930

PROTECTIVE COATING SYSTEM (ALUM STORAGE AREA)

PART 1 GENERAL

1.1 REFERENCES

The publication listed below forms a part of this specification to the extent referenced. The publication is referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 4259	(1988; R 1999) Standard Practice for Abrading Concrete
ASTM D 4263	(1983; R 1999) Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
ASTM D 4414	(1995; R 2001) Standard Practice for Measurement of Wet Film Thickness by Notched Gages
ASTM F 1869	(1998) Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride

INTERNATIONAL CONCRETE REPAIR INSTITUTE (ICRI)

ICRI Technical Guideline 03732	(1997) Selecting and Specifying Surface Preparation for Sealers, Coatings, and Membranes

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 13/NACE No. 6	(1997) Surface Preparation of Concrete

1.2 DEFINITIONS

1.2.1 Wet Film Thickness

The primer or coating film's actual thickness immediately following application. Wet film thickness is measured in mils or thousandths of an inch (0.001 inch).

1.2.2 Dry Film Thickness

The primer or coating film's actual thickness following curing and drying. Dry film thickness is measured in mils or thousandths of an inch (0.001 inch).

1.3 LOCATION

Protective coating system shall be applied to the concrete floor, curbs, and pad in the alum storage area.

1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Protective Coating System; GA.

Manufacturer's current printed recommendations and product data sheets for all protective coating system products, including performance criteria, surface preparation, installation instructions, volatile organic compound (VOC) data, storage requirements (temperature, humidity, and ventilation), and safety requirements. Cleaning and maintenance instructions shall be included.

Material Safety Data Sheets (MSDSs); FIO.

Contractor shall submit MSDSs for any materials brought onsite, including all protective coating system materials, solvents, and abrasive blast media.

Cleaning and Thinner Solutions; FIO.

List of cleaning and thinner solutions allowed by the manufacturer.

SD-04 Samples

Protective Coating System; GA.

Three samples of each color of protective coating system.

SD-07 Certificates

Qualifications of Applicator; GA.

Contractor shall furnish written qualifications of the applicator.

1.5 QUALIFICATIONS OF APPLICATOR

Installation shall be performed by an applicator having satisfactory experience in the application of these or similar materials, or with onsite consultation by a qualified field service representative of the manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver the materials to the project site in new, unopened containers clearly labeled with the name of the product, name of the manufacturer, manufacturer's batch number, generic type of material, application and mixing instructions, hazardous material identification label, and shelf

life. All containers shall be clearly marked indicating any personnel safety hazards associated with the use of or exposure to the materials. All materials shall be handled and stored to prevent damage or loss of label. Do not use or retain contaminated, outdated, prematurely opened, or diluted materials or materials which have exceeded their shelf life.

Materials shall be stored indoors, protected from damage, moisture, direct sunlight, and temperatures below 40 degrees F or above 90 degrees F or in accordance with the manufacturer's requirements. Store all materials only in area or areas designated by the Contracting Officer solely for this purpose. Confine mixing, thinning, cleanup and associated operations, as well as storage of coating materials related debris before approved disposal, to these areas. All materials shall be stored on pallets or similar storage/handling skids off the ground.

1.7 PROTECTION

Protect adjacent surfaces not scheduled to receive the protective coating by masking or by other means to maintain these surfaces free of the coating materials. Provide adequate ventilation and fire protection at all mixing and placing operations. Prohibit smoking and the use of spark or flame producing devices within any mixing or placing operations areas. Provide safety equipment required and recommended by the manufacturer of the protective coating materials. The Contractor shall take all additional precautions and implement all measures necessary to avert potential hazards associated with the protective coating system materials as described on the pertinent MSDSs or container labels.

1.8 ENVIRONMENTAL CONDITIONS

Surfaces and surrounding air temperatures must exceed 55 degrees F, but must be less than 90 degrees F, with materials at not less than 70 degrees F at application or as specified by manufacturer. Do not apply coating materials when dust is being generated. If existing facility lighting is not adequate for protective coating system application, the Contractor shall provide all temporary lighting equivalent to one 200 watt explosion proof incandescent lamp per 100 square feet of work area.

PART 2 PRODUCTS

2.1 MATERIALS AND MANUFACTURERS

1. First Coat: Tnemec Series 104 H.S. Epoxy as manufactured by Tnemec Company, Inc.

2. Second Coat: Tnemec Series 104 H.S. Epoxy as manufactured by Tnemec Company, Inc.

3. Filler and Surfacer: Tnemec Series 218 MortarClad as manufactured by Tnemec Company, Inc.

3. Or approved equals.

2.2 DESCRIPTION

Protective coating system shall consist of a high solids (minimum 80 percent solids by volume) epoxy coating cross-linked with an amine curing agent. Coating shall protect in immersion, salt spray, and chemical exposure.

PART 3 EXECUTION

3.1 PREPARATION

Allow new concrete to cure for 28 days. For every 500 square feet of surface to be coated, verify dryness by testing for moisture with a plastic film tapedown test in accordance with ASTM D 4263. If moisture is indicated, perform calcium chloride moisture tests in accordance with ASTM F 1869 once for every 1000 square feet of surface area to be coated. The moisture vapor emissions rate shall not exceed 3 pounds per 1000 square feet in a 24 hour period.

Shot blast or mechanically abrade concrete surface to remove laitance, curing compounds, sealers, and other contaminants and to provide surface profile in accordance with SSPC SP 13/NACE No. 6, ASTM D 4259, or ICRI Technical Guideline 03732, as appropriate, and manufacturer's written installation instructions. Vacuum clean concrete to remove dirt, dust, and other loose materials. Fill large voids, bugholes, and other cavities with recommended filler or surfacer. After mechanically abrading, all surfaces shall be clean, dry, and free of oil, grease, and other contaminants which could adversely affect the adhesion of the protective coating system. If between final surface preparation work and coating system application, contamination of the prepared and cleaned substrates occurs, recleaning shall be required.

3.2 MOCK-UP

Prior to commencing installation, the Contractor shall install, with the Contracting Officer's approval, a mutually agreed upon mock-up test sample to show final color and appearance of the protective coating system.

3.3 INSTALLATION

The high solids epoxy coating shall be mechanically mixed, applied, and cured in strict accordance with the manufacturer's approved written instructions. Apply a minimum of two finish coats uniformly at a dry film thickness of 6 to 10 mils per coat. Cracks and control joints, construction joints, expansion joints, and all protective coating system terminations shall be installed as indicated on the drawings.

3.4 CLEANUP

Remove waste materials, rubbish, and debris and dispose of them at the Contracting Officer's direction. Do not use drain piping for disposal of coating materials. Leave work area in a clean and tidy condition.

3.5 PROTECTION

Protect the completed work from water, airborne particles, or other surface contaminants until cured for a minimum of 24 hours after application. Protect from traffic, physical abuse, immersion, and chemical exposure until the complete system has thoroughly cured for a minimum of 24 hours at 75 degrees F. For different temperatures, consult the manufacturer's representative about curing times.

3.6 FIELD TESTS AND INSPECTION

The Contractor shall record weather conditions, document job site

occurrences, and report conditions and occurrences potentially detrimental to the coating system. At the start of coating operations and every two hours following until daily work is complete, record ambient air temperature, substrate temperature, and relative humidity. Inspect correct mixing of coating materials in accordance with the manufacturer's written instructions. Inspect and record that the pot life of each coating material used is not exceeded during installation. Following each coat application, inspect surfaces for improperly cured material, blisters, inadequate and/or excessive coating thickness, and other defects. Measure and record the wet film thickness of the coating system using a notched gage in accordance with ASTM D 4414 and at a frequency recommended by the manufacturer and approved by the Contracting Officer. Document each inspection, test, non-compliant area, and location of each non-compliant area.

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SECTION 10201

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SECTION 10201

METAL WALL LOUVERS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

AMCA 500	(1991) Louvers, Dampers and Shutters
AMCA 511	(1991) Certified Ratings Program for Air Control Devices

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 167	(1996) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 366/A 366M	(1997) Commercial Quality (CS) Steel, Carbon (0.15 Maximum Percent), Cold-Rolled
ASTM A 653/A 653M	(1998) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B 209	(1996) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 221	(1996) Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

1.2 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

SD-02 Shop Drawings

Wall Louvers; GA

Show all information necessary for fabrication and installation of louvers. Indicate materials, sizes, thicknesses, fastenings, and profiles.

SD-04 Samples

Wall Louvers; GA

Colors of finishes shall closely approximate colors indicated.

Where color is not indicated, submit the manufacturer's standard colors to the Contracting Officer for selection.

1.3 DELIVERY, STORAGE, AND PROTECTION

Deliver materials to the site in an undamaged condition. Carefully store materials off the ground to provide proper ventilation, drainage, and protection against dampness. Louvers shall be free from nicks, scratches, and blemishes. Replace defective or damaged materials with new.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Galvanized Steel Sheet

ASTM A 653/A 653M, coating designation G90.

2.1.2 Aluminum Sheet

ASTM B 209, alloy 3003 or 5005 with temper as required for forming.

2.1.3 Extruded Aluminum

ASTM B 221, alloy 6063-T5 or -T52.

2.1.4 Stainless Steel

ASTM A 167, Type 302 or 304, with 2B finish.

2.1.5 Cold Rolled Steel Sheet

ASTM A 366/A 366M, Class 1, with matte finish. Use for interior louvers only.

2.2 METAL WALL LOUVERS

Weather resistant type, with bird screens and made to withstand a wind load of not less than 30 pounds per square foot. Wall louvers shall bear the AMCA certified ratings program seal for air performance and water penetration in accordance with AMCA 500 and AMCA 511. The rating shall show a water penetration of 0.20 or less ounce per square foot of free area at a free velocity of 800 feet per minute. Louvers shall have dampers where specified.

2.2.1 Extruded Aluminum Louvers

Fabricated of extruded 6063-T5 or -T52 aluminum with a wall thickness of not less than 0.081 inch.

2.2.2 Formed Metal Louvers

Formed of zinc-coated or stainless steel sheet not thinner than 16 U.S. gage, or aluminum sheet not less than 0.08 inch thick.

2.2.3 Mullions and Mullion Covers

Same material and finish as louvers. Provide mullions where indicated. Provide mullions covers on both faces of joints between louvers.

2.2.4 Screens and Frames

For aluminum louvers, provide 1/2 inch square mesh, 14 or 16 gage aluminum or 1/4 inch square mesh, 16 gage aluminum bird screening. For steel louvers, provide 1/2 inch square mesh, 12 or 16 gage zinc-coated steel; 1/2 inch square mesh, 16 gage copper; or 1/4 inch square mesh, 16 gage zinc-coated steel or copper bird screening. Mount screens in removable, rewirable frames of same material and finish as the louvers.

2.3 FASTENERS AND ACCESSORIES

Provide stainless steel screws and fasteners for aluminum louvers and zinc-coated or stainless steel screws and fasteners for steel louvers. Provide other accessories as required for complete and proper installation.

2.4 FINISHES

Coordinate finish with other exterior building components.

2.4.1 Aluminum

Provide factory-applied anodic coating or organic coating.

2.4.1.1 Anodic Coating

Clean exposed aluminum surfaces and apply an anodized finish as specified.

2.4.1.2 Organic Coating

Clean and prime exposed aluminum surfaces and apply a baked enamel finish as specified.

2.4.2 Steel

Provide factory-applied coating. Clean and phosphate treat exposed surfaces and apply rust-inhibitive primer and baked enamel finish coat, one mil minimum total dry film thickness, color as specified.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Wall Louvers

Install using stops or moldings, flanges, strap anchors, or jamb fasteners as appropriate for the wall construction and in accordance with manufacturer's recommendations.

3.1.2 Screens and Frames

Attach frames to louvers with screws or bolts.

3.2 PROTECTION FROM CONTACT OF DISSIMILAR MATERIALS

3.2.1 Copper or Copper-Bearing Alloys

Paint copper or copper-bearing alloys in contact with dissimilar metal with heavy-bodied bituminous paint or separate with inert membrane.

3.2.2 Aluminum

Where aluminum contacts metal other than zinc, paint the dissimilar metal with a primer and two coats of aluminum paint.

3.2.3 Metal

Paint metal in contact with mortar, concrete, or other masonry materials with alkali-resistant coatings such as heavy-bodied bituminous paint.

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SECTION 10430

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SECTION 10430

EXTERIOR SIGNAGE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z97.1	(1984; Rev 1994) Safety Performance Specifications and Methods of Test for Safety Glazing Materials Used in Buildings

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36/A 36M	(1997a) Carbon Structural Steel
ASTM A 123/A 123M	(1997a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 570/A 570M	(1996) Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality
ASTM A 653/A 653M	(1997) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 924/A 924M	(1997) General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B 26/B 26M	(1997) Aluminum-Alloy Sand Castings
ASTM B 108	(1997) Aluminum-Alloy Permanent Mold Castings
ASTM B 209	(1996) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 221	(1996) Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM C 1036	(1991; R 1997) Flat Glass
ASTM E 84	(1996a) Surface Burning Characteristics of Building Materials

AMERICAN WELDING SOCIETY (AWS)

AWS C1.1	(1966) Recommended Practices for Resistance Welding
AWS D1.1	(1996) Structural Welding Code - Steel
AWS D1.2	(1990) Structural Welding Code - Aluminum

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM AMP 505	(1988) Metal Finishes Manual for Architectural and Metal Products; Section: Applied Coatings

1.2 GENERAL

All exterior signage shall be provided by a single manufacturer. Exterior signage shall be of the design, detail, sizes, types, and message content shown on the drawings, shall conform to the requirements specified, and shall be provided at the locations indicated. Signs shall be complete with lettering, framing as detailed, and related components for a complete installation.

1.3 CHARACTER PROPORTIONS AND HEIGHTS

Letters and numbers on indicated signs for handicapped-accessible buildings shall have a width-to-height ratio between 3:5 and 1:1 and a stroke-width-to-height ratio between 1:5 and 1:10. Characters and numbers on indicated signs shall be sized according to the viewing distance from which they are to be read. The minimum height is measured using an upper case letter "X". Lower case characters are permitted.

1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Exterior Signs; FIO.

Exterior signage schedule in electronic media with spread sheet format. Spread sheet shall include sign location, sign type, and message.

SD-02 Shop Drawings

Exterior Signs; FIO.

Drawings showing elevations of each type of sign; dimensions, details, and methods of mounting or anchoring; shape and thickness of materials; and details of construction. A schedule showing the location, each sign type, and message shall be included.

SD-03 Product Data

Exterior Signs; FIO.

Manufacturer's descriptive data and catalog cuts.

SD-04 Samples

Exterior Signs; FIO.

One sample of each type of sign. Each sample shall consist of a complete sign panel with letters and symbols. Samples may be installed in the work, provided each sample is identified and location recorded. Two samples of manufacturer's standard color chips for each material requiring color selection and 12 inch square sample of sign face color sample.

SD-08 Manufacturer's Instructions

Exterior Signs; FIO.

Manufacturer's installation instructions and cleaning instructions.

1.5 QUALIFICATIONS

Signs, plaques, and dimensional letters shall be the standard product of a manufacturer regularly engaged in the manufacture of the products. Items of equipment shall essentially duplicate equipment that has been in satisfactory use at least 2 years prior to bid opening.

1.6 DELIVERY AND STORAGE

Materials shall be wrapped for shipment and storage, delivered to the jobsite in manufacturer's original packaging, and stored in a clean, dry area in accordance with manufacturer's instructions.

1.7 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one year period shall be provided.

PART 2 PRODUCTS

2.1 ALUMINUM ALLOY PRODUCTS

Aluminum alloy products shall conform to ASTM B 209 for sheet or plate, ASTM B 221 for extrusions and ASTM B 26/B 26M or ASTM B 108 for castings. Aluminum extrusions shall be provided at least 1/8 inch thick and aluminum plate or sheet at least 16 gauge thick. Welding for aluminum products shall conform to AWS C1.1.

2.2 ORGANIC COATING

Surfaces shall be cleaned, primed, and given a semi-gloss baked enamel finish in accordance with NAAMM AMP 505 with total dry film thickness not less than 1.2 mils.

2.3 STEEL PRODUCTS

Structural steel products shall conform to ASTM A 36/A 36M. Sheet and strip steel products shall conform to ASTM A 570/A 570M. Welding for steel products shall conform to AWS D1.2.

2.4 VINYL SHEETING FOR GRAPHICS

Vinyl sheeting shall be 5 to 7 year premium type and shall be in accordance with the flammability requirements of ASTM E 84 and shall be a minimum 0.003 inch film thickness. Film shall include a precoated pressure sensitive adhesive backing, Class 1, or positionable pressure sensitive adhesive backing, Class 3.

2.5 GLASS

Glass shall be in accordance with ASTM C 1036, Type I, Class 1, Quality q3 and ANSI Z97.1.

2.6 ANCHORS AND FASTENERS

Exposed anchor and fastener materials shall be compatible with metal to which applied and shall match in color and finish and shall be non-rusting, non-corroding, and non-staining. Exposed fasteners shall be tamper-proof.

2.7 SHOP FABRICATION AND MANUFACTURE

2.7.1 Factory Workmanship

Work shall be assembled in the shop, as far as practical, ready for installation at the site. Work that cannot be shop assembled shall be given a trial fit in the shop to ensure proper field assembly. Holes for bolts and screws shall be drilled or punched. Drilling and punching shall produce clean, true lines and surfaces. Welding to or on structural steel shall be in accordance with AWS D1.1. Welding shall be continuous along the entire area of contact. Exposed welds shall be ground smooth. Exposed surfaces of work shall have a smooth finish and exposed riveting shall be flush. Fastenings shall be concealed where practical. Items specified to be galvanized shall be by hot-dip process after fabrication if practical. Galvanization shall be in accordance with ASTM A 123/A 123M and ASTM A 653/A 653M, as applicable. Other metallic coatings of steel sheet shall be in accordance with ASTM A 924/A 924M. Joints exposed to the weather shall be formed to exclude water. Drainage and weep holes shall be included as required to prevent condensation buildup.

2.7.2 Dissimilar Materials

Where dissimilar metals are in contact, or where aluminum is in contact with concrete, mortar, masonry, wet or pressure-treated wood, or absorptive materials subject to wetting, the surfaces shall be protected with a coat of asphalt varnish or a coat of zinc-molybdate primer to prevent galvanic or corrosive action.

2.7.3 Shop Painting

Surfaces of miscellaneous metal work, except nonferrous metal, corrosion resisting steel, and zinc-coated work, shall be given one coat of zinc-molybdate primer or an approved rust-resisting treatment and metallic primer in accordance with manufacturer's standard practice. Surfaces of items to be embedded in concrete shall not be painted. Upon completion of work, damaged surfaces shall be recoated.

2.8 COLOR, FINISH, AND CONTRAST

Color of products shall be in accordance with Section 09900 PAINTING,

GENERAL. For buildings required to be handicapped-accessible, the characters and background of signs shall be eggshell, matte, or other non-glare finish. Characters and symbols shall contrast with their background - either light characters on a dark background or dark characters on a light background.

PART 3 EXECUTION

3.1 INSTALLATION

Signs, plaques, or dimensional letters shall be installed in accordance with approved manufacturer's instructions at locations shown on the drawings. Steel conduits installed underground and illuminated signage mounted directly on buildings shall be in conformance with the requirements of Section 16415 ELECTRICAL WORK, INTERIOR. Signs shall be installed plumb and true at mounting heights indicated, and by method shown or specified. Signs mounted on other surfaces shall not be installed until finishes on such surfaces have been completed.

3.1.1 Anchorage

Anchorage and fastener materials shall be in accordance with approved manufacturer's instructions for the indicated substrate. Anchorage not otherwise specified or indicated shall include slotted inserts, expansion shields, and powder-driven fasteners when approved for concrete; toggle bolts and through bolts for masonry; machine carriage bolts for steel; lag bolts and screws for wood.

3.1.2 Protection and Cleaning

The work shall be protected against damage during construction. Hardware and electrical equipment shall be adjusted for proper operation. Glass, frames, and other sign surfaces shall be cleaned in accordance with manufacturer's instructions. After signs are completed and inspected, the Contractor shall cover all project identification, directional, and other signs which may mislead the public. Covering shall be maintained until instructed to be removed by the Contracting Officer or until the facility is to be opened for business. Signs shall be cleaned, as required, at time of cover removal.

3.2 FIELD PAINTED FINISH

Miscellaneous metals and frames shall be field painted in accordance with Section 09900 PAINTING, GENERAL. Anodized metals, masonry, and glass shall be protected from paint. Finish shall be free of scratches or other blemishes.

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PART 3 EXECUTION

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SECTION 10440

INTERIOR SIGNAGE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF-45	(1980; R 1993) Designation System for Aluminum Finishes
AA PK-1	(1996) Registration Record of Aluminum Association Alloy Designations and Chemical Composition Limits for Aluminum Alloys in the Form of Castings and Ingot

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 605	(1992; Addenda Jan 1995) Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 209	(1996) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 221	(1996) Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
	(1996) Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)

AMERICAN WELDING SOCIETY (AWS)

AWS D1.2	(1990) Structural Welding Code - Aluminum

1.2 GENERAL

Interior signage shall be of the design, detail, sizes, types, and message content shown on the drawings, shall conform to the requirements specified, and shall be provided at the locations indicated. Signs shall be complete with lettering, framing as detailed, and related components for a complete installation.

1.2.1 Character Proportions and Heights

Letters and numbers on indicated signs in handicapped-accessible buildings, which do not designate permanent rooms or spaces, shall have a width-to-height ratio between 3:5 and 1:1 and a stroke-width-to-height ratio between 1:5 and 1:10. Characters and numbers on indicated signs shall be sized according to the viewing distance from which they are to be read. The minimum height is measured using an upper case letter "X". Lower case characters are permitted. Suspended or projected overhead signs shall have a minimum character height of 3 inches.

1.2.2 Raised and Brailled Characters and Pictorial Symbol Signs (Pictograms)

Letters and numbers on indicated signs which designate permanent rooms and spaces in handicapped-accessible buildings shall be raised 1/32 inch upper case, sans serif or simple serif type and shall be accompanied with Grade 2 Braille. Raised characters shall be at least 5/8 inch in height, but no higher than 2 inches. Pictograms shall be accompanied by the equivalent verbal description placed directly below the pictogram. The border dimension of the pictogram shall be 6 inches minimum in height. Indicated accessible facilities shall use the international symbol of accessibility.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Interior Signage; GA.

Drawings showing elevations of each type of sign, dimensions, details and methods of mounting or anchoring, shape and thickness of materials, and details of construction. A schedule showing the location, each sign type, and message shall be included.

SD-03 Product Data

Interior Signage; GA.

Manufacturer's descriptive data, catalogs cuts, installation and cleaning instructions.

SD-04 Samples

Interior Signage; GA.

One sample of each of the following sign types showing typical quality and workmanship. The samples may be installed in the work, provided each sample is identified and location recorded.

a. Directional sign.

b. Door identification sign.

c. Changeable letter for building directory.

Two samples of manufacturer's standard color chips for each material requiring color selection.

1.4 QUALIFICATIONS

Signs, plaques, and dimensional letters shall be the standard product of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate signs that have been in satisfactory use at least 2 years prior to bid opening.

1.5 DELIVERY AND STORAGE

Materials shall be delivered to the jobsite in manufacturer's original packaging and stored in a clean, dry area in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 ALUMINUM ALLOY PRODUCTS

Aluminum extrusions shall be at least 1/8 inch thick, and aluminum plate or sheet shall be at least 0.0508 inch thick. Extrusions shall conform to ASTM B 221; plate and sheet shall conform to ASTM B 209. Where anodic coatings are specified, alloy shall conform to AA PK-1 alloy designation 514.0. Exposed anodized aluminum finishes shall be as shown. Welding for aluminum products shall conform to AWS D1.2.

2.2 ANODIC COATING

Anodized finish shall conform to AA DAF-45 as follows:

a. Clear (natural) designation AA-M10-C22-A31, Architectural Class II 0.4 mil or thicker.

b. Integral color anodized designation AA-M10-C22-A32, Architectural Class 0.4 to 0.7 mil.

c. Electrolytically deposited color-anodized designation AA-M10-C22-A34, Architectural Class II 0.4 to 0.7 mil.

2.3 ORGANIC COATING

Organic coating shall conform to AAMA 605, with total dry film thickness not less than 1.2 mils.

2.4 FABRICATION AND MANUFACTURE

2.4.1 Factory Workmanship

Holes for bolts and screws shall be drilled or punched. Drilling and punching shall produce clean, true lines and surfaces. Exposed surfaces of work shall have a smooth finish and exposed riveting shall be flush. Fastenings shall be concealed where practicable.

2.4.2 Dissimilar Materials

Where dissimilar metals are in contact, the surfaces will be protected to prevent galvanic or corrosive action.

2.5 COLOR, FINISH, AND CONTRAST

Color shall be in accordance with Section 09900 PAINTING, GENERAL. In buildings required to be handicapped-accessible, the characters and background of signs shall be eggshell, matte, or other non-glare finish. Characters and symbols shall contrast with their background - either light characters on a dark background or dark characters on a light background.

PART 3 EXECUTION

3.1 INSTALLATION

Signs shall be installed in accordance with approved manufacturer's instructions at locations shown on the drawings. Illuminated signage shall be in conformance with the requirements of Section 16415 ELECTRICAL WORK, INTERIOR. Signs shall be installed plumb and true at mounting heights indicated, and by method shown or specified. Required blocking shall be installed as detailed. Signs which designate permanent rooms and spaces in handicapped-accessible buildings shall be installed on the wall adjacent to the latch side of the door. Where there is no wall space to the latch side of the door, including at double leaf doors, signs shall be placed on the nearest adjacent wall. Mounting location for such signage shall be so that a person may approach within 3 inches of signage without encountering protruding objects or standing within the swing of a door. Signs on doors or other surfaces shall not be installed until finishes on such surfaces have been installed. Signs installed on glass surfaces shall be installed with matching blank back-up plates in accordance with manufacturer's instructions.

3.1.1 Anchorage

Anchorage shall be in accordance with approved manufacturer's instructions. Anchorage not otherwise specified or shown shall include slotted inserts, expansion shields, and powder-driven fasteners when approved for concrete; toggle bolts and through bolts for masonry; machine carriage bolts for steel; lag bolts and screws for wood. Exposed anchor and fastener materials shall be compatible with metal to which applied and shall have matching color and finish. Where recommended by signage manufacturer, foam tape pads may be used for anchorage. Foam tape pads shall be minimum 1/16 inch thick closed cell vinyl foam with adhesive backing. Adhesive shall be transparent, long aging, high tech formulation on two sides of the vinyl foam. Adhesive surfaces shall be protected with a 5 mil green flatstock treated with silicone. Foam pads shall be sized for the signage as per signage manufacturer's recommendations. Signs mounted to painted gypsum board surfaces shall be removable for painting maintenance. Signs mounted to lay-in ceiling grids shall be mounted with clip connections to ceiling tees.

3.1.2 Protection and Cleaning

The work shall be protected against damage during construction. Hardware and electrical equipment shall be adjusted for proper operation. Glass, frames, and other sign surfaces shall be cleaned in accordance with the manufacturer's approved instructions.

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SECTION 10800

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SECTION 10800

TOILET ACCESSORIES

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 1036	(1991) Flat Glass

CODE OF FEDERAL REGULATIONS (CFR)

28 CFR PART 36	(1994) Americans with Disabilities Act (ADA) Standards for Accessible Design

COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-2380	(Rev A) Dispenser, Paper Towel

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Finishes; GA
Accessory Items; GA

Manufacturer's descriptive data and catalog cuts indicating materials of construction, fasteners proposed for use for each type of wall construction, mounting instructions, operation instructions, and cleaning instructions.

1.3 DELIVERY, STORAGE, AND HANDLING

Toilet accessories shall be wrapped for shipment and storage, delivered to the jobsite in manufacturer's original packaging, and stored in a clean, dry area protected from construction damage and vandalism.

1.4 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period shall be provided.

PART 2 PRODUCTS

2.1 MANUFACTURED UNITS

Toilet accessories shall be provided where indicated in accordance with paragraph SCHEDULE. Each accessory item shall be complete with the necessary mounting plates and shall be of sturdy construction with corrosion resistant surface.

2.1.1 Anchors and Fasteners

Anchors and fasteners shall be capable of developing a restraining force commensurate with the strength of the accessory to be mounted and shall be suited for use with the supporting construction. Exposed fasteners shall be of tamperproof design and shall be finished to match the accessory. Tools necessary for tamperproof anchor and fastener installation and removal shall be provided.

2.1.2 Finishes

Except where noted otherwise, finishes on metal shall be provided as follows:

Metal	Finish
Stainless steel	No. 4 satin finish
Carbon steel, copper alloy, and brass	Chromium plated, bright

2.2 ACCESSORY ITEMS

Accessory items shall conform to the requirements specified below. Location of accessory items shall conform to 28 CFR Part 36.

2.2.1 Grab Bar (GB)

Grab bar shall be 18 gauge, 1-1/4 inches OD Type 304 stainless steel. Grab bar shall be form and length as indicated. Exposed mounting flange shall have mounting holes concealed. Grab bar shall have satin finish and peened non-slip surface. Installed bars shall be capable of withstanding a 500 pound vertical load without coming loose from the fastenings and without obvious permanent deformation. Space between wall and grab bar shall be 1-1/2 inch.

2.2.2 Mirrors, Glass (MG)

Glass for mirrors shall be Type I transparent flat type, Class 1-clear. Glazing Quality q1 1/4 inch thick conforming to ASTM C 1036. Glass shall be coated on one surface with silver coating, copper protective coating, and mirror backing paint. Silver coating shall be highly adhesive pure silver coating of a thickness which shall provide reflectivity of 83 percent or more of incident light when viewed through 1/4 inch thick glass, and shall be free of pinholes or other defects. Copper protective coating shall be pure bright reflective copper, homogeneous without sludge, pinholes or other defects, and shall be of proper thickness to prevent "adhesion pull" by mirror backing paint. Mirror backing paint shall consist of two coats of special scratch and abrasion-resistant paint and shall be baked in uniform thickness to provide a protection for silver and copper coatings which will permit normal cutting and edge fabrication.

2.2.3 Mirror, Tilt (MT)

Tilt mirror shall be surface mounted and shall provide full visibility for persons in a wheelchair. Mirror shall have adjustable tilt, extending at least 4 inches from the wall at the top and tapering to 1 inch at the bottom. Size shall be as specified. Glass for mirrors shall conform to ASTM C 1036 and paragraph Glass Mirrors.

2.2.4 Paper Towel Dispenser (PTD)

Paper towel dispenser shall conform to CID A-A-2380, Type I or III, shall be constructed of not less than 0.269 inch Type 304 stainless steel, and shall be surface mounted. Locking mechanism shall be tumbler key lock.

2.2.5 Soap Dispenser (SD)

Soap dispenser shall be surface mounted, liquid type consisting of a vertical Type 304 stainless steel tank with holding capacity of 40 fluid ounces with a corrosion-resistant all-purpose valve that dispenses liquid soaps, lotions, detergents and antiseptic soaps.

2.2.6 Shelf, Metal, Heavy Duty (SMHD)

Heavy duty metal shelf shall be minimum of 18 gauge stainless steel with hemmed edges. Shelves over 30 inches shall be provided with intermediate supports. Supports shall be minimum of 16 gauge, shall be welded to the shelf, and shall be spaced no more than 30 inches apart.

2.2.7 Shelf, Metal, Light Duty (SMLD)

Light duty metal shelf shall be supported between brackets or on brackets. Brackets shall prevent lateral movement of the shelf. Shelf and brackets shall be stainless steel.

2.2.8 Toilet Tissue Dispenser (TTD)

Toilet tissue holder shall be Type II - surface mounted with two rolls of standard tissue stacked vertically. Cabinet shall be stainless steel, satin finish.

2.2.9 Waste Receptacle (WR)

Waste receptacle shall be Type 304 stainless steel, designed for surface mounting. Reuseable liner, of the type standard with the receptacle manufacturer, shall be provided. Capacity shall be not less than 1 cubic foot.

2.2.10 Mechanical Ventilation (MV)

Bathrooms shall be equipped with mechanical exhaust fans and associated ductwork with the fan exhausting, as a minimum, at 50 cfm if operated intermittently or 20 cfm if continuously operated. Such bathroom exhaust shall vent directly to the outside and no exhaust vent termination to other interior portions of the building is allowed.

PART 3 EXECUTION

3.1 INSTALLATION

Toilet accessories shall be securely fastened to the supporting construction in accordance with the manufacturer's approved instructions. Accessories shall be protected from damage from the time of installation until acceptance.

3.2 CLEANING

Material shall be cleaned in accordance with manufacturer's recommendations. Alkaline or abrasive agents shall not be used. Precautions shall be taken to avoid scratching or marring of surfaces.

3.3 SCHEDULE

Accessories Required

Room or Space	MT	PTD	SMLD	SMHD	SD	TTD	GB	WR	MV
1	1	1	1	1	1	1	1	1	1

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SECTION 11240

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SECTION 11240

LIQUID-PHASE GRANULAR ACTIVATED CARBON ADSORPTION SYSTEM

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123/A 123M	(2000) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(2000) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 312/A 312M	(2000) Seamless and Welded Austenitic Stainless Steel Pipes
ASTM A 530/A 530M	(1999) General Requirements for Specialized Carbon and Alloy Steel Pipe
ASTM A 666	(2000) Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
ASTM D 1785	(1999) Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120
ASTM D 1998	(1997) Polyethylene Upright Storage Tanks
ASTM D 2241	(2000) Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2652	(1994; R 1999) Activated Carbon
ASTM D 2854	(1996) Apparent Density of Activated Carbon
ASTM D 2862	(1997) Particle Size Distribution of Granular Activated Carbon
ASTM D 3299	(2000) Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks
ASTM D 3860	(1998) Determination of Adsorptive Capacity of Activated Carbon by Aqueous Phase Isotherm Technique
ASTM D 3922	(1989) Standard Practice for Estimating

	the Operating Performance of Granular Activated Carbon for Removal of Soluble Pollutants from Water
ASTM D 4607	(1994; R 1999) Determination of Iodine Number of Activated Carbon
ASTM D 5421	(1993) Contact Molded "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Flanges
ASTM E 1067	(1989; R 1996) Acoustic Emission Examination of Fiberglass Reinforced Plastic Resin (FRP) Tanks/Vessels
ASTM F 593	(1998) Stainless Steel Bolts, Hex Cap Screws, and Studs

ASME INTERNATIONAL (ASME)

ASME B1.1	(1989) Unified Inch Screw Threads (UN and UNR Thread Form)
ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element
ASME BPVC SEC VIII D1	(1998) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA EWW	(1999) Standard Methods for the Examination of Water and Wastewater
AWWA B604	(1996) Granular Activated Carbon
AWWA B605	(1999) Reactivation of Granular Activated Carbon
AWWA C504	(1994) Rubber-Seated Butterfly Valves
AWWA C509	(1994; Addendum 1995) Resilient-Seated Gate Valves for Water Supply Service
AWWA D100	(1996) Welded Steel Tanks for Water Storage
AWWA D120	(1984; R 1989) Thermosetting Fiberglass-Reinforced Plastic Tanks

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-70	(1998) Cast Iron Gate Valves, Flanged and Threaded Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(1993) Industrial Controls and Systems

NEMA ICS 6 (1993) Industrial Control and Systems, Enclosures

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1910 Occupational Safety and Health Standards

1.2 SYSTEM DESCRIPTION

The activated carbon adsorption system shall be a complete unit process for removal of organic and inorganic contaminants from seawater as specified herein. Equipment shall include, but shall not be limited to, vessels containing activated carbon, supporting equipment and accessories. Terminology shall be in conformance with ASTM D 2652.

1.2.1 Design Requirements

Minimum design life, modular unit: 20 years. Minimum design life, other equipment: 10 years

Adsorption system dimensions:
Maximum vertical projection: 25 ft.
Maximum ground surface coverage: 12 by 25 ft.

1.2.2 Influent Characteristics

Average influent characteristics of the anticipated water to be treated are as follows:

Influent Characteristic	Average
pH	7.0
Total Cadmium (ug/L)	<5.0
Soluble Cadmium (ug/L)	<5
Total Chromium (ug/L)	<22
Soluble Chromium (ug/L)	<22
Total Copper (ug/L)	<10
Soluble Copper (ug/L)	<2
Total Lead (ug/L)	<5
Soluble Lead (ug/L)	<5
Total PCBs (ug/L)	<5
Turbidity/Nephelometric Turbidity units (NTU)	<1.0

1.2.3 Performance Requirements

Flow rate:

Minimum	350 gpm
Average	500 gpm
Maximum	700 gpm

Discharge criteria (monthly average):

Total PCBs (per Aroclor) (ug/L)	0.065
Total Cadmium (ug/L)	9.3
Total Chromium (ug/L)	50
Total Copper (ug/L)	5.6
Total Lead (ug/L)	8.5

1.2.4 Bench Scale Data

1.2.4.1 Bench Scale Test Data

Results of isotherm and micro column tests (as determined by ASTM D 3860and ASTM D 3922, respectively) conducted as part of bench scale water treatment tests (March 2000) are provided in Attachment #1. Analytical data for the filtrate generated during bench scale dewatering tests conducted in 2001 with sediment collected from New Bedford Harbor is also included in Attachement #1.

1.2.4.2 Pilot-Scale Operating Performance Data

Results of pilot-scale operating performance tests are provided in the Draft Wastewater Pilot-Scale Treatment Summary Report, prepared by Foster Wheeler Environmental Corporation and dated January 2001. A summary of this report is included as Attachment #2.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Adsorption Battery Components; GA

Process flow diagrams and instrumentation diagrams(s) showing all major pieces of process equipment with controls. Drawings shall contain complete piping, wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation. Drawings shall show shop and erection details, including cuts, copes, connections, holes, bolts, and welds.

SD-03 Product Data

Activated Carbon Adsorption Units; GA

a. List of Federal, State, and local laws, regulations, and permits concerning activated carbon adsorption units that are applicable to the Contractor's proposed operations and the requirements imposed by those laws, regulations, and permits.

b. Instrumentation and controls; capacities and pressure drop; make and model; complete list of equipment and materials, including manufacturer's descriptive and technical literature; performance charts and curves; catalog cuts; and installation instructions.

c. Structural calculations for the adsorber shells, tanks and mounting and support details.

d. Contractor's designs for foundations, footings and supports.

Activated Carbon; GA

Iodine number; isotherm and column test data. Design calculations indicating removals of each of the listed organic and/or inorganic (if applicable) compounds in the carbon bed.

Reports of testing granular activated carbon in accordance with AWWA B604.

Material Safety Data Sheet; FIO

Material safety data sheet in conformance with 29 CFR 1910 Section 1200(g) for activated carbon.

Adsorption Battery Components; GA

Demonstration of, or design calculations for, the total head loss through the carbon, adsorbers and appurtenant piping.

Posting Framed Instructions; FIO

Wiring and control diagrams, systems layouts and isometrics, instructions, and other sheets, prior to posting. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system shall be prepared in typed form, framed and posted beside the diagrams.

Delivery, Storage, and Handling; FIO

Instructions for any required sampling, preparation and shipping of activated carbon to reactivation or disposal facility.

Activated Carbon Adsorption Units; FIO

A complete list of parts, supplies and recommended spare parts for each different item of material and equipment specified, with current unit prices and source of supply, and a list of the parts recommended by the manufacturer to be replaced after 1 and 3 year(s) of service.

SD-07 Certificates

Activated Carbon; GA

Manufacturer's certificates, including the name and address of the production facility, attesting that the activated carbon furnished meets the specified requirements. Certification of the activated carbon supplier, transporter, and reactivation facility in accordance with AWWA B605. Copies of the Department of Transportation licenses of carbon reactivation service.

Equipment; GA

Verification from a Registered Professional Engineer, licensed to practice mechanical or structural engineering, as appropriate, in the State in which the system was fabricated, stating that: 1) The fabrication drawings and pressure calculations for the shells and tanks were designed for the listed conditions in accordance with the appropriate codes and standards. 2) The erection drawings for the shell and tank foundations and supports were designed for the listed conditions in accordance with the appropriate codes and standards.

SD-10 Operation and Maintenance Data

Complete Activated Carbon Adsorption System; GA

Six (6) complete copies of operating instructions outlining the step-by-step procedures required for system startup, operation and shutdown. The instructions shall include layout, wiring, and control diagrams of the system as installed. The instructions shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operation features.

Six (6) complete copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and trouble shooting guides. Handling and reactivation of spent activated carbon in accordance with AWWA B605. Instructions for handling contaminant/biofouling of the carbon adsorption unit under conditions of the application will be provided where available, including strong acid/alkali/alternative chemical soaks, and including instructions for storage and handling of treatment chemicals and waste products. Routine recommended chemical preventive measures if known will be described in maintenance procedure reports.

1.4 QUALIFICATIONS

1.4.1 Contractor

Contractor shall have had a minimum of 5 years of experience in the construction of water treatment plants, wastewater treatment plants, industrial wastewater treatment plants, and/or industrial wastewater pretreatment plants.

1.4.2 Single Source Supplier

The Contractor shall assign to a single supplier full responsibility for the furnishing of the adsorption system. The designated single supplier, however, need not manufacture the system but shall coordinate the selection, assembly, installation, and testing of the entire system as specified herein.

1.4.3 Manufacturer's Representative

Services of a manufacturer's field service representative who is experienced in the installation, adjustment, and operation of the equipment furnished and who has complete knowledge of the proper operation and maintenance of the system shall be provided.

1.4.4 Welding

Welding qualifications of welding procedures, welders, and welding operators shall be in accordance with Sections 8.2 and 8.8 of AWWA D100.

1.4.5 Reactivation Facility

Qualifications of reactivation facility procedures and operation shall be in accordance with AWWA B605.

1.5 GENERAL REQUIREMENTS

Materials and equipment shall be new and unused with the exceptions noted for reprocessed activated carbon, reprocessed materials and modular treatment units. An estimate or analysis of the pre-existing "heel" and the nature of any residual will be provided with the supply documentation if reprocessed carbon is to be supplied. The Contracting Officer will have the option to refuse delivery of reprocessed carbon if, in the opinion of the Contracting Officer, the quality might interfere with accomplishment or verification of the treatment.

1.5.1 Standard Products

Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Materials and equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

1.5.2 Nameplates

Adsorption shells, pumps and motors shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment. Pressure rated adsorption shells shall bear the appropriate ASME BPVC SEC VIII D1 code stamp.

1.5.3 Safety Requirements

Belts, chains, couplings, and other moving parts shall be completely enclosed by guards to prevent accidental personal injury in accordance with 29 CFR 1910, Subpart O, Machinery and Machine Guarding. Guards shall be removable or so arranged as to allow access to the equipment for maintenance.

1.5.4 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

1.6 DELIVERY, STORAGE, AND HANDLING

Equipment delivered and placed in storage shall be protected from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

PART 2 PRODUCTS

2.1 MEDIA

2.1.1 Activated Carbon

Material shall be free from impurities that affect the serviceability and appearance of the finished product. Activated carbon shall not require dosing or addition of a chemical mixture or solution to the water to be treated or to the water used for backwashing. The following quantity: 20,000 pounds of processed and graded activated carbon shall be furnished for waste water treatment. Material shall conform to the following:

a. Adsorptive capacity, iodine number as determined by ASTM D 4607, not less than 900 milligrams per gram.

b. Apparent density, as determined by ASTM D 2854, 25 to 37 lb. per cu. ft., corrected for moisture.

c. Effective size 0.8 to 1.0 mm, as determined by ASTM D 2862, with the following gradation:

Sieve No. 8 90 percent passing.
Sieve No. 30 4 percent passing.

2.2 ADSORPTION BATTERY COMPONENTS

Adsorption battery shall consist of two units. Performance specified shall refer to each unit and not to the battery as a whole. Adsorption unit shall be a downflow liquid adsorption unit, with a water flow rate not exceeding 700 gpm. Intervals between carbon replacements shall be not less than 60 days based on a carbon usage rate of 1 pound per 3,500 gallons of water.

2.2.1 Head Loss

Head loss in each unit at rated flow shall not exceed 10 psig when filled with fresh media.

2.2.2 Adsorption Shell

2.2.2.1 Permanent Units

Adsorption shells not equipped with an open vent or overflow shall be carbon steel,designed, fabricated, and erected in accordance with ASME BPVC SEC VIII D1 for a gage working pressure of 125 psi and shall be so stamped. Adsorption shells equipped with an open vent or overflow may be fiberglass or polyethylene. Fiberglass shells shall be in accordance with AWWA D120

or with ASTM D 3299 with nozzle flanges in accordance with ASTM D 5421. Polyethylene shells shall conform to ASTM D 1998. Steel shell and both sides of false bottom shall be lined with nontoxic epoxy, vinyl ester or rubber. Shell shall have supports of cast-iron or steel. Supporting structures and shells shall be fabricated for the seismic and wind loads listed in the design requirements, plus live and dead loads of the shell full of water.

2.2.2.2 Connections

A vent and a rupture disc shall be provided on the influent of each adsorber. Each adsorber shall have provisions for carbon fill and removal and with permanent connections for water inlet, outlet, and backwash.

2.2.2.3 Openings

Each shell shall be provided with an access opening 4 x 6 inches or larger. Openings shall be provided with closure and positive seal adequate for the tank pressure rating.

2.2.2.4 Hardware

Bolts and attaching hardware shall be stainless steel, conforming with ASTM F 593.

2.2.3 Collection/Underdrain System

Underdrain system within the shell for collecting treated water shall be as specified below and shall distribute the backwash water uniformly over the entire bed cross-section at velocities that will prevent channeling of the carbon bed. Under actual operating conditions the activated carbon shall not be washed out of the apparatus regardless of the change of demand rate up to the maximum on the apparatus.

2.2.3.1 Nozzle Type

A collector/backwash nozzle shall be provided for each 1 square foot of carbon surface area.

2.2.3.2 Deflector-Plate Type

Deflector-plate type shall be steel, and nontoxic epoxy lined, fastened to the bottom of the shell, and arranged for discharge through radial slots. Pipe connections for treated water outlet or backwash inlet shall be on the underside between the deflector and the shell bottom.

2.2.3.3 False Bottom Type

False bottom type shall consist of a false bottom with attached strainers. Strainers and fasteners shall be stainless steel.

2.2.3.4 *Header-Lateral-Distributor Head Type*

Header-lateral-distributor head type shall consist of a circular, square or branched manifold or header, connected to laterals provided with strainer heads or strainers with openings placed radially so as to discharge horizontally or downward. Headers and laterals shall be stainless steel, conforming to ASTM A 312/A 312M and ASTM A 530/A 530M or polyvinyl chloride, conforming to ASTM D 1785 or ASTM D 2241. Strainer heads and

strainers shall be manufactured of materials compatible with the header-lateral system, and shall be polyethylene, polypropylene, polyvinyl chloride or stainless steel. Laterals and strainer heads, after being placed, shall not protrude into the header or laterals. System shall be supported by a steel plate or steel angles conforming to ASTM A 666 with nontoxic epoxy or rubber linings or by directly on the bottom of the shell.

2.3 MODE OF OPERATION

2.3.1 Serial Operation

Each unit shall have valves on the influent, effluent and backwash connections to allow any unit to operate and function as the lead or lag unit or stand-by as required.

2.3.2 Parallel Operation

Each of the parallel units shall have valves on the influent, effluent and backwash connections adequate to allow the unit to be taken out of service to backwash or change out the activated carbon in the unit without affecting the operation of the other units.

2.3.3 Parallel or Serial Operation

Units designated for use in either series or parallel operation shall have valves on the connections that allow switching between modes of operation without disconnecting any of the piping.

2.4 DIFFERENTIAL PRESSURE SENSOR

Differential pressure sensor shall be capable of measuring plus or minus 5 percent variation in the pressure drop across the media. Sensor shall be equipped with an alarm device to give notice when the pressure differential exceeds the set point.

2.5 INTERLOCKS AND ALARMS

Alarm lights shall be located on the local control panel and duplicated on a panel in the main control room. Audible annunciator shall be located above the appropriate vessel with an automatically resetting waterproof manual shut-off located with no obstructions to access 4 feet above grade..

2.6 PRESSURE GAUGES AND SAMPLING COCKS

2.6.1 Pressure Gauges

Pressure gauges connected to the influent and effluent to indicate the pressure loss through the adsorber and its pipe, valve, and fitting assembly shall be furnished for each adsorption unit. Gauges shall be precision type with bronze Bourdon tube and phenolic case and an accuracy of plus or minus 1/2 percent conforming to ASME B40.1.

2.6.2 Sampling Cocks and Valves

Steel, ground key, lever handle, faucet type sampling cocks or ball valves shall be provided upstream of the adsorbers and on the downstream side of each unit for sampling the influent and the effluent of each of the individual adsorbers.

2.7 VALVES

Design of the valve operators and mechanisms shall avoid initial surges and sudden inrushes of influent or backwash by gradually allowing flows to increase as ports are opened. A dial pointer shall indicate each step of the operation.

2.7.1 Butterfly Valves

Butterfly valves 3 through 72 inches shall conform to AWWA C504.

2.7.2 Gate Valves

Gate valves less than 3 inches in diameter shall be bronze with screwed ends, conforming to MSS SP-70 and valves 3 inches or larger shall conform to AWWA C509. Valves shall open counter clockwise, and the operating wheel shall have an arrow, cast in the metal, indicating the direction of opening.

2.7.3 Package-Type Valve Nest

Package-type valve nest shall consist of a pilot valve connected with fittings as may be required to each one of a nest of valves hydraulically or pneumatically operated. Nest of valves shall have connections to raw water inlet, treated water outlet, backwash inlet and outlet, and activated carbon refill inlet and outlet.

2.7.4 Ball Valves

Full port stainless steel ball valves shall be provided on carbon fill and discharge lines.

2.8 ISOLATION JOINTS

2.8.1 Dielectric Fittings

Dielectric fittings shall be installed between threaded ferrous and nonferrous metallic pipe, fittings and valves. Dielectric fittings shall prevent metal-to-metal contact of dissimilar metallic piping elements and shall be suitable for the required working pressure.

2.8.2 Isolation Joints

Isolation joints shall be installed between nonthreaded ferrous and nonferrous metallic pipe, fittings and valves. Isolation joints shall consist of a sandwich-type flange isolation gasket of the dielectric type, isolation washers, and isolation sleeves for flange bolts. Isolation gaskets shall be full faced with outside diameter equal to the flange outside diameter. Bolt isolation sleeves shall be full length. Units shall be of a shape to prevent metal-to-metal contact of dissimilar metallic piping elements.

2.8.2.1 Sleeve-type Couplings

Sleeve-type couplings shall be used for joining plain end pipe sections. The two couplings shall consist of one steel middle ring, two steel followers, two gaskets, and the necessary steel bolts and nuts to compress the gaskets.

2.8.2.2 Split-sleeve Type Couplings

Split-sleeve type couplings may be used in aboveground installations when approved in special situations and shall consist of gaskets and a housing in two or more sections with the necessary bolts and nuts.

2.9 PIPE AND FITTINGS

Pipe hangers and supports shall be in accordance with Section 15200 PIPELINES, LIQUID PROCESS PIPING. Pipe, valves and fittings for liquids shall be in accordance with Section 15200 PIPELINES, LIQUID PROCESS PIPING. Pipe, valves and fittings for compressed air shall be in accordance with Section 15400 PLUMBING, GENERAL PURPOSE.

2.10 BOLTS, NUTS, AND FASTENERS

Bolts, anchor bolts, nuts, washers, plates, bolt sleeves, and all other types of supports necessary for the installation of the equipment shall be furnished with the equipment and shall be galvanized unless otherwise indicated. Where indicated, specified, or required, anchor bolts shall be provided with square plates at least 4 by 4 by 3/8 inch thick or shall have square heads and washers and be set in the concrete forms with suitable sleeves. Expansion bolts shall have malleable-iron and lead composition elements. Unless otherwise specified, stud, tap, and machine bolts shall be of refined bar iron. All threads shall conform to ASME B1.1. Bolts, anchor bolts, nuts, and washers specified to be galvanized, shall be zinc coated, after being threaded, by the hot-dip process in conformity with ASTM A 123/A 123M or ASTM A 153/A 153M. Bolts, anchor bolts, nuts, and washers indicated to be stainless steel shall be Type 316 stainless steel.

2.11 CONTROLS AND PANELS

Manual or automatic controls and protective or signal devices required for the operation specified, and any control wiring required for controls and devices shall be provided. Motor controls shall conform to NEMA ICS 1. Enclosures for power and control panels shall conform to NEMA ICS 6.

2.12 SPECIAL TOOLS

For each type of equipment furnished special tools necessary for adjustment, operation, maintenance, and disassembly shall be provided; a lever type grease gun or other lubricating device for each type of grease required; and one or more steel cases mounted on the wall complete with flat key locks, two keys, and clips or hooks to hold each tool in a convenient location. Tools shall be high-grade, smooth, forged, alloy, tool steel.

2.13 CARBON STORAGE AND TRANSFER SYSTEM

Removal of spent carbon and installation of fresh and/or reactivated carbon shall be done pneumatically directly from the carbon delivery truck.

2.14 FACTORY TESTS

The adsorption system equipment shall be assembled in the shop, in the configuration outlined in the drawings and specifications, to the maximum practical extent. A factory pressure test shall be made at 125 percent of the rated pressure of the equipment. Fiberglass tanks shall be examined in accordance with ASTM E 1067. Test reports shall be furnished to the Contracting Officer prior to shipment of the equipment.

PART 3 EXECUTION

3.1 EQUIPMENT INSTALLATION

Each adsorber shell or tank shall be mounted on a skid base. Anchor brackets, anchor rods or straps shall be provided to hold the shell to anchors in the footing. Skids shall be fabricated from steel channels and shall be designed to support the equipment and to distribute the weight in transit and in service filled with water without point loading on the tank or concrete slab.

3.2 PIPE, VALVES, FITTINGS AND APPURTENANCES

Installation of piping including cleaning, cutting, threading and jointing, shall be in accordance with Section 15200 PIPELINES, LIQUID PROCESS PIPING or Section 15400 PLUMBING, GENERAL PURPOSE, as appropriate to the application. Differing metals shall be provided with isolation devices.

3.3 ELECTRICAL WORK

Electrical work shall be as specified in Section 16415 ELECTRICAL WORK, INTERIOR.

3.4 *TRANSFER*

3.4.1 Onsite

Spent media shall be unloaded from and new media loaded in permanently mounted adsorbers. Carbon slurry shall be transferred between vessels at a rate sufficient to maintain the carbon in suspension.

3.4.2 Offsite Reactivation of Modular Units

Modular units shall be removed from service, disconnected from the permanent piping, drained of free water and returned to the supplier for reactivation.

3.5 TOOLS

Tools shall be delivered at the same time as the equipment and handed over on completion of the work.

3.6 PAINTING/CORROSION PREVENTION

All ferrous surfaces shall be coated or painted.

3.6.1 Exterior Surfaces

Factory primed surfaces shall be solvent-cleaned before painting. Surfaces that have not been factory primed shall be prepared and primed in accordance with the paint manufacturer's recommendations. The paint system applied to the outside of the tank shall be in accordance with manufacturer's recommendations.

3.6.2 Interior Surfaces

Tank interior surfaces shall be coated with a coating resistant to saltwater conditions. System of three coats, 3.9 - 5.9 mils dry film

thickness (DFT) per coat, for total of 11.7 - 17.7 mils minimum DFT.

3.6.3 Touch-Up Painting

Factory painted items shall be touched up as needed. Factory painted items requiring touching up in the field shall be thoroughly cleaned of all foreign material, primed and top-coated with the manufacturer's standard factory finish.

3.6.4 Corrosion Resistant Metals

Painting of corrosion resistant materials such as copper, brass, bronze, copper-nickel, and stainless steel is not required unless otherwise specified.

3.7 MANUFACTURER'S SERVICES

3.7.1 Manufacturer's Representative

Services shall be provided by a representative of the manufacturer who is experienced in the installation, adjustment, and operation of the equipment specified. The representative shall supervise the installing, adjusting, and testing of equipment.

3.7.2 Field Training

The Contractor shall conduct a training course for designated operating, maintenance and support staff members. The training period, for a total of 16 hours of normal working time, shall start after the system is functionally completed but prior to final acceptance tests. Field training shall cover all of the items contained in the operating and maintenance instructions.

3.8 TESTS

All products shall be carefully inspected for defects in workmanship and material; debris and foreign matter shall be cleaned out of valve openings and seats; all operating mechanisms shall be operated to check their proper functioning; and all nuts and bolts shall be checked for tightness. Valves and other equipment which do not operate easily or are otherwise defective shall be repaired or replaced.

3.8.1 Performance Tests

After installation of the activated carbon adsorption system, operating tests shall be carried out to assure that the system operates properly. If any deficiencies are revealed during any tests, such deficiencies shall be corrected and the tests repeated. Each adsorption unit shall be put through a complete cycle of operation at a constant flow rate of approximately 700 gpm for the capacity test. A complete log of each test run shall be made, giving the following data: date, time of readings and sampling, total backwash, and total water treated. Total organic carbon removed shall be determined by analyses of the influent at such intervals as will give a representative organic carbon content. When the required quantity of water has been run through the adsorber, samples shall be taken of the effluent for analysis. Results of the tests shall be used in determining the capacity and performance of the adsorption unit.

3.8.2 Discharge

During the capacity test, treated water shall stored as necessary to maintain the required flow rate.

3.8.3 Utilities

The obtaining of water, electric power and other utility items as well as the disposal of water drainage are the responsibility of the Contractor.

3.9 POSTING FRAMED INSTRUCTIONS

Framed instructions containing wiring and control diagrams showing the complete layout of the system shall be posted where directed. Condensed operating instructions shall be posted beside the diagrams.

-- End of Section --

ATTACHMENT #1

Bench Scale Water Treatment Test Data

Filter Press Filtrate PCB, TSS, Dissolved and Total Metals
Bench Scale Dewatering Tests (Sept/Oct 2001)

Sample ID	TSS (ppm)	PCB (ppb)	Total Metals (ppb)				Dissolved Metals (ppb)			
			Cadmium	Chromium	Copper	Lead	Cadmium	Chromium	Copper	Lead
DWPZ-100-3244	30	24	5	10	20	19	3.6	1 U	1 U	1 U
DWPZ-200-3576	16	-	1.3	10 U	13	11	0.91	10 U	1 U	2.8
DWPZ-200-3244	28	-	3.5	1 U	9	8.7	3.5	10 U	1 U	1 U
DWPZ-100-3576	9	-	3.2	10 U	6.4	6.1	3	10 U	1.2	1.5
DWPZ-100-3269	-	17.7	0.5U	12	9.2	7	0.5 U	10 U	1.5	1.2
DWPZ-200-3269	-	-	0.5 U	10	8.4	6.8	0.5 U	26	1 U	1 U
DWPZ-200-3509	2	0	6.7	10 U	4.8	5.8	6.9	10 U	1.6	1 U
DWPZ-100-3610	15	3.2	0.6	15	4.4	7.3	1.2	10 U	1.6	1.9
DWPZ-200-3465	-	3.5	0.5 U	11	1.2	2.9	0.5 U	10 U	1 U	1 U
DWPZ-100-3465	-	2.8	0.5 U	16	1.8	6	0.5 U	11	1 U	1 U
DWPZ-200-3313	23	-	1.2	10 U	2.7	7.9	1	20	1 U	3.8
DWPZ-1200-3231	-	3.2	1.1	21	2.8	8.6	1.2	16	1 U	1 U
DWPZ-100-3313	58	44	0.5 U	16	27	20	0.5 U	10 U	1.2	1.4
DWPZ-200-3564	-	7.8	0.66	10 U	4	5.9	0.54	10 U	1 U	1 U
DWPZ-100-3248	-	-	1.9	10 U	12	12	1.6	10 U	2	1.6
DWPZ-200-3248	-	2.9	2.4	10 U	14	14	2.1	10 U	2.3	4.2

PACS

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PACS website: http://members.aol.com/hnpacs/pacs.htm

To: JOE Francis

PCB Report

From: Henry Nowicki, Ph.D.

Activated Carbon Training Courses

Conference program and short course descriptions are available by request (phone 1-800-367-2587) or on PACS website: http://members.aol.com/hnpacs/pacs.htm On-site courses are available.

Activated Carbon Short Courses and Annual Conference	May 2000 Pittsburgh, PA	September 2000 Pittsburgh, PA
Activated Carbon Adsorption Short Course Instructor: Drs. Milton Manes and H. Nowicki	May 23-24	Sept 18-19
Design/Operation of Liquid and Vapor Phase Process Systems, Short Course Instructor: Wayne Schuliger, P.E.	May 25	Sept. 20
International Activated Carbon Conference (IACC-8)	→ → →	Sept. 21-22
Briquetting, Extrusion - Agglomeration Technologies for Particle Enlargement. Course Instructor: Dr. Engelleither	May 26	Sept. 23-24

PACS

(724) 457-6576

Professional Analytical and Consulting Services, Inc.
409 Meade Drive
Coraopolis, PA 15108

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To: Joe Francis
Foster Wheeler Environmental

From: Henry G. Nowicki, Ph.D.

Date: March 23, 2000

Subject: Interpretation of Isotherm and Mini-Column PCB-1242 Data

Based on the polychlorinated biphenyl-1242 (PCB-1242) isotherm and mini-column laboratory scale evaluations activated carbon adsorption appears to be a viable remediation technology for an initial 0.961 ppb with an effluent objective of 0.02 ppb. Isotherms and mini-columns are intended to provide a relatively low cost feasibility for the use of activated carbon adsorption. Results indicate that activated carbon is feasible to provide PCB-1242 reduction to your objective. It is well known that polychlorinated biphenyls are effectively adsorbed by activated carbon sorbents. It is recommended that the laboratory feasibility study be followed by a field pilot unit to validate system performance and estimate carbon usage in the real-world for the application, using a field pilot unit.

The pH and total suspended solids (TSS) were determined at our laboratory. The pH was 6.9 and the TSS was 30.9 milligrams per liter. These water parameters are compatible with running an activated carbon adsorption system. The final engineered design system may need periodic backwashing to recover the TSS in the raw water. The activated carbon industry can supply process units with automatic backwash capabilities.

The summarized laboratory analysis results for PCB-1242 determinations for the Carbon Isotherm Data and the Column Run Samples Data are each enclosed on separate pages. These summarized isotherm and column data are on page 3 and 4.

The isotherm technique consist of contacting one liter of the PCB contaminated water with increasing amounts of powdered activated carbon. A ten-point isotherm was provided, nine carbon dosages and one control run with no added activated carbon. Granular activated carbon is ground to a 325 mesh powder, this grinding is done to obtain faster equilibrium with the aqueous phase PCB-1242 pollutants. Isotherms are designed to indicate GO or NO GO feasibility for an activated carbon application.

This isotherm practice consists of the determination of the adsorptive capacity of activated carbon for adsorbable constituents by contacting the water or waste water solution with different amounts of pulverized activated carbon, followed by determination of the amount of the constituents remaining in solution after carbon contact, and calculating the adsorptive capacity from a Freundlich isotherm plot. The Freundlich isotherm plot and associated calculations are enclosed. To calculate the adsorptive capacity from the Freundlich plot draw a vertical line from the point on the abscissa scale corresponding to the original starting concentration and intersect it with the extrapolated isotherm plot. The mg of PCB-1242 per gram of sorbent is read from the ordinate scale. This value from our experimental data is 0.08 mg/g. This value was obtained by using 0.9 ppb on the abscissa and intersecting the extrapolated isotherm line and reading it at the 0.08 mg/g ordinate scale position. This is shown on page 5. This value represents the amount of impurity adsorbed when the activated carbon is in equilibrium with the influent concentration of 0.9 ppb.

The mini-column technique consists of making a column of the powdered sorbent and pumping the contaminated water thru the mini-column at 3-5 ml per minute. The mini-column is also known as an accelerated and micro-columns. The effluent mini-column samples are collected for contaminant analysis. The column used in this study contained one gram of Calgon Carbon Corporation activated carbon ground to a 325 mesh. The small particles are able to obtain faster equilibrium with the aqueous phase small particles and eliminate any wall effects in the column. The column head is taken apart to remove solids build-up in samples which have large amounts of solids. Engineered carbon adsorption systems may have a pre-treatment system to remove particulate matter. No PCB-1242 was detected in the first 29 liters eluting from the mini-column. PCB-1242 breakthru was observed in the 30th liter pumped thru the mini-column. PCB-1242 has a reported detection limit of 0.02 ppb. This is a good clean-up performance. This data is suggestive of obtaining 3,500 gallons of water clean-up per pound of activated carbon.

Joe, the isotherm and mini-column results both indicate feasibility for using activated carbon to solve your problem. Building a 4-6 inch activated carbon column pilot system at the job site and putting contaminated water through the pilot system and performance periodic PCB-1242 laboratory analysis is the recommended next action.

Please call upon me if I can be of any further assistance. Best regards.

Note: Joe, please let your friends know that PACS will provide short courses on activated carbon adsorption. Titles and dates are:

1. **Activated Carbon Adsorption** Instructors: Dr. Milton Manes and Dr. H. Nowicki
   May 23-24 and Sept. 18-19 in Pittsburgh, PA
2. **Activated Carbon Process Systems** Instructor: Wayne Schuliger, P.E.
   May 25 and Sept. 20 in Pittsburgh, PA

PACS provides the only public scheduled courses on this subject. Enclosed is a yellow sheet with the PACS 2000 and 2001 training course schedule.

Carbon Isotherm Data

Activated Carbon (gm)	Sample ID	PCB Result, ug/l
0.0 (Control)	N-120	0.8
0.05	N-121	0.41
0.1	N-123	0.34
0.2	N-124	0.28
0.5	N-125	0.34
1	N-126	0.28
2	N-127	ND
5	N-128	ND
10	N-129	ND
20	N-130	ND

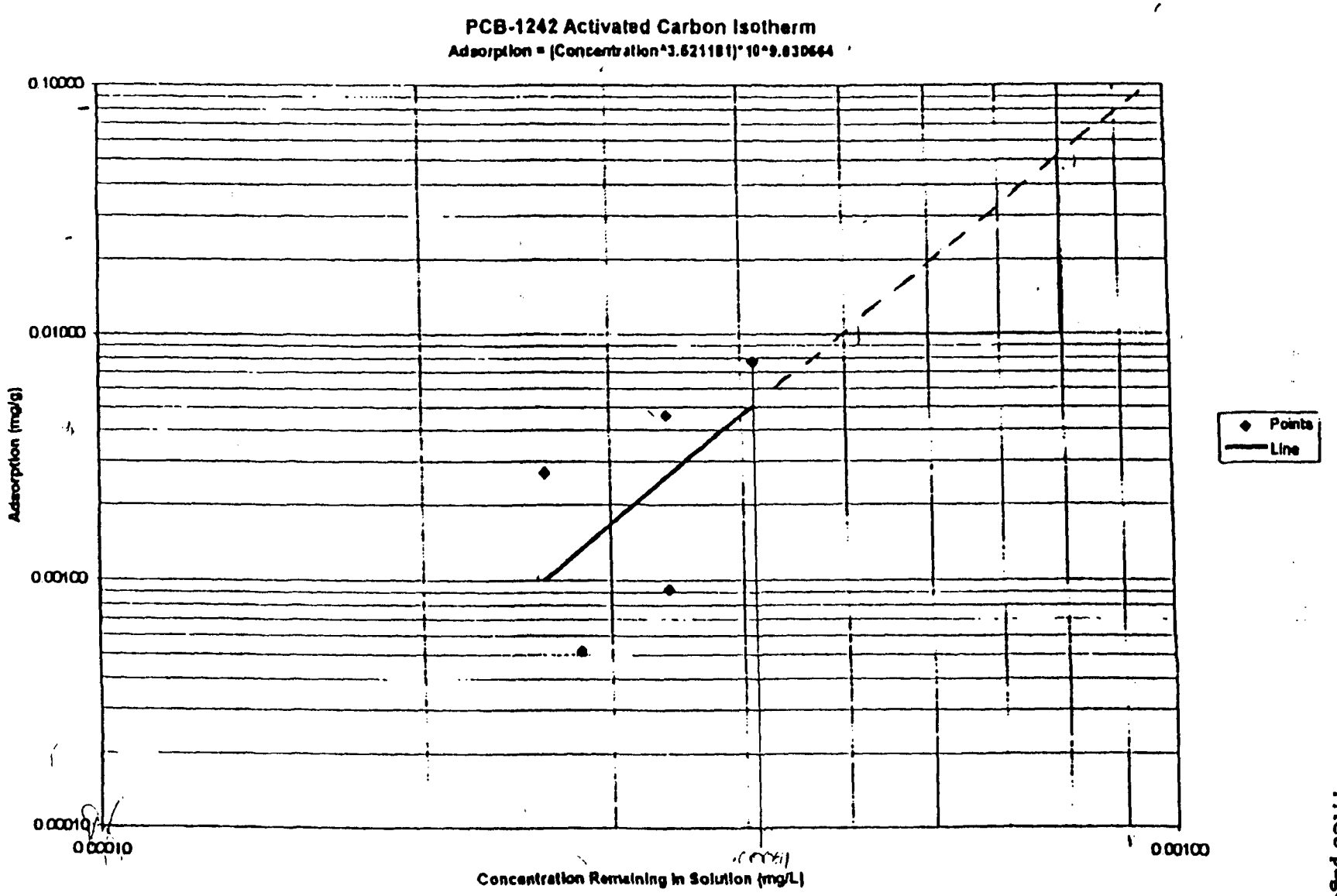
NOTES:
ND: Non-Detect, detection limit 0.020ug/l

Column Run Samples

Volume thru-put, liters	Sample ID	PCB Result, ug/l
1	N-130	ND
2	N-131	NA
3	N-132	NA
4	N-133	NA
5	N-134	ND
6	N-135	NA
7	N-136	NA
8	N-137	NA
9	N-138	NA
10	N-139	ND
11	N-140	NA
12	N-141	NA
13	N-142	NA
14	N-143	NA
15	N-144	NA
16	N-145	ND
17	N-146	NA
18	N-147	NA
19	N-148	NA
20	N-149	NA
21	N-150	ND
22	N-151	NA
23	N-152	NA
24	N-153	NA
25	N-154	ND
26	N-155	ND
27	N-156	ND
28	N-157	ND
29	N-158	ND
30	N-159	0.085
31	N-160	0.33
32	N-161	0.37
33	N-162	NA
34	N-163	0.39
35	N-164	NA
36	N-165	0.32
37	N-166	NA
38	N-167	ND
39	N-168	NA
40	N-169	NA

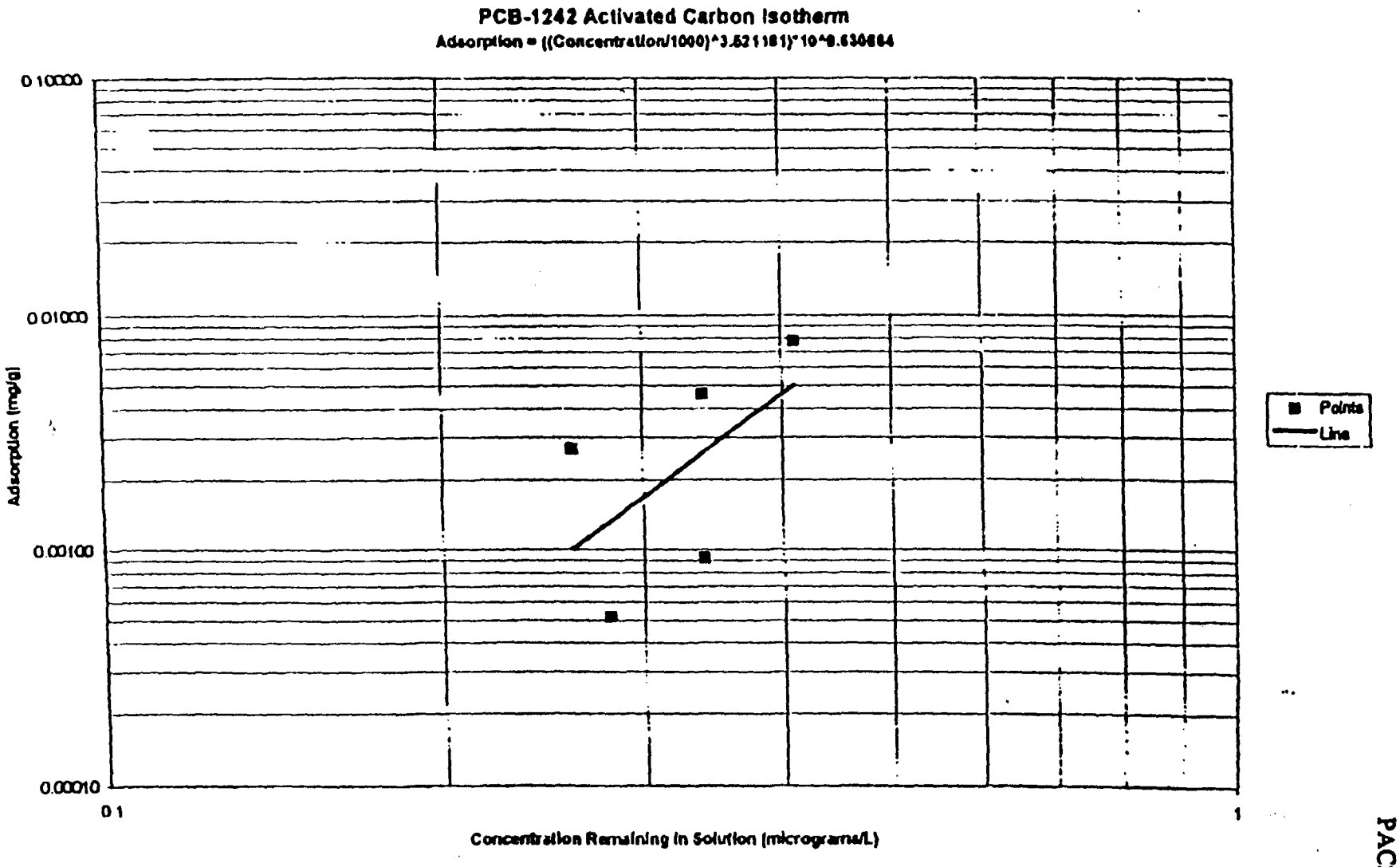
NOTES:

ND	Non-Detect, detection limit 0.
NA	Sample Not Analyzed
Shading	Indicates which samples wer



PACS page 5

3/7/2000
PCB 2.xls



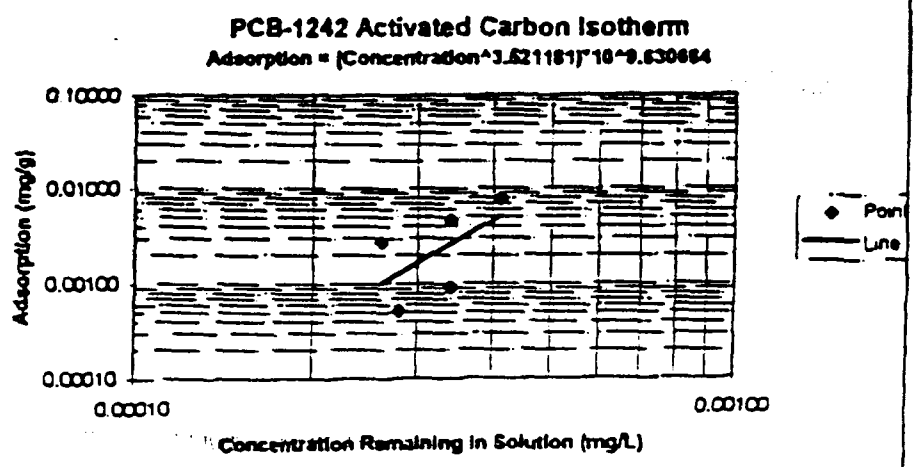
PCB_1242.xls
3/7/2000

log10(Capacity) =		3.521181113	*log10(Concentration)			+	9.630664
Capacity =		Concentration^(	3.521181			)*10^(	9.630664

*******GO TO ROW 50 to ENTER RAW DATA******

Perform regression analysis on columns G (y range) and F (x range) whose rows have numbers. DO NOT change output position of regression analysis.
Click on graph icon. Change range to B7 through last number position in column D
Add title to graph.

Straight Line point No	x axis value Concentration (ppb)	x axis value Concentration (ppm)	Points	Line		log10 (x axis value)	log10 (y axis value)
1	0.41	0.00041	0.00780	0.005054310		-3.387216	-2.107905
2	0.34	0.00034	0.00460	0.002614405		-3.468521	-2.337242
3	0.26	0.00026	0.00270	0.001016666		-3.585027	-2.568636
4	0.34	0.00034	0.00092	0.002614405		-3.468521	-3.036212
5	0.28	0.00028	0.00052	0.001319665		-3.552842	-3.283997
6		Undetected					
7		Undetected					
8		Undetected					
9		Undetected					
10							
11							
12							
13							

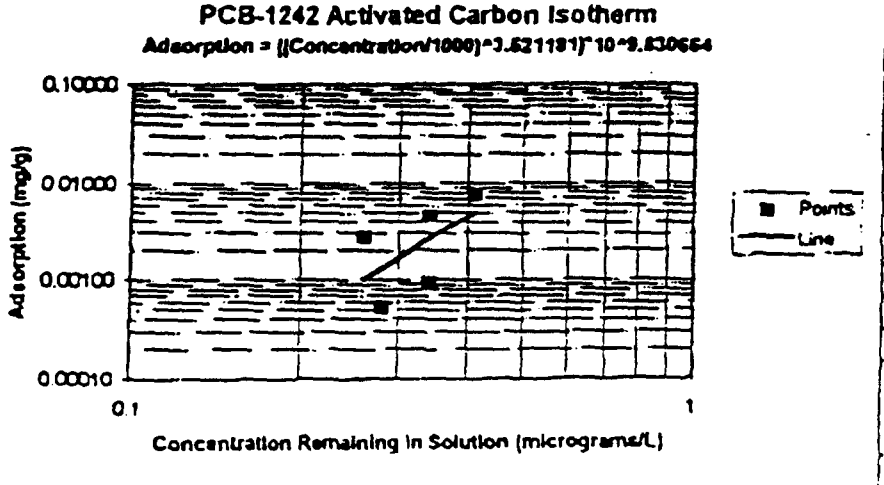


After you enter raw data, return to row 6.

Enter data in yellow spaces. Enter grams in place of one-thirteen.

If V is not 1L, change to proper liter equivalent

M Grams of Sorbent		C Concentration Remaining in Solution, mg/L	V Volume Liters	(C)V Constituent Remaining in Solution, mg	X Constituent Adsorbed mg	X/M mg/g	X/M Values
Control		0.00080	1.000	0.00080	xxxxxxxxx	xxxxxxxxx	xxxxxxxxx
0.0500		0.00041	1.000	0.00041	0.00039	0.00780	0.00780
0.1000		0.00034	1.000	0.00034	0.00046	0.00460	0.00460
0.2000		0.00026	1.000	0.00026	0.00054	0.00270	0.00270
0.5000		0.00034	1.000	0.00034	0.00046	0.00092	0.00092
1.0000		0.00028	1.000	0.00028	0.00052	0.00052	0.00052
2.0000		Undetected	1.000				
5.0000		Undetected	1.000				
10.0000		Undetected	1.000				
20.0000		Undetected	1.000				
			1.000				
			1.000				
			1.000				
			1.000				



	Regression	<-- Activate	
	Y range	$G8:$G17	<-- Highlight
	X Range	$D8:$D17	
	Reg Placement		

comer

Regression Statistics

Multiple R	0.565336239
R Square	0.319605063
Adjusted R Squ	0.092806751
Standard Error	0.463687258
Observations	5

Analysis of Variance

	df	of Squares	ean Square	F	nificance F
Regression	1	0.302987	0.302987	1.409204	0.320622
Residual	3	0.645018	0.215006		
Total	4	0.948005			

	Coefficients	ndard Error	t Statistic	P-value	Lower 95%	Upper 95%
Intercept	9.630663782	10.36133	0.929481	0.405253	-23.3437	42.60508
x1	3.521181113	2.966207	1.187099	0.300869	-5.91882	12.96098

mg/L
0.0004
0.0003
0.0003
0.0003
0.0003
Undetected
Undetected
Undetected
Undetected

ATTACHMENT #2

Pilot Scale Water Treatment Test Data

Pilot Scale Treatment of PCB Contaminated Dredge Water
New Bedford Harbor Superfund Project

Introduction

The New Bedford Harbor Superfund Site (the Site), located in Bristol County, Massachusetts, extends from the shallow northern reaches of the Acushnet River estuary south through the commercial harbor of New Bedford and into 17,000 adjacent areas of Buzzards Bay. Industrial and urban development surrounding the harbor has resulted in sediments becoming contaminated with high concentrations of many pollutants, notably polychlorinated biphenyls (PCBs) and heavy metals, with contaminant gradients decreasing from north to south. From the 1940s into the 1970s two electrical capacitor manufacturing facilities, one located near the northern boundary of the site and one located just south of the New Bedford Harbor hurricane barrier, discharged PCB-wastes either directly into the harbor or indirectly via discharges to the City's sewerage system.

The New Bedford Harbor Site has been divided into three operable units (OU) or phases of site cleanup: The hot spot operable unit (OU #2), the upper and lower harbor operable unit (OU #1), and the Buzzards Bay or outer harbor operable unit. This paper presents the results of a pilot-scale water treatment study conducted in support of the water treatment system design for OU #1.

Background

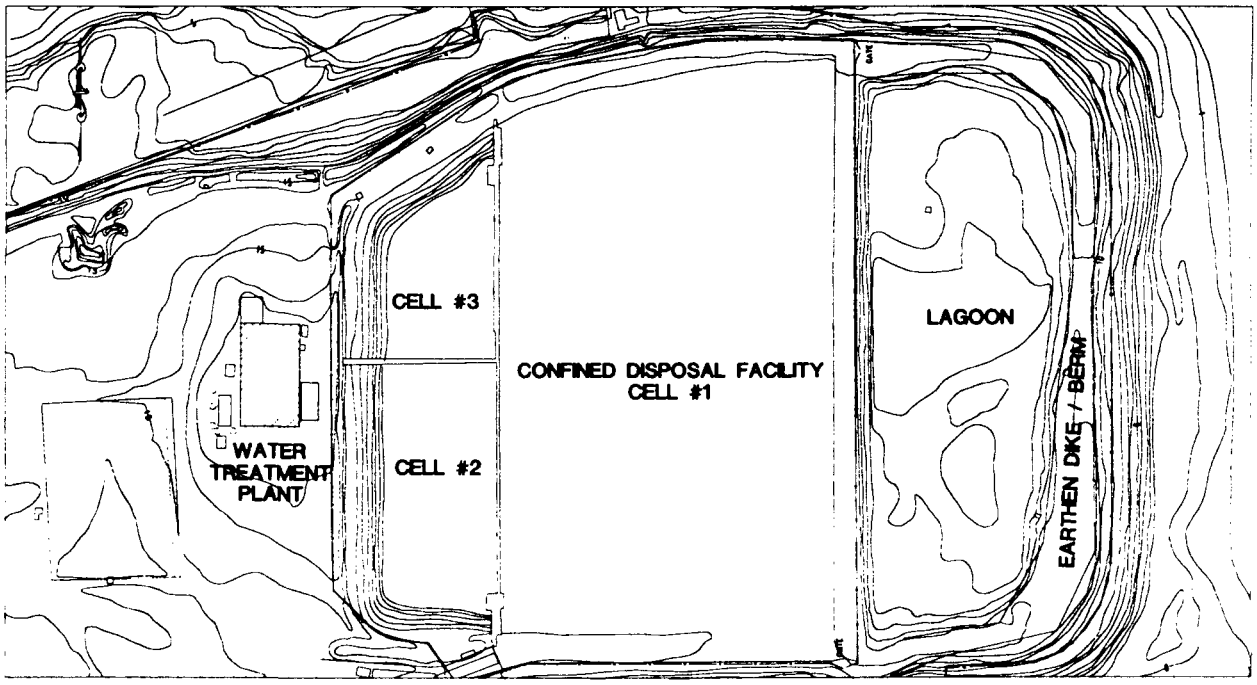
In 1994, a 350 gallon per minute (gpm) water treatment plant (WTP) was constructed at the New Bedford Harbor Superfund Site (Figure 1) to treat wastewaters generated during hydraulic dredging of the Hot Spots sediment (PCBs > 4,000 mg/L) removal activities (OU #2). The WTP consisted of an equalization basin, chemical addition, a settling basin, sand filtration, cartridge filtration, and one (1) 270 kilowatt (kW) Ultraviolet (UV)/Oxidation system. The WTP operated from April 1994 to September 1995 and treated approximately 160 million gallons of water. The discharge limits for PCBs and heavy metals for OU#2 are presented in Table 1.

Table 1: Monthly Average Discharge Standards

Contaminant	OU #1 Discharge Standard (µg/l)	OU #2 Discharge Standard (µg/l)
PCBs	0.065 per Aroclor	0.71 ug/l (total)
Cadmium	9.3	6.0
Chromium	50	7.1
Copper	5.6	8.3
Lead	8.5	4.8

For OU #1, approximately 750,000 yd^3 of PCB contaminated sediment (400-500 mg/l average) will be dredged and placed in shoreline confined disposal facilities (CDFs). As with OU#2, the resultant wastewater from dredging will require treatment prior to discharge back into the harbor. However, as shown in Table 1, the PCB discharge limit for OU#1 was reduced by an order of magnitude based on risk assessments and operational data obtained during the OU#2 operations.

Figure 1: Existing WTP Layout



In May 1999, the existing WTP was operated to treat accumulated water associated with the stored OU#2 dredge sediments. These tests indicated that the existing UV/Oxidation system would not be able to meet the more stringent discharge limits. However, treatability tests were conducted to simulate the chemical addition and settling anticipated for a full-scale system. Water from these treatability tests was sent to Calgon Carbon Corporation (Calgon) for UV/Oxidation bench scale testing. The UV/Oxidation bench scale results indicated that given an influent flow rate of 1,200 gpm and a PCB concentration of 2 ppb, the new discharge limit for the 3 to 5 year project could be achieved utilizing the existing 270 kilowatt (kW) system and five (5) additional 360 kW systems. The capital and annual operational costs associated with a 1,200-gpm treatment system were estimated to be $ 1.8 million and $2.1 million, respectively. In addition, Calgon indicated that if the influent concentration were to exceed 2 ppb, additional UV/Oxidation units would be necessary in order to achieve the PCB discharge limit. Therefore, as a result of the high costs associated with UV/Oxidation, FWENC began to investigate carbon adsorption as an alternative tertiary treatment method for the wastewaters from dredging.

Historically, carbon adsorption has been documented as an effective method of removing PCBs from wastewaters. Results of site specific bench scale granular activated carbon (GAC) tests performed by PACS, Inc. indicated that GAC would be an effective alternative to UV/Oxidation. The capital and annual O&M costs for a 1,200 gpm GAC system were estimated to be $252,000 and $131,000, respectively. Therefore, based on bench scale testing and the potential cost savings of GAC, it was determined to conduct a pilot scale test of the proposed WTP system.

Process Description

The pilot-scale wastewater treatment system was operated from September 11, 2000 through September 29, 2000 and treated approximately 1 million gallons of water generated during the dredging pilot study. The treatment system consisted of chemical addition (alum, polymer), an inclined plate clarifier, ultra-fine
(<0.45 μm) sand filtration, and GAC adsorption. Portions of the existing WTP were utilized to conduct the pilot scale tests and the existing UV/Oxidation system was also evaluated using the more aggressive filtration system. A detailed descriptions of the individual unit processes are provided in the following sections.

CDF Cell #1

As was done during OU#2, sediments dredged during the dredge pilot study were discharged to CDF Cell #1. The resulting supernatant was then pumped from the CDF Cell #1 to CDF Cell #2 using a portable pump located at the site. In order to control the concentration of total suspended solids within the supernant, flexible hose and adjustable piping were used to pump water from varying depths within the cell. The average concentration of PCBs within the dredged sediments was 400 mg/l.

CDF Cell #2

CDF Cell #2 was utilized as an equalization basin prior to the wastewater being pumped to the inclined plate clarifier. Utilizing CDF Cell #2 eliminated any mixing effects that could occur as the dredged slurry was discharged into CDF Cell#1 and provided for a more consistent and representative wastewater stream entering the water treatment system.

Inclined Plate Clarifier

Wastewater was pumped to the inclined plate clarifier from CDF Cell #2 at approximately 100 gpm. Both alum and polymer were added inline to the influent water before the clarifier flash/slow mix tanks. The pilot scale inclined plate clarifier, which was obtained from another Superfund site, had a capacity of approximately 2,500 gallons and provided a residence time of 25 minutes.

The resultant flocculent settled to the bottom of the clarifier and the effluent gravity flowed into CDF Cell #3. The accumulated sludge was pumped from the bottom of the clarifier into a diaphragm plate and frame filter press for dewatering or back to CDF Cell #1.

CDF Cell #3

CDF Cell #3 was utilized as an equalization basin for the filtration and tertiary treatment systems. Due to the flowrate differential between the clarification and filtration processes, influent water to CDF Cell #3 accumulated at 100 gpm for the first several days of the study. Once approximately 200,000 gallons of wastewater had been collected in CDF Cell #3, the existing sump pumps were used to pump the water at 165 gpm (minimum) through an ultrafine (0.45 μm) sand filtration unit and subsequently to the GAC polishing units. The CDF Cell #3 pumps were operated for 10 hours per day. The increase in the effluent flow rate (100 gpm vs. 165 gpm) was necessary due to the minimum flowrate requirement (165 gpm) of the existing WTP.

Sand Filtration

The sand filtration unit was rated for 0.45 micron nominal filtration and was sized to reduce the total suspended solids (TSS) from 30 mg/L (ppm) to less than 5 ppm. The sand filters were operated at a flow rate of 165 gpm. A recirculation flow rate of 225 gpm was maintained in order to achieve optimal filtration. All backwash water necessary for the periodic cleanout of the sand filters was returned to CDF Cell #1.

Granular Activated Carbon (GAC)

Four 3000 lbs. GAC vessels (2 sets of 2 carbon vessels in parallel) were placed immediately after the sand filtration to ensure compliance with the discharge criteria. These GAC vessels were capable of treating a flow rate of 280 gpm, however they were normally operated at a flow rate of 165 gpm. The effluent from the GAC vessels was then discharged to the harbor.

UV/Oxidation

After completion of pilot testing using the GAC treatment system, the existing UV/Oxidation unit was used to treat the wastewater for an additional five days at a flow rate of 165 gpm (minimum). Effluent from the UV/Oxidation unit flowed through the four GAC vessels for final polishing prior to discharge to the harbor.

Pilot Scale WTP Results

Water samples were collected before and after each of the unit processes. The water samples were analyzed for turbidity, PCBs, dissolved metals (cadmium, copper, chromium, and lead) and total metals. However, since only PCBs and copper were detected above the discharge limits in the influent stream, only this data is summarized in Table 2.

The data collected indicates that the contaminants present within the wastewaters are strongly associated with the suspended particles and by removing these suspended solids the majority of the contaminants can be removed from the wastewater stream. However, due to the source of the wastewater (seawater) there are colloidal particles present which flocculation, clarification and filtration alone cannot remove. The concentration of PCBs and copper associated with these colloidal particles is sufficient enough that the wastewater could exceed the discharge limits for OU#1. Therefore, some type of tertiary treatment (GAC or UV/Oxidation) will be required in order to achieve the discharge limits for OU #1.

Table 2 – Summary of Pilot Scale WTP Results: Average PCBs and Copper Concentrations

Stream #	Turbidity (NTUs)	Total PCBs (µg/l)	Dissolved Copper (µg/l)	Total Copper (µg/l)
1	16.15	7.03	10.48	18.64
2	6.23	6.03	7.37	9.4
3	1.03	1.26	7.87	8.64
4	0.48	0.94	11.92	14.98
5	0.5	< 0.065	15.0	17.4
6	-	< 0.065	<3.0	3.79
7	0.15	< 0.065	< 3.0	< 3.0

Where:

Stream #1 – Clarifier influent
Stream #2 – Clarifier Effluent
Stream #3 – Sand Filter influent
Stream #4 – GAC/UV/Ox Influent
Stream #5 – UV/Ox Effluent
Stream #6 – GAC Midpoint
Stream #7 - GAC Effluent

Conclusions

Based on the data collected during the pilot scale WTP testing, the following conclusions were made for each of the process operations:

Inclined Plate Clarifier

An inclined plate clarifier can effectively remove the majority of suspended solids present in the influent stream. The addition of alum and polymer was shown to effectively remove suspended solids present thus reducing the load to the filtration system and increasing the effectiveness of the tertiary system (GAC or UV/oxidation). The data indicates that the heavy metals are more closely associated with the larger suspended solids that were removed in the clarifier and that the PCBs have more affinity to the smaller pin floc particles that settled out in CDF Cell #3.

Sand filtration

The sand filtration system was promoted as being able to remove <0.45 µm particles. However, the test data indicates that due to the colloidal particles present, the sand filters were only about 60% effective in removing these particles. Therefore, while the sand filters were effective in removing suspended solids, traditional sand filtration systems (< 10 µm) will likely be just as effective. The concentrations of the contaminants within the wastewater stream did not significantly change after passing through the sand filter.

Tertiary Treatment (GAC versus UV/Oxidation)

Both the GAC and UV/Oxidation systems were shown to be capable of achieving the discharge limit for PCBs during the pilot test. However, it should be noted that the UV/Oxidation system was only run at half of its flow capacity and as a result the wastewater steam was exposed to twice as much energy. Historical data indicated that the existing system will not be able to meet the lower discharge limits when operated at its design capacity of 350 gpm. In addition, the UV/Oxidation system was not designed for and as a result did not remove the dissolved metals

present in the wastewater stream. While not selected for that purpose, GAC was also able to remove the dissolved metals such that the discharge stream met all the discharge requirements.

Heavy Metals Removal

The existing WTP was not designed to remove dissolved heavy metals present in the wastewater stream and the historical operational data indicated that by removing the majority of the suspended solids the heavy metals discharge limits could still be met. As a result of the OU#2 operational data, it was determined that the OU#1 WTP would not require a dissolved metal removal system.

The pilot scale data indicates that the dissolved copper concentrations were above the discharge limits and, as a result were not removed in the clarification, filtration and UV/Oxidation processes. However, the dissolved metals were removed to below the detection limit in the GAC system. This likely is a result of the GAC being able to further filter the wastewater and remove the colloidal particles that are present in the wastewater stream. In addition, GAC is capable of removing trace amounts of dissolved metals due to the particle charges of the material.

Flexibility of GAC vs.UV/Ox

Previous studies have indicated that UV/Oxidation can achieve the desired discharge limits if the influent concentration of PCBs does not exceed 2 ppb. Therefore, if the PCB concentration greatly exceeded this level the removal effectiveness would decrease unless the system was designed to handle a higher PCB concentration. The treatment effectiveness of GAC on the other hand is primarily dependent on the absorption capacity of the carbon. If the concentration of PCB varies in the influent, it would only result in more carbon being exhausted. While this would affect the O&M economics if the concentration remained above the design PCB concentrations, it would not result in an exceedence of the discharge limit.

Recommendations

The anticipated wastewaters resulting from OU#1 sediment dredging can be effectively treated with a WTP that consists of chemical addition, clarification, filtration and carbon adsorption. A WTP which includes GAC would 1) provide for a more flexible treatment system, 2) reduce both PCB and heavy metal concentrations to below the discharge limits, and 3) result in substantially lower capital and annual O&M costs.

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SECTION 11242

CHEMICAL FEED SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 1785	(1994) Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM F 441	(1995) Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80

NATIONAL ASSOCIATION OF PLUMBING-HEATING-COOLING CONTRACTORS (NAPHCC)

NAPHCC-01	(1996) National Standard Plumbing Code

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2002) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 50	(1995; Rev Oct 1996) Enclosures for Electrical Equipment

1.2 GENERAL REQUIREMENTS

1.2.1 Standard Products

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

1.2.2 Nameplates

Pumps and motors shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

1.2.3 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with SECTION 01330 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Chemical Feed Systems; GA.

List of materials, list of equipment, including a complete list of parts and supplies with current unit prices and source of supply. List of special tools for each type of equipment furnished including special tools necessary for adjustment, operation, maintenance, and disassembly.

SD-02 Shop Drawings

Chemical Feed Systems; GA.

Detail drawings containing complete piping, wiring, schematic, flow diagrams, and any other details required to demonstrate that the systems have been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for installation, maintenance and operation.

SD-03 Product Data

Chemical Feed Systems; GA.

Manufacturer's descriptive and technical literature, catalog cuts, performance charts, and pump curves.

SD-06 Test Reports

Testing; GA.

Test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed systems. Each test report shall indicate the final position of controls.

SD-08 Manufacturer's Instructions

Chemical Feed Systems; GA.

Material safety data sheets, Installation installation instructions, and framed instructions.

SD-10 Operation and Maintenance Data

Chemical Feed Systems; GA.

Six (6) complete copies of operating instructions outlining the

step-by-step procedures required for system startup, operation and shutdown. The instructions shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. The instructions shall include as-built drawings of the piping layout, equipment layout, and simplified wiring and control diagrams of the systems as installed. Flow diagrams shall be included in the instructions.

1.4 DELIVERY AND STORAGE

Material and equipment delivered and placed in storage shall be stored with protection from the weather, excessive humidity, and excessive temperature variation, and dirt, dust, or other contaminants.

PART 2 PRODUCTS

2.1 CHEMICAL FEED SYSTEMS

The systems shall consist of storage tanks from which the chemical solutions shall, by means of pumps or mechanical devices, be delivered through piping to the point of application. Each chemical feeding system shall include gauges, back pressure regulators, strainers, pressure relief valves, sight glasses and flow metering devices, check valves, and hand valves. Construction shall be as simple as practicable to provide equipment isolation, bypass and reliable service and to be readily accessible for inspection, cleaning, adjustment, repairs, and replacements. System data and drawings shall be submitted for approval prior to delivery.

2.1.1 Capacity

Each chemical metering pump shall be capable of delivering chemical solution at any rate from the minimum flow rate to the maximum flow rate and shall be capable of continuous operation at rated capacity. Accuracy shall be plus or minus 2 percent over a 10 to 1 range from the required maximum capacity to the minimum pumping rate.

2.1.1.1 Aluminum Sulfate Feed System

Aluminum sulfate feed system shall conform to the following:

a. Aluminum sulfate solution delivery.

Storage Tank: 4,500 gallons
Feed Tank: 500 gallons
Number of pumps: 4 (recirculation: DP-202, transfer: DP-201, and feed: MP-201 A/B).
Type: recirculation/transfer - diaphragm type; feed - motor driven metering pump.
Controls: Manual and automatic rate adjustment.
Concentration: 48.5 percent.
Pressure: 2 psig backpressure at point of injection.
Feed/flow rate: Feed - Minimum 10 gph; maximum 30 gph.
Transfer/Recirculation - 20 gph @ 10 psi

2.1.1.2 Polymer Feed System

a. The automated polymer dilution/feed system shall consist of an

integrated equipment package capable of automatically metering, diluting, activating, and pumping liquid polymer and water. The system shall have the capability of handling emulsions and solutions. The system shall be designed to mix a 20-50 percent concentration liquid polymer solution with viscosities up to 60,000 CPS with water and automatically produce a metered polymer solution and to convey the diluted polymer solution to the application points shown on the drawings. The system shall be an integrated package, pre-piped and pre-wired. The configuration shall provide for a complete polymer feed system occupying the smallest possible space. The feed system output range shall be 15 - 50 gph of 0.5% polymer solution.

b. Mixing Requirements

Polymer mixing system shall be specifically designed to invert, disperse, and activate in solution emulsion and dispersion polymers with viscosities from 200-60,000 cps.

c. Water Flow

The system shall have a 316 stainless steel solenoid valve for on/off control of dilution water supply and to a meter type flow indicator equipped with integral rate-adjusting valve. The flow indicator shall have a valve stop and guided float. Water flow rate shall be adjustable from 5-100 USGPH. Water supply input and stock solution output fittings shall both be 1/2-inch FNPT. Polymer feed system shall be capable of operating with a water supply pressure of 30 to 90 psi.

d. Controls and Metering Pumps

Components shall include but not be limited to: Solenoid valve and rotometers with rate valve on water, metering pumps (MP-202 A/B), mixing chamber, detention chamber, and cabinet.

Controls to allow future remote changing of capacity to be provided. A LOCAL/REMOTE switch to be provided. Controls to be variable stroke-rate and stroke-length, with readily accessible dials. Remote signal to be 4-20 mA dc.

Metering pumps to be as recommended by the polymer feed system manufacturer. Pump capacities to meet the requirements of the system. Controls shall be variable stroke-rate and stroke-length, with readily accessible dials.

Metering pump discharge shall include vent valve, back pressure valve and pressure relief. Pressure relief may be internal.

The polymer feed system shall also be equipped with a loss of flow sensor which, upon sensing that water flow has been interrupted for any reason, will place the feed system on standby and will restart it automatically when flow is restored.

e. Accessories

Polymer feed system controls, rotometers and other devices shall be housed in a fiberglass reinforced polyester (FRP) or 316 stainless steel enclosure. Provide adjustable controls provided for polymer dosage rate in pounds per day and dilution water in gallons per hour.

2.1.1.3 Algaecide Feed System

Algaecide feed system shall conform to the following:

a. Algaecide delivery.

Tank: 55 gallon drum
Number of pumps: 1 (MP-203).
Type: Positive displacement type metering pump.
Controls: Manual and automatic rate adjustment.
Concentration: 100 percent.
Pressure: 2 psig backpressure at point of injection.
Feed/flow rate: Minimum 1 gph; maximum 5 gph.

2.1.2 Controls

The chemical metering machines shall be provided with the appurtenances and accessories, as required, for feed rate control. Manual range adjustment shall be provided on all systems.

2.1.2.1 Metering Pumps or Mechanical Devices

All metering pumps or mechanical devices shall be of the positive displacement, double diaphragm type, hydraulically activated and with diaphragms balanced during operation.

2.1.3 Metering Pumps or Mechanical Devices

2.1.3.1 Power

Metering pumps shall be of the electronic solenoid operated type. They shall be positive displacement with no mechanical linkage. Output volume shall be adjustable while pumps are in operation. Power supply will be 115 volt, 60 Hertz

2.1.3.2 Pressure

Pumps shall be pressure limited, that is when the back pressure exceeds the magnetic force of the power coil, the pump shall stop and no damage will occur

2.1.3.3 Housing

Pumps shall be totally enclosed for corrosion protection. Housings and covers shall be resistant to the atmosphere involved. Component and major assemblies shall be modular to allow easy replacement without soldering.

2.1.3.4 Metering Head

The metering head shall be flat diaphragm operated with check valves in materials resistant to the chemicals stated.

2.1.4 Calibration Standpipes

Chemical feeding machines shall be provided with a calibration standpipe for measuring pump output. The standpipe shall allow convenient observation of the change of fluid level for at least 1/2 minute at full stroke and maximum speed settings, and shall be Schedule 80, clear PVC pipe conforming to ASTM D 1785 with Schedule 80 fittings equipped with a flanged

connection to the pump manifold and an end cap fitted with a PVC vacuum breaker and ball valve for air venting. The standpipe shall have a clear, observable length of at least 12 inches and shall be permanently calibrated in gallons and fractions thereof, to allow reading of the fluid contents with an accuracy of 1 percent.

2.1.5 Valves

2.1.5.1 Metering Pump Valves

The metering pump shall be equipped with adjustable internal vacuum and pressure relief valve, hydraulic oil refill valve, and automatic air bleed valve.

2.1.5.2 Suction and Discharge Valves

Suction and discharge valve cartridge shall be fitted with ball checks.

2.1.5.3 Back Pressure Valve

Back pressure regulating valve shall be provided as required, and factory adjusted to crack open at 25 psig. The regulators shall be of polyvinyl chloride construction with fluorocarbon resin or chlorosulphonated polyethylene diaphragms. Diaphragms shall be spring opposed with loading pressures adjustable by means of a screw in the top works.

2.1.6 Pulsation Dampeners

Pulsation dampeners shall be provided where required and suitably sized for the displacement of each pump. Pulsation dampeners shall have a diaphragm separating the upper chamber from the lower chamber. The upper chamber shall be charged with compressed air to 50 percent of the expected line pressure. The diaphragm shall be of molded construction and shall prevent the air charge from being dissolved in the process fluid. The lower chamber shall be plastic or lined with inert plastic material to prevent corrosion by the process fluid. The upper chamber shall be equipped with a tire valve type charging valve and air pressure gauge. An air line and air hose with pressure regulator and hand-operated, lever-type valve suitable for charging the pulsation dampers shall also be provided.

2.1.7 Chemical Feed System Tanks

Tanks shall be fully resistant to the effects of the solution concentrations listed below. Tank fittings shall be pressure rated for 1.5 times the weight of solution at full capacity. Each tank shall have the capacity listed and shall be equipped with a fill nozzle, vent, discharge, level instrument, bottom drain, and two spare connections. Tanks shall be reinforced to withstand all forces when full of solution. Tanks shall be completely shop fabricated with no field assembly permitted. Drain connection shall provide complete drainage of the tank. All gaskets shall be fluorocarbon elastomer; nuts and bolts shall be Type 316 stainless steel; and steel supports shall be either stainless or epoxy coated. Each tank shall be furnished with a calibrated side wall strip to indicate volume. A permanent plastic sign indicating the tank contents shall be attached to the front of each tank with black lettering, 3 inches tall, clearly visible to operating staff on a clear background.

2.1.7.1 Aluminum Sulfate Storage Tank

Aluminum sulfide storage tank shall conform to the following:

Resistant. (FRP Bisphenol A fumarate Resin, cross linked polyethylene or equivalent.)
Number of tanks: 1
Minimum tank capacity: 4,500 gallons.
Tank dimensions: 8 ft diameter, 12 ft height.
Sign shall read: "DANGER - ALUMINUM SULFATE SOLUTION."

2.1.7.2 Aluminum Sulfate Feed Tank

Aluminum sulfide feed tank shall conform to the following:

Resistant. (FRP Bisphenol A fumarate Resin, cross linked polyethylene or equivalent.)
Number of tanks: 1
Minimum tank capacity: 500 gallons.
Tank dimensions: 4 ft diameter, 6 ft height.
Sign shall read: "DANGER - ALUMINUM SULFATE SOLUTION."

2.1.8 Solution Gauges

Solution gauges shall be diaphragm type with Bourdon tube and diaphragm compartments filled completely with oil, and shall be made of materials suitable for the application.

2.1.9 Injectors

a. Pipe-Type Injectors

Injectors for chemical solution shall be introduced into the water or mains by means of a hard rubber or plastic injection nozzle, or by means of a suitable diffuser tube inserted into the main through a corporation cock. The device for introducing the solution into a pressure main shall be constructed in such a way that accidental breakage of discharge hose or tubing will not cause water to escape from the water-service line, and will allow disassembling of the unit without leakage from the main.

b. Tank Type Injectors

Injectors in tanks shall be open-channel diffuse type, 1-inch in diameter with 2 staggered rows of 1/8-inch holes. The injector shall be braced between the sidewalls of the tank with non corrosive brackets.

2.1.10 Tank Covers

Tanks shall be provided with a hinged removable cover to allow access to the tops of the tanks during operation. The cover will allow for removal and maintenance of tank internals and appurtenances when the cover is removed. The cover shall provide an air tight seal when closed. Tanks larger than 36 inches in diameter shall be fitted with 24-inch manways.

2.2 PIPING

2.2.1 Backflow Preventer

Backflow preventer devices or air gaps shall be provided on tank fill lines in accordance with NAPHCC-01.

2.2.2 Chemical Solution Piping

Chemical solution piping smaller than 2-inch diameter shall be PVC pipe conforming to ASTM D 1785 or CPVC pipe conforming to ASTM F 441. Fittings for plastic pipe shall be of plastic with flanged or threaded joints. Joints for rubber hose shall be made using a clamp-type mechanical coupling. Chemical solution piping shall be completely resistant to the corrosive characteristics of the chemical being pumped.

2.3 ELECTRICAL WORK

Electric motor-driven equipment specified shall be provided complete with motor, motor starter, and controls. Electrical equipment and wiring shall be in accordance with Section 16415 ELECTRICAL WORK, INTERIOR and shall conform to NFPA 70. Electrical ratings shall be as indicated.

2.3.1 Motor Starters

Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary for the motor control specified.

2.3.2 Control and Protective Devices

Manual or automatic control and protective or signal devices required for the operation and any control wiring required for controls and devices shall be provided. Equipment shall be prewired to the maximum practicable extent. Control cabinets shall conform to UL 50. The metering pumps shall be equipped with hand-off-automatic (H-O-A) switches. Pump operation (on/off control and speed control) shall be executed via signals from the main PLC control panel when the H-O-A is in the Automatic "A" position. When the switch is in the Hand "H" position, control shall be local at the pump. Switches shall be provided with the metering pumps.

2.4 EQUIPMENT APPURTENANCES

Bolts, nuts, anchors, washers and all other types of supports necessary for the installation of the equipment shall be galvanized steel, cadmium plated or Type 316 stainless steel.

2.5 SPARE PARTS

After approval of the detail drawings, and not later than 2 months prior to the date of beneficial occupancy, auxiliary equipment and spare parts shall be furnished as follows:

a. Spare parts for each different item of material and equipment specified including all of the parts recommended by the manufacturer to be replaced after 1 and 3 years service.

b. For each machine: One extra of each part used that is made from glass, hard rubber, or clear plastic; one extra set of solution-hose connections; one extra set of diaphragms; two filler plug seal washers; two ball checks; two seats; two complete sets of all gaskets; and one spare diaphragm for back pressure regulator.

c. For each different size and type of machine: For each different size of direct current motor, one SCR circuit board with 12 drive motor fuses and 12 SCR controller fuses; overload replacement elements for each size and type of motor; one hydraulic plunger assembly for each different size

metering pump; one of each type of material back pressure regulator, with three spare springs and fluorocarbon resin diaphragms for each; one spare diaphragm and air valve for pulsation dampener.

2.6 FACTORY PAINTING

Factory painting shall conform to manufacturer's standard factory finish, provided it does not discolor in the presence of hydrogen sulfide fumes, high water vapor atmosphere, alkaline water vapor, and concentrated chlorine (oxidizing) conditions. Coating shall be not less than 1.75 mils thick.

2.7 FRAMED INSTRUCTIONS

Framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, shall be posted where directed. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system shall be prepared in typed form, framed as specified above for the wiring and control diagrams, and posted beside the diagrams. Proposed diagrams, instructions, and other sheets shall be submitted prior to posting.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Chemical Feeding Equipment

The chemical metering machines and all equipment appurtenances shall provide complete and integrated systems in accordance with the instructions of the manufacturer and under the direct supervision of the manufacturer's representative.

3.1.2 Pump Support

Pump stands and platforms shall be adequate to support each pumping system.

3.1.3 *Pipe, Tubing, Hangers and Supports*

The installation of pipes and tubes shall be in accordance with Section 15400 PLUMBING, GENERAL PURPOSE.

3.2 PAINTING

Factory painted items requiring touching up in the field shall be thoroughly cleaned of all foreign material and shall be primed and top-coated with the manufacturer's standard factory finish provided it does not discolor in the presence of high water vapor atmosphere, alkaline water vapor, and concentrated chlorine (oxidizing) conditions. Equipment which did not receive a factory finish shall be painted as specified in Section 09900 PAINTING, GENERAL. Coating shall be not less than 1.75 mils thick.

3.3 TESTING

After installation of the chemical metering machines is complete, operating tests shall be carried out to assure that the chemical metering

installations operate properly. If any deficiencies are revealed during any tests, such deficiencies shall be corrected and the tests shall be reconducted. Reports of all tests shall be submitted prior to final acceptance of the installation.

3.3.1 Tanks

Tanks shall be cleaned of loose debris and dried prior to testing. Tanks shall be field tested for leaks or damage in shipment. The tanks shall be hydrostatically tested to 2 psig or 1.5 times the system operating pressure, whichever is greater, to detect large leaks and then with the specified chemical to detect small leaks. Tanks shall be tested with each solution for a period of 24 hours at which time no visible leakage shall be evident. All pipes, hoses, pumps, water, power, and other equipment required to convey the test liquids and to carry out the tests shall be supplied by the Contractor. Damage or leaks in tanks shall be repaired or tanks shall be replaced. Damaged ceramic tanks shall be replaced.

3.3.2 Metering Pumps

Chemical solution pumps shall be tested to demonstrate that the pumps are capable of operating without vibration or leakage. Testing shall be performed at the maximum design flow rate and at half the design flow rate. Testing shall be demonstrated while controlled and operated in all feasible modes with the pumps operated singly and in unison. The response of each pump shall be plotted on curves for the various operating pressures encountered and the results shall be compared to the curves shown on the manufacturer's published pump data. If control characteristic curves are not available at the time of testing, the pump manufacturer's service engineer shall generate such curves for each pump. Pump curves shall graphically depict the pump displacement at 25, 50, 75, and 100 percent of maximum stroke position for all pumps. Curves shall be generated only for the specified back pressure.

3.3.3 Time, Volume, and Pumping Pressure

Pumps shall be tested by filling the standpipe with chemical and measuring the outage, with all other equipment valved off. The time, volume and pumping pressures shall be recorded. The portable standpipe shall be furnished by the Contractor.

3.3.4 Test Pressure

Tests shall be carried out at 25 psig. Back pressure valves shall be manually controlled for this testing, and shall be reset as necessary after testing. The time to deliver a given quantity of chemical at a given stroke and speed setting shall be the same at all pressures.

3.3.5 Flow

Pumps shall be tested to demonstrate zero gpm flow at a zero stroke or speed setting. Failure to meet this test shall be cause for rejection.

3.3.6 Synchronization

The pumps shall be operated for a period of 4 hours to demonstrate that the double diaphragm systems do not lose their synchronization. Loss of synchronization shall also be cause for rejection and the pump shall be repaired or replaced as necessary. Repaired or replaced equipment shall be

fully retested.

3.3.7 Chemical Waste

Chemicals wasted during testing procedures shall be neutralized to achieve a pH value between 6.5 and 9.5 and a chlorine concentration of not more than 1 percent (10,000 mg/L). All chemicals wasted during testing procedures shall be routed through the treatment process at a rate that the process can assimilate without upset.

3.4 POSTING FRAMED INSTRUCTIONS

Framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire systems, shall be posted where directed. Framed instructions shall be posted prior to acceptance testing of the systems.

3.5 MANUFACTURER'S SERVICES

Services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified shall be provided. The representative shall supervise the installation, adjustment, and testing of the equipment.

3.6 FIELD TRAINING

The Contractor shall conduct a field training course for designated operating, maintenance and supervisory staff members. Training shall be provided for a total period of 8 hours of normal working time and shall start after the systems are functionally complete, but prior to final acceptance tests. Field training shall cover all of the items contained in the operating and maintenance instructions.

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SECTION 11310

PUMPS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN BEARING MANUFACTURERS ASSOCIATION (AFBMA)

AFBMA Std 9	(1990) Load Ratings and Fatigue Life for Ball Bearings
AFBMA Std 11	(1990) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 153/A 153M	(1998) Zinc Coating (Hot-Dip) on Iron and Steel Hardware

ASME INTERNATIONAL (ASME)

ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(1993) Industrial Controls and Systems
NEMA MG 1	(1993; Rev 1; Rev 2; Rev 3; Rev 4) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2002) National Electrical Code

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Equipment Installation; GA

Drawings containing complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall

show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

SD-03 Product Data

Pump System; GA

Pump characteristic curves showing capacity in gpm, net positive suction head (NPSH), head, efficiency, and pumping horsepower from 0 gpm to 110 percent (100 percent for positive displacement pumps) of design capacity. A complete list of equipment and material, including manufacturer's descriptive data and technical literature, performance charts and curves, catalog cuts, and installation instructions.

Spare Parts; FIO

Spare parts data for each different item of material and equipment specified, after approval of the related submittals, and not later than 1 month prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

Pump System Instructions; FIO

Diagrams, instructions, and other sheets proposed for posting.

SD-06 Test Reports

Field Testing and Adjusting Equipment; GA

Performance test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall indicate the final position of controls.

SD-10 Operation and Maintenance Data

Pump System; GA

Six (6) copies of operation and six (6) copies of maintenance manuals for the equipment furnished. One complete set prior to performance testing and the remainder upon acceptance. Operation manuals shall detail the step-by-step procedures required for system startup, operation, and shutdown. Operation manuals shall include the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features. Maintenance manuals shall list routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Maintenance manuals shall include piping and equipment layout and simplified wiring and control diagrams of the system as installed. Manuals shall be approved prior to the field training course.

1.3 DELIVERY AND STORAGE

All equipment delivered and placed in storage shall be stored with

protection from the weather, excessive humidity and excessive temperature variation, and dirt, dust, or other contaminants.

1.4 FIELD MEASUREMENTS

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

PART 2 PRODUCTS

2.1 GENERAL MATERIAL AND EQUIPMENT REQUIREMENTS

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site. Pump casings shall be constructed of cast iron of uniform quality and free from blow holes, porosity, hard spots, shrinkage defects, cracks, and other injurious defects. Impellers shall be stainless steel unless otherwise specified for rotors.

2.1.1 Nameplates

Each major item of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

2.1.2 Equipment Guards

Belts, pulleys, chains, gears, projecting setscrews, keys, and other rotating parts so located that any person may come in close proximity thereto shall be enclosed or guarded.

2.1.3 Special Tools

One set of special tools, calibration devices, and instruments required for operation, calibration, and maintenance of the equipment shall be provided.

2.1.4 Electric Motors

Motors shall conform to NEMA MG 1.

2.1.5 Motor Controls

Controls shall conform to NEMA ICS 1.

2.1.6 Bolts, Nuts, Anchors, and Washers

Bolts, nuts, anchors, and washers shall be steel; galvanized in accordance with ASTM A 153/A 153M.

2.1.7 Pressure Gauges

Compound gauges shall be provided on the suction side of pumps and standard pressure gauges on the discharge side of pumps. Gauges shall comply with ASME B40.1. Gauge ranges shall be as appropriate for the particular installation.

2.2 SUBMERSIBLE CENTRIFUGAL PUMPS

Submersible centrifugal pumps shall be centrifugal type pumps designed to pump solids up to 2-1/2 inches in diameter and shall be capable of withstanding submergence as required for the particular installation.

2.2.1 Pump Characteristics

Pump numbers P-601 A/B located in the new water treatment building shall have the following operating characteristics:

a. Pump Service: Building Sump Pump.

b. Design Operating Point: 100 gpm flow, 40 feet head.

c. Impeller Type: Enclosed or open.

d. Operating Speed: 1,750 rpm.

e. Depth of Submergence: 3 feet.

f. Motor Type: NEMAB, oil filled, squirrel cage induction. Non-overloading over the entire pump curve.

g. Electrical Characteristics: 480 volts ac, 3 phase, 60 Hz.

h. Size: Within rated load driving pump at specified rpm.

i. Pump Control: Level controlled by floats.

2.2.2 Pump Casing

The casing shall be capable of withstanding operating pressures 50 percent greater than the maximum operating pressures. The volute shall have smooth passages which provide unobstructed flow through the pump.

2.2.3 Mating Surfaces

Mating surfaces where watertight seal is required, including seal between discharge connection elbow and pump, shall be machined and fitted with nitrile rubber O-rings. Fitting shall be such that sealing is accomplished by metal-to-metal contact between mating surfaces, resulting in proper compression of the O-rings without the requirement of specific torque limits.

2.2.4 Coatings

Exterior surfaces of the casing in contact with sewage shall be protected by a sewage resistant coal tar epoxy coating. All exposed nuts and bolts shall be stainless steel.

2.2.5 Impeller

The impeller shall be of the shrouded non-clogging design to minimize clogging of solids, fibrous materials, heavy sludge, or other materials found in sewage. The impeller shall be statically, dynamically, and hydraulically balanced within the operating range and to the first critical speed at 150 percent of the maximum operating speed. The impeller shall be

securely keyed to the shaft with a locking arrangement whereby the impeller cannot be loosened by torque from either forward or reverse direction.

2.2.6 Wearing Rings

Wearing rings, when required, shall be renewable type and shall be provided on the impeller and casing and shall have wearing surfaces normal to the axis of rotation. Material for wear rings shall be standard of pump manufacturer. Wearing rings shall be designed for ease of maintenance and shall be adequately secured to prevent rotation.

2.2.7 Pump Shaft

The pump shaft shall be of high grade alloy steel and shall be of adequate size and strength to transmit the full driver horsepower with a liberal safety factor.

2.2.8 Seals

A tandem mechanical shaft seal system running in an oil bath shall be provided. Seals shall be of ceramic and carbon with stainless steel metal parts and BUNA-N elastomers with each interface held in contact by its own spring system.

2.2.9 Bearings

Pump bearings shall be ball or roller type designed to handle all thrust loads in either direction. Pumps depending only on hydraulic balance end thrust will not be acceptable. Bearings shall have an ABEMA L-10 life of 50,000 hours minimum, as specified in AFBMA Std 9 or AFBMA Std 11.

2.2.10 Motor

The pump motor shall have Class F insulation, NEMA B design, in accordance with NEMA MG 1, and shall be watertight. The motor shall be oil filled.

2.2.11 Power Cable

The power cable shall comply with NFPA 70, Type SO, and shall be of standard construction for submersible pump applications. The power cable shall enter the pump through a heavy duty entry assembly provided with an internal grommet assembly to prevent leakage. The cable entry junction chamber and motor shall be separated by a stator lead sealing gland or terminal board which shall isolate the motor interior from foreign material gaining access through the pump top.

2.2.12 Installation Systems

2.2.12.1 Rail Mounted Systems

Rail mounted installation systems shall consist of guide rails, a sliding bracket, and a discharge connection elbow. Guide rails shall be of the size and type standard with the manufacturer and shall not support any portion of the weight of the pump. The sliding guide bracket shall be an integral part of the pump unit. The discharge connection elbow shall be permanently installed in the wet well along with the discharge piping. The pump shall be automatically connected to the discharge connection elbow when lowered into place and shall be easily removed for inspection and service without entering the pump well.

2.2.12.2 Bolt Down Systems

The pump mount system shall include a base designed to support the weight of the pump. The base shall be capable of withstanding all stresses imposed upon it by vibration, shock, and direct and eccentric loads.

2.2.12.3 Lifting Chain

Lifting chain to raise and lower the pump through the limits indicated shall be provided. The chain shall be galvanized and shall be capable of supporting the pump.

2.3 SELF-PRIMING CENTRIFUGAL PUMPS

Self-priming centrifugal pumps shall be designed to pump solids up to 3 inches in diameter for low head units and 1-1/4 inches in diameter for high head units and shall be of the centrifugal type capable of repeated reprime when handling trash-laden sewage.

2.3.1 Pump Characteristics

Pump numbers P-101 A/B/C located in the existing treatment building shall have the following operating characteristics:

a. Pump Service: Clarifier Feed Pumps.

b. Design Operating Point: 700 gpm flow, 30 feet head.

c. Maximum Operating Point: 1,000 gpm flow, 44 feet head.

d. Maximum Priming Lift: 15 feet

e. Impeller Type: Non-clog self priming.

f. Rotation Direction: Clockwise.

g. Operating Speed: 2,200 rpm (maximum).

h. Motor Type: Standard John Deere 4045D or equivalent.

i. Electrical Characteristics: 480 volts ac, 3 phase, 60 Hz.

j. Size: Within rated load driving pump at specified rpm.

k. Pump Control: Variable frequency.

Pump numbers P-301 A/B/C located in the existing treatment building shall have the following operating characteristics:

a. Pump Service: Filtration Feed Pumps.

b. Design Operating Point: 700 gpm flow, 97 feet head.

c. Maximum Operating Point: 1,000 gpm flow, 140 feet head.

d. Maximum Priming Lift: 15 feet

e. Impeller Type: Non-clog self priming.

f. Rotation Direction: Clockwise.

g. Operating Speed: 2,400 rpm (maximum).

h. Motor Type: Caterpillar 3126TA or equivalent.

i. Electrical Characteristics: 480 volts ac, 3 phase, 60 Hz.

j. Size: Within rated load driving pump at specified rpm.

k. Pump Control: Variable frequency.

2.3.2 Pump Casing

The casing shall be capable of withstanding pressures 50 percent greater than the maximum operating pressures. The pump casing shall contain no openings of smaller diameter than the specified sphere size. There shall be no internal devices that will inhibit maintenance or interfere with priming and performance. The pump shall be designed to retain sufficient liquid in the casing to ensure unattended operation. The casing shall be such that the impeller can be removed without disturbing the suction and discharge connections. Front access shall be provided to the pump interior to permit inspection and cleaning of the pump interior without removing suction or discharge piping.

2.3.3 Impeller

The impeller shall be of the two-vane, semi-open, non-clog type with pump-out vanes cast integrally on its backside. The impeller shall be statically, dynamically, and hydraulically balanced within the operating range and to the first critical speed at 150 percent of the maximum operating speed. The impeller shall be securely keyed to the shaft with a locking arrangement whereby the impeller cannot be loosened by torque from either forward or reverse direction.

2.3.4 Wear Plate

A replaceable wear plate constructed of alloy steel shall be provided.

2.3.5 Pump Shaft

Pump shaft shall be of high grade alloy steel or stainless steel and shall be of adequate size and strength to transmit the full driver horsepower with a liberal safety factor.

2.3.6 Pump Shaft Sleeve

The pump shaft shall be protected from wear by a high grade alloy steel or stainless steel shaft sleeve. A seal, if needed, shall be placed between the shaft and sleeve to prevent leakage.

2.3.7 Seals

The pump shaft shall be sealed against leakage by oil lubricated mechanical seal. The stationary sealing member shall be silicon carbide and the rotating member shall be silicon carbide. The seal shall be such that the faces will not lose alignment during shock loads that cause deflection, vibration, and axial or radial movement of the pump shaft.

2.3.8 Bearings

Pump bearings shall be ball or roller type designed to handle all thrust loads in either direction.

2.3.9 Lubrication

Bearings shall be oil bath lubricated. An oil reservoir for oil bath lubricated bearings shall be provided. The reservoir shall have an overflow opening to prevent overfilling and shall have a drain at the lowest point.

2.3.10 Suction Check Valve

The pump shall contain a suction check valve to maintain prime. The suction check valve shall be removable without disturbing the suction piping. The pump shall be capable of automatic prime or reprime in the event of check valve failure.

2.3.11 Pump Support

A common fabricated steel base plate shall be provided for the pump and motor.

2.3.12 Coupling

Power shall be transmitted from the motor to the pump by a flexible coupling. Flexible couplings shall be of the heavy duty type, keyed or locked to the shaft.

2.4 DIAPHRAGM PUMPS

Diaphragm pumps shall be of the self-priming, positive displacement type designed to pump sludge of various concentrations and levels of abrasiveness. The pump shall be designed such that operating the pump without liquid in the pump casing will not damage any portion of the pump.

2.4.1 Pump Characteristics

Pump numbers DP-101, DP-102, DP-103, DP-201, and DP-202 located in the new water treatment building shall have the following operating characteristics:

a. Pump Service: Clarifier Underflow Transfer Pump (DP-101), Clarifier Slurry Recycle Pump (DP-102), Slurry Transfer Pump(DP-103), Alum Transfer Pump (DP-201), Alum Recirculation Pump (DP-202).

b. Operator: Air.

c. Peak Capacity: 150 gpm flow for a 2 inch pump.

d. Total Dynamic Head: 10 to 40 psi feet

e. Suction and Discharge Check Valve Size: 2-inch flanged

f. Diaphragm Material: Rubber.

g. Maximum solids handling size: 1/4 inch.

h. Size: Within rated load driving pump at 100 psi maximum air supply pressure.

i. Pump Control: Level control.

2.4.2 Casing

All interior wetted parts shall be either polypropylene or PVDF. The pump body shall be designed to permit access to the casing interior without disassembling the suction and discharge piping.

2.4.3 Suction and Discharge Check Valves

The suction and discharge check valves shall be of the quick opening ball check type. Quick-opening ball check valves shall have replaceable polypropylene seats and an easily removable cover plate to permit inspection and cleaning of the valve interior without disassembling the adjacent piping. Check valve ball shall be made of Teflon.

2.4.4 Air-Operated Actuators

A complete air operated actuator shall be provided, with all accessories required for proper operation, including the following:

2.4.4.1 Valve

A three-way solenoid valve on the air supply line. The valve shall operate on a signal from the flow control timer.

2.4.4.2 Timer

An adjustable solid state flow control timer to control pump air supply.

2.4.4.3 Muffler

An air exhaust muffler to ensure quiet operation.

2.4.4.4 Pressure Regulator

An air pressure regulator to maintain a constant air supply pressure to the pumping system. The air pressure regulator shall be field adjustable from 20 to 120 psi.

2.4.4.5 Strainer

An air supply strainer to remove particles larger than 5 microns from the air supply. The strainer shall have a removable cover to permit cleaning without dismantling adjacent piping.

2.4.4.6 Lubricator

A lubricator shall be provided for each diaphragm pump.

PART 3 EXECUTION

3.1 EQUIPMENT INSTALLATION

3.1.1 Pump Installation

Pumping equipment and appurtenances shall be installed in the position indicated and in accordance with the manufacturer's written instructions. All appurtenances required for a complete and operating pumping system shall be provided, including such items as piping, conduit, valves, wall sleeves, wall pipes, concrete foundations, anchors, grouting, pumps, drivers, power supply, seal water units, and controls.

3.1.2 *Concrete*

Concrete shall conform to Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.

3.2 PAINTING

Pumps and motors shall be thoroughly cleaned, primed, and given two finish coats of paint at the factory in accordance with the recommendations of the manufacturer. Field painting required for ferrous surfaces not finished at the factory is specified in Section 09900 PAINTING, GENERAL.

3.3 FIELD TESTING AND ADJUSTING EQUIPMENT

3.3.1 Operational Test

Prior to acceptance, an operational test of all pumps, drivers, and control systems shall be performed to determine if the installed equipment meets the purpose and intent of the specifications. Tests shall demonstrate that the equipment is not electrically, mechanically, structurally, or otherwise defective; is in safe and satisfactory operating condition; and conforms with the specified operating characteristics. Prior to applying electrical power to any motor driven equipment, the drive train shall be rotated by hand to demonstrate free operation of all mechanical parts. Tests shall include checks for excessive vibration, leaks in all piping and seals, correct operation of control systems and equipment, proper alignment, excessive noise levels, and power consumption.

3.3.2 Retesting

If any deficiencies are revealed during any test, such deficiencies shall be corrected and the tests shall be reconducted.

3.4 MANUFACTURER'S SERVICES

Services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified shall be provided. The representative shall supervise the installation, adjustment, and testing of the equipment.

3.5 POSTING FRAMED INSTRUCTIONS

Framed instructions containing wiring and control diagrams under glass or in laminated plastic shall be posted where directed. Condensed operating instructions, prepared in typed form, shall be framed as specified above and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the system.

3.6 FIELD TRAINING

A field training course shall be provided for designated operating and maintenance staff members. Training shall be provided for a total period

of 4 hours of normal working time and shall start after the system is functionally complete, but prior to final acceptance tests. Field training shall cover all of the items contained in the operating and maintenance manuals.

-- End of Section --

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SECTION 11394

SAND FILTRATION SYSTEM

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36/A 36M	(1997a) Carbon Structural Steel
ASTM A 53	(1998) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 126	(1995) Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A 153/A 153M	(1998) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 167	(1996) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 193/A 193M	(1998) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A 194/A 194M	(1998) Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service
ASTM A 216/A 216M	(1998) Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
ASTM A 276	(1998) Stainless Steel Bars and Shapes
ASTM A 283/A 283M	(1998) Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A 307	(1997) Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 312/A 312M	(1995a) Seamless and Welded Austenitic Stainless Steel Pipes
ASTM A 420/A 420M	(1996a) Piping Fittings of Wrought Carbon Steel and Alloy Steel for Low-Temperature Service

ASTM A 707/A 707M	(1998) Forged Carbon and Alloy Steel Flanges for Low-Temperature Service
ASTM C 127	(1988; R 1993) Specific Gravity and Absorption of Coarse Aggregate
ASTM C 128	(1997) Specific Gravity and Absorption of Fine Aggregate
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM C 582	(1995) Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion Resistant Equipment
ASTM C 1147	(1995) Determining the Short Term Tensile Weld Strength of Chemical Resistant Thermoplastics
ASTM D 1330	(1985; R 1995) Rubber Sheet Gaskets
ASTM D 1784	(1996) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 1785	(1996b) Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2241	(1996b) Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2564	(1996a) Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 3139	(1998) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D 3299	(1995a) Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks
ASTM D 3308	(1997) PTFE Resin Skived Tape
ASTM D 4097	(1995a) Contact-Molded Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks
ASTM F 477	(1996) Elastomeric Seals (Gaskets) for Joining Plastic Pipe

ASME INTERNATIONAL (ASME)

ASME B16.1	(1989) Cast Iron Pipe Flanges and Flanged Fittings
ASME B16.3	(1992) Malleable Iron Threaded Fittings

ASME B16.5	(1996; B16.5a) Pipe Flanges and Flanged Fittings NPS 1/2 thru NPS 24
ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element
ASME BPV VIII Div 1	(1998) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA B100	(1996) Filtering Material
AWWA C110	(1993) Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (75mm through 1200mm), for Water and Other Liquids
AWWA C111	(1995) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115	(1996 Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C151	(1996) Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids
AWWA D100	(1996) Welded Steel Tanks for Water Storage

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	(1998) Structural Welding Code - Steel

ISA (ISA)

ISA S5.1	(1984; R 1992) Instrumentation Symbols and Identification

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-67	(1995) Butterfly Valves
MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application
MSS SP-70	(1998) Cast Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(1997) Cast Iron Swing Check Valves, Flanges and Threaded Ends
MSS SP-72	(1992) Ball Valves with Flanged or Butt-Welding Ends for General Service

MSS SP-78	(1998) Cast Iron Plug Valves, Flanged and Threaded Ends
MSS SP-85	(1994) Cast Iron Globe & Angle Valves Flanged and Threaded Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(1993) Industrial Controls and Systems
NEMA MG 1	(1993; Rev 1; Rev 2; Rev 3; Rev 4) Motors and Generators

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC PS 13.01	(1991) Epoxy-Polyamide Painting System
SSPC SP 6/NACE 3	(1994) Commercial Blast Cleaning

1.2 SYSTEM DESCRIPTION

The filtration system shall be a pressure filtration system. The filtration system shall be designed, constructed, and installed to comply with the following design conditions. The Contractor shall supply auxiliary systems and equipment required to maintain complete and workable filter systems including, but not limited to, required piping between units, auxiliary equipment for plumbing and power, and controls and interfaces between auxiliary equipment and the filter. Chemical additives will be allowed to enhance the filtration system. The installation shall be constructed indoors. 480 volts of electricity, 125 psi of air pressure, and 40 psi of water pressure are available for installation.

1.2.1 Influent Flow Characteristics

Design Flow:	700 gallons per minute
Maximum Flow Rate:	1000 gallons per minute
Minimum Available Head:	140 feet
Design Influent Temperature:	35-55 degrees F
Maximum Influent Temperature:	70 degrees F
Minimum Influent Temperature:	32 degrees F
Flow Conditions:	Continuous
Design Influent, Suspended Solids:	30 mg/L
Design Influent, Particle Size:	Not Available
Maximum pH:	9
Minimum pH:	6
Source of Process Water:	Sediment Mechanical Dewatering Filtrate

1.2.2 Design Criteria

Number of Filters:	4 to 12
Maximum Effluent, Suspended Solids:	5 mg/L
Maximum Effluent, Particle Size:	Not Available
Backwash Type:	Intermittent
Removal Efficiency:	50% or more of the 0.45 micron particles and 80% or more of the 2 micron particles

	on a single pass through the filter
Maximum Differential Pressure:	25 psi
Maximum Allowable Footprint:	25 ft x 16 ft
Maximum Clearance Height:	13 ft

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Shop Drawings; GA

Shop drawings consisting of a complete list of equipment and materials, including manufacturer's descriptive and technical literature; performance charts and curves; catalog cuts; and installation instructions. Shop drawings shall also contain complete wiring and schematic diagrams; equipment layout and anchorage; and any other details required to demonstrate that the system has been coordinated and will properly function as a unit.

SD-03 Product Data

Posting Framed Instructions; FIO

Proposed diagrams and instructions shall be submitted prior to posting.

Qualifications; GA

Qualifications of the installer, and the manufacturer's and media supplier's representatives.

Media; GA

Characteristics of each filter media material.

Materials and Equipment; GA

Catalog cuts and other pertinent information on filters, pumps, tanks, mixers, piping, and flow elements.

Control System; GA

Detailed description of the proposed control system. The description shall include, but not be limited to, the following items:

a. Product information for sensors/transducers and field instruments.

b. Programmable Controller System Information

(1) System Description.

(2) Hardware Description.

(3) Software Description.

c. Panels, Consoles, and Cabinets Information

(1) Layout Drawings.

(2) Panel schematic and internal point-to-point wiring interconnect and/or piping diagrams.

(3) Electrical control schematics in accordance with JIC standards for all circuits indicated in the specifications or on the Contract Drawings. No "typical" wiring diagrams will be acceptable and no tables or charts to describe wire numbers will be acceptable. Wires shall be labeled and shown on the submittal drawings.

(4) Plan showing equipment layout.

(5) Stock lists or Bill of Materials for each panel including tag number, functional name, manufacturer's name, manufacturer's model number, and quantity for components mounted in and on the panel, console, or cabinet.

d. Field wiring and piping diagrams and point-to-point wiring diagrams including interconnections between field devices, panels, control stations, lighting panels, and motor starters.

e. Instrument loop diagrams for analog display, control and I/O loops prepared using ISA standard symbols.

f. System Software Documentation shall include the following as a minimum:

(1) Complete hard copies of ladder diagram programming.

(2) Complete listing of external and internal I/O address assignments, register assignments, and preset constant values along with functional point descriptions. Also list unused/undefined I/O and data table registers available.

(3) Complete hard copies of program documentation for all types of programs.

(4) Detailed system memory map defining memory segments used and spare memory segments available for system memory, I/O tables, Data Tables, and control program.

(5) Complete database listing.

(6) User's manual describing procedures and providing examples for use of programming terminal, accessories, and system utility routines to perform control, program modification, program verification, diagnostics, program documentation, loading and backup, and other required system support functions.

Spare Parts; FIO

After approval of the shop drawings, and not later then 14 days

prior to the start of operation, spare parts data for each different item of material and equipment specified. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

SD-06 Test Reports

Acceptance Testing; GA

Test reports in booklet form showing field tests performed to adjust each component and to prove compliance with the specified performance criteria. Each test report shall indicate the final position of controls.

Factory Tests; GA

Test reports in booklet form showing results of factory tests performed.

SD-07 Certificates

Materials and Equipment; GA

Manufacturer's certificates attesting that the equipment meets the specified material and performance requirements.

SD-10 Operation and Maintenance Data

Field Training; FIO

Six (6) complete copies of operating instructions outlining the step-by-step procedures required for system startup, operation, and shutdown. The instructions shall include the manufacturer's name, model number, service manual, parts list, and brief description of equipment and their basic operating features. Six (6) complete copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and trouble shooting guides. The instructions shall include simplified diagrams for the system as installed. The manual shall require valves be numbered and tagged and shall provide a schematic indicating the number of each valve. Each set shall be permanently bound and shall have a hard cover. The following identification shall be inscribed on the covers: the words "OPERATING AND MAINTENANCE INSTRUCTIONS," name and location of the facility, name of the Contractor, and contract number. These instructions shall include, but not be limited to the following:

a. System layout showing piping, valves, and controls and installation requirements.

b. Approved wiring, logic, and control diagrams prepared in accordance with ISA S5.1 including a drawing index, legend and symbols list, and abbreviations and identifiers.

c. A control sequence describing startup, operation, and shutdown; including the functional and operational description of the control system covering the procedures for programming, operation, startup, shut-down, and calibration.

d. Operating and maintenance instructions for each piece of equipment, including checkout, troubleshooting, and servicing.

e. Manufacturer's bulletins, cut sheets and descriptive data, parts list, and recommended spare parts.

1.4 QUALIFICATIONS

1.4.1 Installer

The installer shall have a minimum of 5 years experience in the installation of similar filtration systems and shall show evidence of satisfactory operation for each installation.

1.4.2 Manufacturer's Representative

A representative of the filtration system manufacturer, who is familiar with the design and experienced in the installation, adjustment, and operation of the equipment specified shall be present at the jobsite during installation of the filtration system.

1.4.3 Media Supplier Representative

A representative of the media supplier who is experienced in the installation of the specified filtration media shall be present at the jobsite during media installation.

1.5 DELIVERY, STORAGE AND HANDLING

Equipment delivered and placed in storage shall be protected from the weather, excessive humidity, excessive temperature variation, and dirt, dust, or other contaminants.

1.6 FIELD MEASUREMENTS

The Contractor shall verify all dimensions in the field and shall advise the Contracting Officer of any discrepancy before performing the work.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.1.2 Nameplates

Each major item of equipment shall have the manufacturer's name, address, type of style, model or serial number, and catalog number on a plate secured to the item of equipment.

2.1.3 Protection of Moving Parts

Belts, chains, couplings, and other moving parts shall be completely enclosed by guards to prevent accidental personal injury. Guards shall be removable or arranged to allow access to the equipment for maintenance. If equipment is housed in a lockable housing, this shall be sufficient protection and no additional guards are necessary.

2.1.4 Special Tools

One set of special tools, calibration devices, and instruments required for operation, calibration, and maintenance of the equipment shall be provided.

2.1.5 Steel Plates, Shapes and Bars

ASTM A 36/A 36M.

2.1.6 Pipe and Fittings

Pipe and fittings shall conform to the standards specified below.

2.1.6.1 Steel Pipe

ASTM A 53.

a. Flanged Joints: ASTM A 707/A 707M.

b. Welded Joints: AWS D1.1.

c. Bolts: ASTM A 307, Grade B.

d. Fittings: ASTM A 420/A 420M.

2.1.6.2 Ductile Iron Pipe

AWWA C115.

a. Flanged Pipe: AWWA C115 with ASME B16.1, Class 125 flanges.

b. Rubber-Gasket Joints: AWWA C111.

c. Fittings: AWWA C110.

d. Push-on Joints: AWWA C151.

e. Bolts and Nuts: ASTM A 307, Grade B.

2.1.6.3 Stainless Steel Pipe

ASTM A 312/A 312M, Schedule 40, Type 316 or Type 304.

a. Flanged Pipe: ASME B16.5, Class 150.

b. Rubber-Gasket Joints: ASTM D 1330.

c. Fittings: ASME B16.3.

d. Bolts: ASTM A 193/A 193M, Class 1, Grade B8.

e. Nuts: ASTM A 194/A 194M, Grade 8.

2.1.6.4 Polyvinyl Chloride (PVC) Pipe

PVC pipe and fittings less than 4 inch diameter shall be in accordance with ASTM D 1785 or ASTM D 2241. PVC pipe and fittings 4 inch in diameter or larger shall be in accordance with ASTM D 2241 and shall have push-on joints.

a. Push-on Joints: ASTM D 3139 or ASTM F 477.

b. Solvent Cement: ASTM D 2564.

2.1.7 Pipe Hangers and Supports

MSS SP-58 and MSS SP-69.

2.1.8 Valves

2.1.8.1 Steel Valves

ASTM A 216/A 216M, Grade WCB.

2.1.8.2 Cast Iron Valves

ASTM A 126, Class B.

a. Globe and Angle Valves: MSS SP-85.

b. Gate Valves: MSS SP-70.

c. Plug Valves: MSS SP-78.

d. Butterfly Valves: MSS SP-67.

e. Ball Valves: MSS SP-72.

f. Check Valves: MSS SP-71.

2.1.8.3 PVC Valves

ASTM D 1784, Class 12454-B (formerly designated Type I, Grade 1).

2.1.9 Other Materials

2.1.9.1 Polypropylene Support Material

ASTM C 1147.

2.1.9.2 Joint Compound

Joint compound for threaded joints shall be a stiff mixture of graphite and oil, inert filler and oil, or a graphite compound.

2.1.9.3 Joint Tape

Joint tape for threaded joints shall comply with ASTM D 3308.

2.2 GENERAL REQUIREMENTS

2.2.1 Electrical Work

Electrical motor-driven equipment specified shall be provided complete with motors and motor starters and controls. Motor starters shall be provided complete with properly sized thermal overload protection and other appurtenances necessary for the motor specified. Electrical work shall be as specified in Section 16415 ELECTRICAL WORK, INTERIOR. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices, shall be provided.

2.2.2 Electric Motors

Motors shall conform to NEMA MG 1. Motor with nameplate horsepowers equal or greater than 1/2 hp shall be suitable for 480 volt, 3 phase operating service, unless otherwise specified. Motors of greater than 1 hp shall be high efficiency type as specified in Section 16415 ELECTRICAL WORK, INTERIOR.

2.2.3 Motor Controls

Controls shall conform to NEMA ICS 1.

2.2.4 Electrical Power Control

An automatic complete electrical power, control, and instrumentation system as specified or recommended by the equipment manufacturer for the safe operation and supervision of the filter units and related equipment shall be provided, except those items specified to be furnished under other sections. Schematics and interconnection wiring diagrams for power, control, and instrumentation circuits shall be provided to equipment specified. Terminal blocks (plus 25 percent spare terminals) shall be provided in panels to terminate field and interconnection wiring. Control power transformers, relays, adjustable timers, auxiliary contacts, switches, or additional equipment as required shall be provided to interconnect the filter equipment to a remote plant monitoring system, and control circuits as shown on schematic or instrument control system drawings. Conduit wiring between control panels and control devices shall be furnished as part of this specification.

2.2.5 Remote Alarm and Process Variable Monitoring

2.2.6 Bolts, Nuts, Anchors, and Washers

Bolts, nuts, anchors, and washers shall be steel, galvanized in accordance with ASTM A 153/A 153M.

2.2.7 Valves

Transfer of water to and from the filtration unit shall be accomplished by a motor actuated valve for automatic or manual operation. Design of the valve mechanisms shall be such that gradually increasing flows will be attained as ports are opened and initial surges and sudden inrushes of water are avoided. A dial pointer shall indicate each step of the operation.

2.2.8 Pressure Gauges

Gauge sizes and scale ranges shall be as shown or scheduled on the Contract Drawings. Gauges shall comply with ASME B40.1 Type 2A, as a minimum.

Compound gauges shall be provided on the suction side of pumps and standard pressure gauge on the discharge side of pumps. Gauges shall have clear acrylic or shatterproof glass windows and shock-resistant cases. The design operations should be at the midpoint of the graduated scale. Major divisions shall be equally spaced and shall be in whole integers. Scale units shall be engraved on the scale face. Pointer travel shall not be less than 200 degrees nor more than 270 degrees arc. Gauge accuracy shall be plus or minus 0.5 percent of span. Each gauge, except those for hydraulic systems, shall have a process shutoff valve.

2.2.9 Gauge Panel

A gauge panel shall be provided on which 2 nominal pressure gauges to sense unit inlet and outlet pressures and two (2) differential pressure sensor switches shall be mounted. The first differential pressure sensor switch will initiate the sand filter backwash sequence. The second differential pressure sensor switch shall be wired to a control panel which sounds an alarm when the differential pressure between the sand filter inlet and outlet headers exceeds the maximum differential pressure specified in Paragraph Design Criteria.

2.2.10 Tank Requirements

2.2.10.1 General

Tanks specified shall be provided in accordance with the following general requirements, unless otherwise indicated. Each tank shall include flanged fittings for inlet, outlet, air relief, pressure relief, and drain. The size, elevation and orientation shall be provided in accordance with construction drawings. Hold down lugs shall be provided to anchor the tank to the base.

2.2.10.2 Tank Construction Materials

The tank construction material shall be compatible with the material to be handled. Tanks constructed of polyethylene, polypropylene, and fiberglass reinforced plastic (FRP) shall conform to applicable material and construction provisions of ASTM C 582, ASTM D 3299, and ASTM D 4097. Tanks constructed of steel shall conform with applicable material and construction provisions of AWWA D100. Carbon steel tanks shall be fabricated with ASTM A 283/A 283M carbon steel Grade C or D and protected with an appropriate interior coating system for the intended service in accordance with applicable requirements in Section 09900 PAINTING, GENERAL. Stainless steel tanks shall be fabricated of Type 304 stainless steel conforming to ASTM A 167 with structural support conforming to ASTM A 276. Exterior painting or coating shall be provided in accordance with Paragraph PAINTING.

2.3 MEDIA

Filter materials shall conform to the requirements of AWWA B100. Sieve analysis shall be performed in accordance with ASTM C 136 and AWWA B100. Specific gravity shall be determined in accordance with ASTM C 127 for support media and ASTM C 128 for silica sand and high-density media.

2.4 PRESSURE FILTERS

2.4.1 Pressure Filter Tank

The filter vessels shall be of welded steel construction and shall be tested to withstand a hydrostatic pressure of 100 psi. The vessel shall be designed and fabricated in accordance with the ASME BPV VIII Div 1 and shall be so stamped and certified. Lifting lugs, supports, connections and appurtenances shall be as detailed on the drawings. The filter tank construction shall be in accordance with Paragraph Tank Requirements and prepared in accordance with the requirements of Paragraph PAINTING and Paragraph MATERIALS PROTECTION.

2.4.2 Underdrain System

Each filter shall be furnished with an underdrain system. The underdrain shall be of the standard manufacturer's design particular to the supplied filter unit and furnished with the constructed package unit. The underdrain system shall be designed to withstand all loads due to design pressures, design loading rates, and loads from the media to be installed in the filter tank.

2.4.3 Media

The media shall provide uniform voids distribution from coarse to fine in the direction of flow. Filter materials shall conform to the requirements of AWWA B100.

2.4.4 Distributor/Collector

Each filter shall be provided with an influent distributor/backwash collector. The influent distributor and waste water collector shall be fabricated as an integral part of the filter tank. The system shall be constructed from steel of the manufacturer's standard design.

2.4.5 Equipment Control

2.4.5.1 Control Valves

The filter influent, backwash, and waste valves shall allow for automatic operation of each filter unit.

2.4.6 Equipment Control Panel

A control panel with a NEMA 4X enclosure shall be supplied to contain all necessary timers, lights, contact switches, internal wiring, etc. and associated equipment to allow for the completely automatic operation of the system. The control panel shall provide for automatically starting and stopping pumps, manual operation of the control valves, automatic and manual backwash initiation. Backwash initiation shall be triggered by high head loss and manual initiation. The panel shall be completely assembled, wired, and tested at the factory prior to shipment. The panel shall be provided with required switches for manual operation should it be required.

2.5 SAMPLE PORTS

Two sample ports, at a minimum, shall be located on each unit; one to sample the influent and one to sample the effluent. The sample ports shall be readily accessible and shall be of the manufacturer's standard design and placement.

2.6 DRAIN LINE

A drain line shall be located to facilitate the removal of water from the filter tank. The drain line shall be readily accessible and shall be of the manufacturer's standard design and placement.

2.7 SPARE PARTS

Standard spare parts shall be provided as recommended in the manufacturer's instruction manuals for each component of the equipment.

2.8 MATERIALS PROTECTION

The interior and exterior of fabricated ferrous metal components shall be treated after fabrication to prevent corrosion. The surfaces of the filter tanks shall be sandblasted and completely factory finish painted prior to shipment. Insulating components such as gaskets, couplings, or bushing or dielectric-type which will prevent corrosion of bimetallic-type contacts, shall be used at connections between dissimilar metals.

PART 3 EXECUTION

3.1 GENERAL

3.1.1 Fabrication

Work not required to be performed in the field shall be performed in a factory under controlled conditions.

3.1.2 Installation

The system shall be installed such that proper waste water flow through the unit and required effluent conditions as specified in Paragraph Design Criteria will be achieved and maintained. Electrical work shall be in accordance with the applicable requirements of Section 16415 ELECTRICAL WORK, INTERIOR.

3.2 PAINTING

Painting shall be performed in accordance with applicable requirements provided in Section 09900 PAINTING, GENERAL, and additional requirements provided herein.

3.2.1 General

Metal surfaces, except aluminum, bronze, brass, galvanized steel, and stainless steel shall be painted. Surface preparation and painting shall be performed in the shop or in the field as indicated. Manufactured items, such as motors and switchboards, shall be finished with the manufacturer's standard finish.

3.2.2 Preparation and Application

Ferrous metal surfaces shall be prepared in accordance with SSPC SP 6/NACE 3 and painted with two coats of epoxy paint in accordance with SSPC PS 13.01.

3.2.3 Testing

Coating shall be examined for flaws and tested for thickness. Thickness of coatings shall be measured wet and dry using a commercial film thickness gauge. The Contracting Officer shall be notified in advance of any

painting. Additional coats shall not be applied until the previous coat has been approved. Repair or additional coats shall be accomplished at no additional cost to the Government.

3.2.4 Coating Repair

If welding is required after application of the coating, or if the coating is damaged in any way, repair shall consist of preparing the affected area in compliance with SSPC SP 6/NACE 3 and reapplying the coating to that area. If holidays are detected or film thickness is insufficient, the surface shall be prepared and additional coats applied in the affected area in compliance with the manufacturer's instructions.

3.3 VALVE AND PIPE INSTALLATION

3.3.1 Valves

Valves shall be installed as nearly as possible in the position shown. Valves shall be erected and supported in their respective position free from distortion and strain on appurtenances during handling and installation. Material shall be inspected for defects in workmanship and material. Debris and foreign material shall be cleaned out of valve openings and seats; operating mechanisms shall be operated to check their proper functioning, and nuts and bolts checked for tightness. Valves and other equipment which do not operate easily or are otherwise defective shall be repaired or replaced.

3.3.2 Piping

Piping shall be installed to accurate lines and grades. Where temporary supports are used they shall be sufficiently rigid to prevent shifting or distortion of the pipe. Provision shall be made for expansion where necessary. Piping shall pitch toward low points, and provision shall be made for draining these low points. A sufficient number of unions or flanges shall be used to allow for the dismantling of all water pipe, valves, and equipments. Installation of piping including cleaning, cutting, threading and jointing, shall be in accordance with Section 15400 PLUMBING, GENERAL PURPOSE.

3.4 FILTER TANK

3.4.1 General

The filter tank shall be installed in accordance with the recommendations of the manufacturer and by workers experienced in the installation of this type of equipment. Components with corrosion protective coating shall be checked and any damaged or abraded areas shall be restored to the original or an equivalent coating.

3.4.2 Erection of Equipment

Equipment shall be properly aligned. The unit shall be turned to a vertical position and set in place. The anchor bolts shall be set in place and the nuts tightened against the shims. After the foundation alignments have been approved, the stationary assembly shall be securely bolted in place. The alignment of equipment shall be further checked after securing to the foundations. Bracing and shipping support shall be removed from the bottom and/or interior of the tank. Piping shall be connected as indicated. Valves shall be closed.

3.5 UNDERDRAIN

The underdrain shall be installed in accordance with approved shop drawings and requirements of the manufacturer, including instructions of the manufacturer's representative. The filter tank shall be cleaned and washed prior to installation of the underdrain. Broken or defective components shall be replaced. The manufacturer-supplied underdrain shall not be modified. Following installation, the underdrain system shall be completely cleaned and washed free of loose materials and debris. Any damaged surfaces shall be restored to the original or equivalent coating. Internal water pressure or testing of the system shall not be performed for a minimum of 7 days after completion of installation. The underdrain system shall be maintained in clean condition until installation of filter media.

3.6 SUPPORT MEDIA

The gravel shall be placed by hand to avoid movement to the underdrain system and to ensure free passage of water from the underdrain. Each gravel layer shall be completed before the next layer above is started. Gravel that becomes mixed shall be removed and shall be replaced in layers as specified. The correct thickness of each layer shall be obtained as follows: Before the gravel is placed, the top of each layer shall be marked on the side of the filter. Then the top of each layer shall be leveled against a water surface held at the appropriate mark. None of the particles shall be less than half submerged, and there shall be no places where additional gravel can be placed without the particles extending more than 1/2 their volume above the water surface. The support gravel shall be backwashed after it has been placed, in accordance with AWWA B100.

3.7 FILTER MEDIA INSTALLATION

Media shall be installed under the supervision of the filter equipment supplier. Before installing the filter media, the Contractor shall check all piping connections and ensure filter components are in good condition and proper position. Media shall be placed to the depths required by the manufacturer

3.7.1 Media Layers

Each layer of media shall be completed before the next layer above is started. Each layer of media shall be deposited so as not to disturb the level surface of the layer below. Any media which is made dirty before or after placement shall be removed and replaced.

3.7.2 Cleaning of Media

The filter media shall be backwashed, scraped, and skimmed in accordance with AWWA B100 to remove excess fine material upon completion of placement of each layer. The number of washes, the wash rate, and duration of wash required to achieve the specified gradation for each layer shall be in accordance with the recommendations of the filter media supplier.

3.8 IDENTIFICATION SYSTEMS

3.8.1 Identification Tags

Identification tags made of brass, engraved laminated plastic, or engraved

anodized aluminum, indicating service and valve number shall be installed on valves, except those valves installed on supplies at plumbing fixtures. Tags shall be 1-3/8 inch minimum diameter, and marking shall be stamped or engraved. Indentations shall be black, for reading clarity. Tags shall be attached to valves with No. 12 AWG, copper wire, chrome-plated beaded chain, or plastic straps designed for that purpose.

3.8.2 Color Coding

Color coding for piping identification shall be as specified in Section 09900 PAINTING, GENERAL.

3.9 VENT LINE INSTALLATION

The vent line shall be installed according to the manufacturer's standard design and placement. The vent line shall be located in position to reduce system operating pressure prior to replacement of filter elements.

3.10 POSTING FRAMED INSTRUCTIONS

Framed instructions containing wiring and control diagrams under glass or in laminated plastic shall be posted where directed. Condensed operating instructions, prepared in typed form, shall be framed as specified above and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the system.

3.11 FIELD TESTS AND INSPECTIONS

3.11.1 General

The Contractor shall perform field tests in the presence of the Contracting Officer and shall provide labor, equipment, and incidentals required for the tests. The Contractor shall provide for disposal of all waste residuals resulting from the tests. The Contractor shall notify the Contracting Officer 7 days prior to the date and time for the acceptance tests. Any deficiencies found shall be rectified and work affected by such deficiencies shall be retested.

3.11.2 Initial Operation

Following completion of installation of the treatment systems, and after the Contractor and manufacturer's representative agree the system is ready for operation, the system shall be operated over an initial operating period not to exceed 7 days. The Contractor shall demonstrate proper operation of the equipment, including, but not limited to, the ability of the system to produce the minimum specified effluent requirements detailed in Paragraph Design Criteria, proper operation of the media cleaning equipment, and the control system ability to provide the correct operational logic to optimize the filtration process.

3.11.3 Acceptance Testing

Acceptance testing shall commence not sooner then 7 days and not later than 14 days following approval of the initial operation. The acceptance tests shall demonstrate the ability of the filtration system to meet the effluent specified requirements when operating at the design flow rate and to demonstrate the control system ability to provide the correct operational logic to optimize the filtration process. The tests shall be conducted over 7 days of continuous operation. For the filtration system to qualify

for process acceptance, the average value of each of the filtered water effluent parameters monitored during the continuous testing shall not exceed the values of the specified parameters. In the event that the specified filtered water quality requirements are not met during the period that acceptance testing is conducted, the defective equipment or operation shall be modified or replaced and the testing repeated. The schedule for retesting is subject to approval by the Contracting Officer.

3.12 FIELD TRAINING

A field training course shall be provided for designated operating and maintenance staff members. Training shall be provided for a total period of 8 hours of normal working time and shall start after the system is functionally complete but prior to final acceptance test. Field training shall cover all of the items contained in the Operation and Maintenance Manual.

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SECTION 11395

POLISHING FILTRATION SYSTEM

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36/A 36M	(1997a) Carbon Structural Steel
ASTM A 53	(1998) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 126	(1995) Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A 193/A 193M	(1998) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A 194/A 194M	(1998) Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service
ASTM A 216/A 216M	(1998) Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
ASTM A 307	(1997) Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 312/A 312M	(1995a) Seamless and Welded Austenitic Stainless Steel Pipes
ASTM A 420/A 420M	(1996a) Piping Fittings of Wrought Carbon Steel and Alloy Steel for Low-Temperature Service
ASTM A 707/A 707M	(1998) Forged Carbon and Alloy Steel Flanges for Low-Temperature Service
ASTM C 1147	(1995) Determining the Short Term Tensile Weld Strength of Chemical Resistant Thermoplastics
ASTM D 1330	(1985; R 1995) Rubber Sheet Gaskets
ASTM D 1784	(1996) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl

	Chloride) (CPVC) Compounds
ASTM D 1785	(1996b) Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2241	(1996b) Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2564	(1996a) Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 3139	(1998) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D 3308	(1997) PTFE Resin Skived Tape
ASTM F 477	(1996) Elastomeric Seals (Gaskets) for Joining Plastic Pipe

ASME INTERNATIONAL (ASME)

ASME B16.1	(1989) Cast Iron Pipe Flanges and Flanged Fittings
ASME B16.3	(1992) Malleable Iron Threaded Fittings
ASME B16.5	(1996; B16.5a) Pipe Flanges and Flanged Fittings NPS 1/2 thru NPS 24
ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C110	(1993) Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (75mm through 1200mm), for Water and Other Liquids
AWWA C111	(1995) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115	(1996 Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C151	(1996) Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	(1998) Structural Welding Code - Steel

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-67	(1995) Butterfly Valves

MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application
MSS SP-70	(1998) Cast Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(1997) Cast Iron Swing Check Valves, Flanges and Threaded Ends
MSS SP-72	(1992) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-78	(1998) Cast Iron Plug Valves, Flanged and Threaded Ends
MSS SP-85	(1994) Cast Iron Globe & Angle Valves Flanged and Threaded Ends

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC PS 13.01	(1991) Epoxy-Polyamide Painting System
SSPC SP 6/NACE 3	(1994) Commercial Blast Cleaning

1.2 SYSTEM DESCRIPTION

The filtration system shall be a filtration system. The filtration system shall be designed, constructed, and installed to comply with the following design conditions. The Contractor shall supply auxiliary systems and equipment required to maintain complete and workable filter systems including, but not limited to, required piping between units, auxiliary equipment for plumbing and power, and controls and interfaces between auxiliary equipment and the filter. Chemical additives will not be allowed to enhance the filtration system. The installation shall be constructed indoors. 480 volts of electricity, 125 psi of air pressure, and 40 psi of water pressure is available for installation.

1.2.1 Cartridge Influent

Design Flow:	700 gallons per minute
Maximum Flow Rate:	5.8 gallons per 25 cm filter equivalent
Design Inlet Pressure:	50 psi
Design Influent Temperature:	35-55 degrees F
Maximum Influent Temperature:	70 degrees F
Minimum Influent Temperature:	32 degrees F
Flow Conditions:	Continuous
Design Influent, Suspended Solids:	5 mg/L
Design Influent, Particle Size:	Not Available
Maximum pH:	8
Minimum pH:	6
Source of Process Water:	Sediment Mechanical Dewatering Filtrate

1.2.2 Cartridge Design Criteria

Total Number Operating Units:	2
Number of On-line Units:	1
Number of Stand-by Units:	1
Number of Elements per Unit:	120
Design Effluent, Suspended Solids:	<1 mg/L
Design Effluent, Particle Size:	Not Available

Maximum Differential Pressure: 20-25 psi at design temperature

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Shop Drawings; GA

Shop drawings consisting of a complete list of equipment and materials, including manufacturer's descriptive and technical literature; performance charts and curves; catalog cuts; and installation instructions. Shop drawings shall also contain complete wiring and schematic diagrams; equipment layout and anchorage; and any other details required to demonstrate that the system has been coordinated and will properly function as a unit.

SD-03 Product Data

Posting Framed Instructions; FIO

Proposed diagrams and instructions shall be submitted prior to posting.

Qualifications; GA

Qualifications of the installer, and the manufacturer's and media supplier's representatives.

Media; GA

Characteristics of each filter media material.

Materials and Equipment; GA

Catalog cuts and other pertinent information on filters, pumps, tanks, mixers, piping, and flow elements.

Spare Parts; FIO

After approval of the shop drawings, and not later then 7 days prior to the start of operation, spare parts data for each different item of material and equipment specified. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

SD-07 Certificates

Materials and Equipment; GA

Manufacturer's certificates attesting that the equipment meets the specified material and performance requirements.

SD-10 Operation and Maintenance Data

Field Training; FIO

Six (6) complete copies of operating instructions outlining the step-by-step procedures required for system startup, operation, and shutdown. The instructions shall include the manufacturer's name, model number, service manual, parts list, and brief description of equipment and their basic operating features. Six (6) complete copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and trouble shooting guides. The instructions shall include simplified diagrams for the system as installed. The manual shall require valves be numbered and tagged and shall provide a schematic indicating the number of each valve. Each set shall be permanently bound and shall have a hard cover. The following identification shall be inscribed on the covers: the words "OPERATING AND MAINTENANCE INSTRUCTIONS," name and location of the facility, name of the Contractor, and contract number. These instructions shall include, but not be limited to the following:

a. System layout showing piping, valves, and controls and installation requirements.

b. Operating and maintenance instructions for each piece of equipment, including checkout, troubleshooting, and servicing.

c. Manufacturer's bulletins, cut sheets and descriptive data, parts list, and recommended spare parts.

1.4 QUALIFICATIONS

1.4.1 Installer

The installer shall have a minimum of 2 years experience in the installation of similar filtration systems and shall show evidence of satisfactory operation for each installation.

1.4.2 Manufacturer's Representative

A representative of the filtration system manufacturer who is familiar with the design and experienced in the installation, adjustment, and operation of the equipment specified shall be present at the jobsite during installation of the filtration system.

1.4.3 Media Supplier Representative

A representative of the media supplier who is experienced in the installation of the specified filtration media shall be present at the jobsite during media installation.

1.5 DELIVERY, STORAGE AND HANDLING

Equipment delivered and placed in storage shall be protected from the weather, excessive humidity, excessive temperature variation, and dirt, dust, or other contaminants.

1.6 FIELD MEASUREMENTS

The Contractor shall verify all dimensions in the field and shall advise the Contracting Officer of any discrepancy before performing the work.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.1.2 Nameplates

Each major item of equipment shall have the manufacturer's name, address, type of style, model or serial number, and catalog number on a plate secured to the item of equipment.

2.1.3 Protection of Moving Parts

Belts, chains, couplings, and other moving parts shall be completely enclosed by guards to prevent accidental personal injury. Guards shall be removable or arranged to allow access to the equipment for maintenance. If equipment is housed in a lockable housing, this shall be sufficient protection and no additional guards are necessary.

2.1.4 Special Tools

One set of special tools, calibration devices, and instruments required for operation, calibration, and maintenance of the equipment shall be provided.

2.1.5 Steel Plates, Shapes and Bars

ASTM A 36/A 36M.

2.1.6 Pipe and Fittings

Pipe and fittings shall conform to the standards specified below.

2.1.6.1 Steel Pipe

ASTM A 53.

a. Flanged Joints: ASTM A 707/A 707M.

b. Welded Joints: AWS D1.1.

c. Bolts: ASTM A 307, Grade B.

d. Fittings: ASTM A 420/A 420M.

2.1.6.2 Ductile Iron Pipe

AWWA C115.

a. Flanged Pipe: AWWA C115 with ASME B16.1, Class 125 flanges.

b. Rubber-Gasket Joints: AWWA C111.

c. Fittings: AWWA C110.

d. Push-on Joints: AWWA C151.

e. Bolts and Nuts: ASTM A 307, Grade B.

2.1.6.3 Stainless Steel Pipe

ASTM A 312/A 312M, Schedule 40, Type 316 or Type 304.

a. Flanged Pipe: ASME B16.5, Class 150.

b. Rubber-Gasket Joints: ASTM D 1330.

c. Fittings: ASME B16.3.

d. Bolts: ASTM A 193/A 193M, Class 1, Grade B8.

e. Nuts: ASTM A 194/A 194M, Grade 8.

2.1.6.4 Polyvinyl Chloride (PVC) Pipe

PVC pipe and fittings less than 4 inch diameter shall be in accordance with ASTM D 1785 or ASTM D 2241. PVC pipe and fittings 4 inch in diameter or larger shall be in accordance with ASTM D 2241 and shall have push-on joints.

a. Push-on Joints: ASTM D 3139 or ASTM F 477.

b. Solvent Cement: ASTM D 2564.

2.1.7 Pipe Hangers and Supports

MSS SP-58 and MSS SP-69.

2.1.8 Valves

2.1.8.1 Steel Valves

ASTM A 216/A 216M, Grade WCB.

2.1.8.2 Cast Iron Valves

ASTM A 126, Class B.

a. Globe and Angle Valves: MSS SP-85.

b. Gate Valves: MSS SP-70.

c. Plug Valves: MSS SP-78.

d. Butterfly Valves: MSS SP-67.

e. Ball Valves: MSS SP-72.

f. Check Valves: MSS SP-71.

2.1.8.3 PVC Valves

ASTM D 1784, Class 12454-B (formerly designated Type I, Grade 1).

2.1.9 Other Materials

2.1.9.1 Polypropylene Support Material

ASTM C 1147.

2.1.9.2 Joint Compound

Joint compound for threaded joints shall be a stiff mixture of graphite and oil, inert filler and oil, or a graphite compound.

2.1.9.3 Joint Tape

Joint tape for threaded joints shall comply with ASTM D 3308.

2.2 GENERAL REQUIREMENTS

2.2.1 Bolts, Nuts, Anchors, and Washers

Bolts, nuts, anchors, and washers shall be same as filter housing.

2.2.2 Valves

Transfer of water to and from the filtration unit shall be accomplished by motor actuated valves for automatic operation. Design of the valve mechanisms shall be such that gradually increasing flows will be attained as ports are opened and initial surges and sudden inrushes of water are avoided. A dial pointer shall indicate each step of the operation.

2.2.3 Pressure Gauges

Gauge sizes and scale ranges shall be as shown or scheduled on the Contract Drawings. Gauges shall comply with ASME B40.1 Type 2A, as a minimum. Compound gauges shall be provided on the suction side of pumps and standard pressure gauge on the discharge side of pumps. Gauges shall have clear acrylic or shatterproof glass windows and shock-resistant cases. The design operations should be at the midpoint of the graduated scale. Major divisions shall be equally spaced and shall be in whole integers. Scale units shall be engraved on the scale face. Pointer travel shall not be less than 200 degrees nor more than 270 degrees arc. Gauge accuracy shall be plus or minus 0.5 percent of span. Each gauge, except those for hydraulic systems, shall have a process shutoff valve.

2.3 CARTRIDGE FILTER

2.3.1 Equipment Capacity

The Contractor shall supply two filtration units. One unit shall be on-line, one shall be standby. Each on-line and standby unit shall have the capacity to treat the entire waste stream as specified in Paragraph Cartridge Design Criteria.

2.3.2 Filter Material

The filter material shall be of acrylic fiber and phenolic resin construction.

2.3.3 Cartridge Style

The cartridge style shall be of double open end industrial.

2.3.4 Gasket or O-Ring Material

The gasket or O-ring material shall be polyethylene foam.

2.3.5 Pore Size/Rating

The filter pore size shall be 5 microns.

2.3.6 Filter Cartridge Dimensions

The filter cartridge shall be the standard length of 40 inches. The cartridge inside diameter shall be 1-1/16 inches. The cartridge outside diameter shall be 2-19/32 inches.

2.3.7 Filter Housing

2.3.7.1 Material of Construction

The filter housing head, shell, and associated internal and external connections and internal and external hardware shall be constructed of 304 stainless steel. The housing shall be prefabricated and delivered to the site in such a condition that the unit can be fastened in the location designated on the design drawings. The filter housing shall have the following dimensions and inlet, outlet, and system control connections:

Diameter:	3 ft
Overall Height:	8 ft
Inlet/Outlet:	8 in. dia. Flange
Body/Sump Drain:	Flange
Vent:	Flange
Gauge:	Flange

2.3.7.2 Shell O-Ring Material

The filter housing shell O-ring material shall be viton-a.

2.4 SAMPLE PORTS

Two sample ports, at a minimum, shall be located on each unit; one to sample the influent and one to sample the effluent. The sample ports shall be readily accessible and shall be of the manufacturer's standard design and placement.

2.5 DRAIN LINE

A drain line shall be located to facilitate the removal of water from the filter tank. The drain line shall be readily accessible and shall be of the manufacturer's standard design and placement.

2.6 SPARE PARTS

Standard spare parts shall be provided as recommended in the manufacturer's instruction manuals for each component of the equipment.

PART 3 EXECUTION

3.1 GENERAL

3.1.1 Fabrication

Work not required to be performed in the field shall be performed in a factory under controlled conditions.

3.1.2 Installation

The system shall be installed such that proper waste water flow through the unit and required effluent conditions as specified in Paragraph System Description. Electrical work shall be in accordance with the applicable requirements of Section 16415 ELECTRICAL WORK, INTERIOR.

3.2 PAINTING

Painting shall be performed in accordance with applicable requirements provided in Section 09900 PAINTING, GENERAL, and additional requirements provided herein.

3.2.1 General

Metal surfaces, except aluminum, bronze, brass, galvanized steel, and stainless steel, shall be painted. Surface preparation and painting shall be performed in the shop or in the field as indicated. Manufactured items, such as motors and switchboards, shall be finished with the manufacturer's standard finish.

3.2.2 Preparation and Application

Ferrous metal surfaces shall be prepared in accordance with SSPC SP 6/NACE 3 and painted with two coats of epoxy paint in accordance with SSPC PS 13.01.

3.2.3 Testing

Coating shall be examined for flaws and tested for thickness. Thickness of coatings shall be measured wet and dry using a commercial film thickness gauge. The Contracting Officer shall be notified in advance of any painting. Additional coats shall not be applied until the previous coat has been approved. Repair or additional coats shall be accomplished at no additional cost to the Government.

3.2.4 Coating Repair

If welding is required after application of the coating, or if the coating is damaged in any way, repair shall consist of preparing the affected area in compliance with SSPC SP 6/NACE 3 and reapplying the coating to that

area. If holidays are detected or film thickness is insufficient, the surface shall be prepared and additional coats applied in the affected area in compliance with the manufacturer's instructions.

3.3 VALVE AND PIPE INSTALLATION

3.3.1 Valves

Valves shall be installed as nearly as possible in the position shown. Valves shall be erected and supported in their respective position free from distortion and strain on appurtenances during handling and installation. Material shall be inspected for defects in workmanship and material. Debris and foreign material shall be cleaned out of valve openings and seats; operating mechanisms shall be operated to check their proper functioning, and nuts and bolts checked for tightness. Valves and other equipment which do not operate easily or are otherwise defective shall be repaired or replaced.

3.3.2 Piping

Piping shall be installed to accurate lines and grades. Where temporary supports are used they shall be sufficiently rigid to prevent shifting or distortion of the pipe. Provision shall be made for expansion where necessary. Piping shall pitch toward low points, and provision shall be made for draining these low points. A sufficient number of unions or flanges shall be used to allow for the dismantling of all water pipe, valves, and equipments. Installation of piping including cleaning, cutting, threading and jointing, shall be in accordance with Section 15400 PLUMBING, GENERAL PURPOSE.

3.4 IDENTIFICATION SYSTEMS

3.4.1 Identification Tags

Identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and valve number shall be installed on valves, except those valves installed on supplies at plumbing fixtures. Tags shall be 1-3/8 inch minimum diameter, and marking shall be stamped or engraved. Indentations shall be black, for reading clarity. Tags shall be attached to valves with No. 12 AWG, copper wire, chrome-plated beaded chain, or plastic straps designed for that purpose.

3.4.2 Color Coding

Color coding for piping identification shall be as specified in Section 09900 PAINTING, GENERAL.

3.5 VENT LINE INSTALLATION

The vent line shall be installed according to the manufacturer's standard design and placement. The vent line shall be located in position to reduce system operating pressure prior to replacement of filter elements.

3.6 FIELD TESTS AND INSPECTIONS

3.6.1 General

The Contractor shall perform field tests in the presence of the Contracting Officer and shall provide labor, equipment, and incidentals required for

the tests. The Contractor shall provide for disposal of all waste residuals resulting from the tests. The Contractor shall notify the Contracting Officer 7 days prior to the date and time for the acceptance tests. Any deficiencies found shall be rectified and work affected by such deficiencies shall be retested.

3.6.2 Initial Operation

Following completion of installation of the treatment systems, and after the Contractor and manufacturer's representative agree the system is ready for operation, the system shall be operated over an initial operating period not to exceed 7 days. The Contractor shall demonstrate proper operation of the equipment, including, but not limited to, the ability of the system to produce the minimum specified effluent requirements detailed in Paragraph System Description, proper operation of the media cleaning equipment, and the control system ability to provide the correct operational logic to optimize the filtration process.

3.6.3 Acceptance Testing

Acceptance testing shall commence not sooner then 7 days and not later than 14 days following approval of the initial operation. The acceptance tests shall demonstrate the ability of the filtration system to meet the effluent specified requirements when operating at the design flow rate and to demonstrate the control system ability to provide the correct operational logic to optimize the filtration process. The tests shall be conducted over 7 days of continuous operation. For the filtration system to qualify for process acceptance, the average value of each of the filtered water effluent parameters monitored during the continuous testing shall not exceed the values of the specified parameters. In the event that the specified filtered water quality requirements are not met during the period that acceptance testing is conducted, the defective equipment or operation shall be modified or replaced and the testing repeated. The schedule for retesting is subject to approval by the Contracting Officer.

3.7 FIELD TRAINING

A field training course shall be provided for designated operating and maintenance staff members. Training shall be provided for a total period of 4 hours of normal working time and shall start after the system is functionally complete but prior to final acceptance test. Field training shall cover all of the items contained in the Operation and Maintenance Manual.

-- End of Section --

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SECTION 11540

INCLINED PLATE CLARIFIER

PART 1 GENERAL

1.1 SUMMARY

An inclined plate clarifier will be used to remove suspended solids from the seawater effluent of a dredging slurry dewatering operation. The maximum total suspended solids concentration will be 50 mg/l. The inclined plate clarifier includes a rapid flash mix, slow floculation mix and sludge thickening tanks as an integral part of the unit. The Subcontractor shall furnish all labor, materials, equipment and incidentals, plates, fittings, supports, gauges and appurtenances for a clarifier as specified herein.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI B16.5	(1981) Pipe Flanges and Flanged Fittings
ANSI H35.2	(1997) Dimensional Tolerances for Aluminum Mill Products

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 181	Flanged Pipe Connections Grade 1 (150 psi)
ASTM A 36/ A 36 M	(1997) Carbon Structural Steel

ANMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA D100	(1996) Welded Steel Tanks for Water Storage
AWWA D103	(1997) Factory-Coated Bolted Steel Tanks for Water Storage

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(1993; Rev 1; Rev 2; Rev 3; Rev4) Motors and Generators

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having a "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Clarifier Design; GA

Provide dimensions of all major components, fittings, attachments, mixers, and motors; wall thickness; locations of fittings, attachments and joints; width and thickness of joint overlays; welding procedures; location and weights for any auxiliary equipment; service conditions - chemical environment and temperature; total weight of clarifier and fittings; description of fabrication; statement that fabrication is in accordance with these specifications; description of nozzles showing details of construction and attachment to clarifier; complete detailed instructions on the installation of the clarifier, which reference specifically the methods for this installation; design and details for supports, where applicable; hydraulic profile showing liquid levels.

SD-19 Operation and Maintenance Manuals

Operation and Maintenance (O&M) Manuals; GA,

Six copies of operation and maintenance manuals for the equipment furnished. One complete draft prior to performance testing and the remainder upon acceptance. Operation and maintenance manuals shall detail the step-by-step procedures required for system initial startup, routine startup, operation, short and long-term shutdown, routine maintenance procedures and schedules, possible breakdowns and repairs, and troubleshooting guides. Operation and maintenance manuals shall include the manufacturer's name, model number, parts list, recommended spare parts, and brief description of all equipment and their basic operating features. Operation and maintenance manuals shall also include piping and equipment layout and simplified wiring and control diagrams of the system as installed. Manuals shall be approved prior to the field training course.

1.4 PRODUCT REQUIREMENTS

The clarifier shall be furnished by a manufacturer who is fully experienced, reputable, and qualified in the design and fabrication of inclined plate clarifiers.

Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products. Items of equipment shall essentially duplicate equipment that has been in satisfactory use at least 2 years prior to bid opening

All parts shall be so designed and proportioned as to have liberal strength and stiffness, and to be especially adapted for the work to be done. Ample room and facilities shall be provided for access.

Clarifier shall be furnished, completely assembled or in major subassemblies with all accessories such that field work will involve final assembly and installation and connection of external equipment.

The manufacturer shall be responsible for the design and structural integrity of the clarifier.

1.5 NAMEPLATES

The clarifier shall have the manufacturer's name, address, type or style model or catalog number, and serial number on a plate secured to the item of equipment, and tag number as specified by Foster Wheeler.

1.6 VERIFICATION OF DIMENSIONS

The Subcontractor shall become familiar with all details of the work, and shall advise Foster Wheeler of any discrepancy before performing any work. Materials and equipment shall fit into the space allotted without interference to building features or other equipment and with adequate and acceptable clearances allowed for entry, maintenance and operation.

1.7 FACTORY TEST

1.7.1 Quality Control

The manufacturer shall have quality control procedures adequate to ensure that all fabrications comply with these specifications. Quality control shall include a final inspection by the manufacturer and a written record of this final inspection. All tests shall be witnessed by the manufacturer's design engineer and quality control inspector.

1.7.2 Inspection

The manufacturer's inspection shall include the following:

Thickness measurements.

Measurements showing compliance with dimensions and tolerance of clarifier walls, bottoms, tops, and flanges, and flatness of flanges.

1.7.3 Testing

Clarifiers shall be hydrostatically tested for leaks by filling with water. Tanks shall be checked for leaks after they have been filled for at least one hour prior to painting. Foster Wheeler may request that this be performed in their presence at the time of inspection.

1.7.4 Inspection and Test Report

A separate inspection and test record shall be made for each tank. Inspection and test records shall be submitted to Foster Wheeler for review prior to delivery and shall contain certification that the above referenced tests have been performed and have been witnessed by the design engineer and the quality control inspector.

1.8 MANUFACTURER'S SERVICES

The clarifier manufacturer shall provide the services of a factory trained representative for a minimum period of two days per unit to supervise installation, perform initial start-up of the equipment, to instruct the Owner's operating personnel in the operation and maintenance of the equipment, and to adjust the equipment for satisfactory operation after installation. The manufacturer's representative performing this service shall be a direct employee of the equipment manufacturer, normally engaged

in this type of service work.

1.9 DELIVERY AND STORAGE

The Subcontractor shall require the manufacturer to assume responsibility for packaging to prevent normal transit and handling damage.

Flange faces shall be protected from damage.

All openings shall be covered to prevent entrance of dirt, water and debris.

Clarifier shall be mounted on skids or a protective framework so constructed as to provide easy handling for fork truck or similar device, and/or shall be provided with lifting lugs, cleats, etc., to permit handling by crane. Nozzles, manholes, or other fittings shall not be used for lifting.

A detail plan shall be provided for unloading and installation of the clarifier.

1.10 GUARANTEE

The Vendor shall guarantee in writing that the equipment furnished shall be free of manufacturing and fabrication defects in material and workmanship for a period of 12 months after the equipment is satisfactorily placed in service. Should defects be identified, the vendor shall provide all labor, equipment, materials and transportation to repair such defects at no cost to Foster Wheeler

PART 2 PRODUCTS

2.1 CLARIFIER

The inclined plate clarifier shall have a maximum height of 25 feet and sufficient clearance to allow for manual removal and cleaning of the inclined plates. The maximum area available for the clarifier is 18 feet by 35 feet.

The inclined plate clarifier shall be epoxy lined carbon steel or equivalent and shall have a total flow of 2,000 GPM when operated at an overflow rate of 1.0 GPM/sq.ft. The inclined plates shall have a total horizontal projected setting area of 2,400 sq.ft. (minimum) and shall be set at an angle of 55 to 60 deg.

Flanged connections shall be provided for influent, effluent and sludge drain connections. Flanges shall be flat-faced, slip on welded flanges with a hole pattern for a standard 150 lb. flange.

The inclined plate clarifier shall be designed to operate with the flow in an upward direction. The horizontal spacing of the plates shall be a minimum of 1.25 inches.

The inclined plates shall be fiber reinforced plastic. Each plate pack shall be individually installed in the clarifier so that cranes are not required to remove a plate pack for inspection of the plates and/or the interior of the clarifier tank.

Velocity within the rapid mix tank, slow mix tank and clarifier shall be

appropriate to avoid the shearing of floc. The rapid mix and slow mix tanks shall be integral units to the clarifier and properly designed for discharge into the clarifier influent chamber. The influent chamber shall be designed to ensure even cross sectional distribution of the influent.

The effluent shall be collected by an overflow box. The trough shall be equipped on each side with an adjustable fiberglass weir plate for collecting water from the individual plates. By leveling the adjustable weir, an even overflow across each plate shall be positively assured by simple visual inspection of the weir.

a. Flow Rate

Minimum: 700 gpm
Maximum: 2,000 gpm

b. Water Temperature

Maximum: 70 degrees F
Minimum: 32 degrees F

c. Influent/Effluent pH

	Influent	Effluent
Maximum:	9.0	9.0
Minimum:	6.0	6.0

d. Space Availability

Maximum Area: 18 feet by 35 feet

2.2 RAPID FLASH MIX TANK

The inclined plate clarifier shall have a rapid mix system as an integral unit to the system. The rapid mix system shall include a tank mixer, motor and any other accessories required for the systems installation and operation.

The tank shall be epoxy lined carbon steel or equivalent. The tank dimensions shall be selected to insure maximum effective mixing. The maximum tank width shall not exceed the width of the clarifier. The mixer shall be propeller-type, fixed speed drive designed to operate on 230/460 volts, three phase, 60 Hz electric power.

2.3 SLOW MIX FLOCCULATION TANK

The inclined plate clarifier shall have a slow mix system as an integral unit to the system. The slow mix system shall include a tank, mixer, motor and other accessories required for the systems installation and operation.

The tank shall be epoxy lined carbon steel or equivalent. The tank dimensions shall be selected to insure maximum effective mixing while minimizing floc break-up. The maximum tank width shall not exceed that of the clarifier. The flocculation mixer shall be picket-type, variable-speed drive designed to operate on 230/460 V, three phase, 60 Hz electrical power.

2.4 SLUDGE THICKENING TANK

The clarifier shall have a sludge thickening/holding tank with a volume as recommended by the manufacturer. The tank shall have a picket fence type thickener with scraper; augar or vibratory thickener designed to operate on 230/460 V, three pahse, 60 Hz electrical power. A level control for sludge removal shall be provided.

2.5 MOTOR REQUIREMENTS

Each electric motor-driven mixer shall be driven by a totally-enclosed fancooled continuous-duty electric motor. Motor shall have a 1.15 service factor. Motors shall be high efficiency type, squirrel-cage induction motors having normal-starting-torque and low-current characterisitcs, and shall be of sufficient size so that the nameplate horsepower rating will not be exceeded throughout the entire published pump characeristic curve. Motor bearings shall provide smooth operations under the conditions encountered for the life of the motor. Adequate thrust bearing shall be provided in the motor to carry the weight of all rotating parts plus the hydraulic thrust and shall be capable of withstanding upthrust imposed during pump starting and under variable pumping head conditions specified. Calss F insulation with a class B temperature rise at 40 degrees C ambient. Motors shall conform to NEMA 4Text

2.6 CLARIFIER ACCESSORIES

2.6.1 Clarifier Cover

The clarifier shall be provided with a clear removable cover to allow access to the top of the clarifier during operation. The cover will allow for removal of the inclined plates when the cover is removed. The cover shall provide an air tight seal when closed.

2.6.2 Steel Pipe Fittings

Steel pipe fitting shall conform to the following and shall be reinforced.

2.6.3 Flanged Fittings

Flanged Fittings: Carbon steel, 150 lb, ASNI B16.5, ASTM A181, or A105.

2.6.4 Flange Gaskets

Gaskets shall be fabricated from a resin base material. Gasket stock shall be approximately 3/22-in. thick in its free state and 1/16-in. thick after compression in a flanged joint.

2.6.5 Platforms and Walkways

Clarifier shall be supplied with a steel platform around the perimeter complete with ladder, handrails and toe plates per 29CFR1926 Subpart L.

2.6.5.1 Level Sensor for Sludge

An infrared or ultrasonic level sensor and switch shall be included in the sludge thickening tank. The sensor shall be capable of detecting the interface between the sludge blanket and water. The switch will be capable of interfacing with PLC and SCADA systems. The switch will generate an

output signal indicating a high sludge level before the sludge blanket rises above the bottom of the plate packs.

PART 3 EXECUTION3.1 INSTALLATION

The subcontracor shall install the inclined plate clarifier in accordance with the manufacurer's instructions. TIt shall be the responsibility of the subcontractor to coordinate the delivery and installation of the clarifer to minimize interference and/or delays.

Should any defect become evident during installation, testing, or within the guarranty period, the sibcontractor shall repair or replace the tank and/or fittings as approved by Foster Wheeler.Text

3.2 INSPECTIONS AND TESTING

Tank Inspection and testing shall be in accordance with Section 11 of AWWA D100. Mill and Shop inspections are not required. Contractor shall perform the hydrostatic test. Final hydrostatic test shall be performed before painting.

3.3 PAINTING

The subcontractor shall paint the inclined plate clarifier at the factory in accordance with the recommendations of the manufacturer.

3.3.1 Surface Preparation

All steel surfaces shall receive a commercial blast in accordance with SSPC-SP-6-63 to remove rust, mill scale and weld slag. All weld splatter and surface roughness shall be removed by chipping and grinding smooth.

All prepared surfaces shall be thoroughly dry and free from preparation dust and foreign matter prior to the application of any coating. Craftsmen applying protective coatings shall be thoroughly familiar with the application guidelines and preparation requirements of the product to be applied. All materials shall be evenly applied and shall be free from obvious defects.Text

3.3.2 Application

Immediately after surface preparation, a polyamide-cured epoxy designed for protection of steel shall be applied. No discoloration of the clean area shall occur prior to the application of this coat. All steel surfaces shall receive a 3 mil film thickness of this protective coating.

Dry film thickness of all coats shall be made by employing standard calibrated dry film thickness gauges.

3.4 Paint Touch-Up Kit

A paint touch-up kit shall be provided for repair of any scratches or marks that occur during shipment or installation. Detailed instructions shall be included and the materials shall be compatible with the coatings as outlined above.

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SECTION 13120

STANDARD METAL BUILDING SYSTEMS

PART 1 GENERAL

1.1 CODES AND REFERENCES

The codes and reference publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. Commonwealth of Massachusetts State Building Code is the basic code governing the Project. In case of contradiction, the most stringent code applies.

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 101	(1997) Voluntary Specifications for Aluminum, Vinyl (PVC) and Wood Windows and Glass Doors

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC FCD	(1995a) Quality Certification Program
AISC Pub No. S303	(1992) Code of Standard Practice for Steel Buildings and Bridges
AISC Pub No. S329	(1985; Appx A June 1994) Allowable Stress Design Specification for Structural Joints Using ASTM A 325 or A 490 Bolts
AISC Pub No. S342 L	(1993) Load and Resistance Factor Design Specification for Structural Steel Buildings
AISC ASD Spec S335	(1989) Specification for Structural Steel Buildings - Allowable Stress Design, Plastic Design

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI Cold-Formed Mnl	(1996) Cold-Formed Steel Design Manual

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36/A 36M	(1997ael) Carbon Structural Steel
ASTM A 53/A 53M	(1999b) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 252	(1998) Welded and Seamless Steel Pipe Piles
ASTM A 325	(1997) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

ASTM A 463/A 463M	(1999a) Steel Sheet, Aluminum-Coated by the Hot-Dip Process
ASTM A 490	(1997) Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength
ASTM A 490M	(1993) High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints (Metric)
ASTM A 500	(1999) Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 501	(1999) Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
ASTM A 529/A 529M	(1996) High-Strength Carbon-Manganese Steel of Structural Quality
ASTM A 570/A 570M	(1998) Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality
ASTM A 572/A 572M	(1999b) High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A 588/A 588M	(1997a) High-Strength Low-Alloy Structural Steel with 50 ksi (345 MPa) Minimum Yield Point to 4 in. (100 mm) Thick
ASTM A 606	(1998) Steel, Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance
ASTM A 607	(1998) Steel, Sheet and Strip, High-Strength, Low-Alloy, Columbium or Vanadium, or Both, Hot-Rolled and Cold-Rolled
ASTM A 618	(1999) Hot-Formed Welded and Seamless High-Strength Low-Alloy Structural Tubing
ASTM A 653/A 653M	(1999a) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 792/A 792M	(1999) Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
ASTM C 518	(1998) Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM C 578	(1995) Rigid, Cellular Polystyrene Thermal Insulation
ASTM C 612	(1993) Mineral Fiber Block and Board Thermal Insulation

ASTM C 991	(1998) Flexible Glass Fiber Insulation for Pre-Engineered Metal Buildings
ASTM C 1289	(1998) Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
ASTM D 522	(1993a) Mandrel Bend Test of Attached Organic Coatings
ASTM D 523	(1989; R 1999) Specular Gloss
ASTM D 610	(1995) Evaluating Degree of Rusting on Painted Steel Surfaces
ASTM D 714	(1987; R 1994e1) Evaluating Degree of Blistering of Paints
ASTM D 968	(1993) Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM D 1308	(1987; R 1998) Effect of Household Chemicals on Clear and Pigmented Organic Finishes
ASTM D 1654	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D 2244	(1995) Calculation of Color Differences from Instrumentally Measured Color Coordinates
ASTM D 2247	(1999) Testing Water Resistance of Coatings in 100% Relative Humidity
ASTM D 2794	(1993; R 1999e1) Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D 3359	(1997) Measuring Adhesion by Tape Test
ASTM D 4214	(1998) Evaluating Degree of Chalking of Exterior Paint Films
ASTM D 4587	(1991) Conducting Tests on Paint and Related Coatings and Materials Using a Fluorescent UV-Condensation Light- and Water-Exposure Apparatus
ASTM D 5894	(1996) Standard Practice for Cyclic Salt Fog/UV Exposure of Painted Metal, (Alternating Exposures in a Fog/Dry Cabinet and a UV/Condensation Cabinet)
ASTM E 84	(1999) Surface Burning Characteristics of Building Materials
ASTM E 96	(1995) Water Vapor Transmission of

Materials

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7	(1998) Minimum Design Loads for Buildings and Other Structures

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	(2000) Structural Welding Code - Steel

COMMONWEALTH OF MASSACHUSETTS

780 CMR	(2001) Massachusetts State Building Code

ENGINEERING TECHNICAL INSTRUCTIONS AND ENERGY SAVINGS ANALYSIS

TI 809-04	(1998) Seismic Design for Buildings
TI 809-07	(1998) Design of Cold-Formed Load Bearing Steel Systems and Masonry Veneer/Steel Stud Walls

METAL BUILDING MANUFACTURERS ASSOCIATION (MBMA)

MBMA Low Rise Manual	(1996) Low Rise Building Systems Manual

SHEET METAL & AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA Arch. Manual	(1993; Errata; Addenda Oct 1997) Architectural Sheet Metal Manual

STEEL WINDOW INSTITUTE (SWI)

SWI Specifier's Guide	(1995) The Specifier's Guide to Steel Windows

UNDERWRITERS LABORATORIES (UL)

UL 580	(1994; Rev thru Feb 1998) Tests for Uplift Resistance of Roof Assemblies

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Drawings; GA

Detail foundation and building drawings consisting of specifications, catalog cuts, design and erection drawings shall contain an isometric view of the roof showing the design wind uplift pressure and dimensions of edge and corner zones; shop painting and finishing specifications.

SD-03 Product Data

Design Analysis; GA

Design analysis as one package with the detail drawings. The design shall meet the Massachusetts State Building Code and all other pertinent codes. The design analysis, signed by a Professional Engineer registered in the State of Massachusetts, shall include a list of the design loads, and complete calculations for the building, its components, and the building foundation system. Formulas and references shall be identified. Assumptions and conclusions shall be explained, and cross-referencing shall be clear. The design analysis shall include, but not be limited to, the following wind and seismic information:

a. Wind forces on various parts of the structure. Both positive and negative pressures shall be calculated with the controlling pressure summarized.

b. Lateral forces due to seismic loading.

Computer programmed designs shall be accompanied by stress values and a letter of certification, signed by a Professional Engineer registered in the State of Massachusetts, stating the design criteria and procedures used and attesting to the adequacy and accuracy of the design. A narrative of the computer program delineating the basic methodology shall be included in the submittal. The program output shall be annotated and supplemented with sketches to make it easier for an engineer unfamiliar with the program to verify the input and output. Critical load conditions used in the final sizing of the members shall be emphasized. The design analysis shall include the name and office phone number of the designer and checker who function as a point of contact to answer questions during the detail-drawing review.

Instruction Manuals; GA

Manufacturer's literature for individual building component systems.

Erection; GA

Manufacturer's erection instruction and erection drawings describing the preparation requirements, assembly sequence, temporary bracing, shoring, and related information necessary for erection of the metal building including its structural framework and components.

Qualifications; GA

Qualifications of the manufacturer, the manufacturer's Representative when one is used, and qualifications and experience of the building erector. A brief list of locations where buildings of similar design have been used shall be included with the detail drawings and shall also include information regarding date of completion, name and address of owner, and how the structure is used.

SD-04 Samples

Accessories; FIO

One sample of each type of flashing, trim, closure, cap and similar items. Size shall be sufficient to show construction and configuration.

Roofing and Siding; FIO

One piece of each type and finish (exterior and interior) to be used, 9 inches long, full width. The sample for factory color finished covering shall be accompanied by certified laboratory test reports showing that the sheets to be furnished are produced under a continuing quality control program and that a representative sample consisting of not less than 5 pieces has been tested and has met the quality standards specified for factory color finish.

Fasteners; FIO

Two samples of each type to be used, with statement regarding intended use. If so requested, random samples of bolts, nuts, and washers as delivered to the job site shall be taken in the presence of the Contracting Officer and provided to the Contracting Officer for testing to establish compliance with specified requirements.

Insulation; FIO

One piece of each type to be used, and descriptive data covering installation.

Gaskets and Insulating Compounds; FIO

Two samples of each type to be used and descriptive data.

Sealant; FIO

One sample, approximately 1 pound, and descriptive data.

Wall Liners; FIO

One piece, 9 inches long, full width.

SD-07 Certificates

Metal Building Systems; GA

a. A Certificate from the metal building manufacturer stating that the metal building was designed from a complete set of the contract drawings and specifications and approved design submittals, and that the building furnished complies with the specified requirements.

b. Certificates of Compliance for structural bolts, framing steel, roofing and siding, and steel wall liner panels.

c. Warranty certificate. At the completion of the project the Contractor shall furnish signed copies of the 5-year Warranty for Metal Building System, a sample copy of which is attached to this section, the 20-year Manufacturer's Material Warranties, and the Manufacturer's 20-year System Weathertightness Warranty.

1.3 GENERAL REQUIREMENTS

The metal building system covered under this specification shall be provided by a single manufacturer and shall include all components and assemblies that form a building. Structural Standing Seam Metal Roofing System, when specified, shall be furnished as part of a single manufacturer's system.

1.3.1 Building Configuration

Buildings shall have vertical walls and gable roof. Roof slope shall be 1/2:12. Building shall be single-span structure, rigid frame (tapered beam or plate girder). Building dimensions shall be as standard with the manufacturer and not less than those indicated, but exceeding the indicated dimensions only by the amount of the closest standard size thereto. Eave height shall be measured from the top of the finished floor to the intersection of the insides of the roof and sidewall sheets. The clear opening between the finished floor and the bottom of the roof steel shall be as indicated on the drawings.

1.3.2 Qualifications

1.3.2.1 Manufacturer

Metal building shall be the product of a recognized steel building systems manufacturer who has been in the practice of manufacturing steel building systems for a period of not less than 5 years. The manufacturer shall be chiefly engaged in the practice of designing and fabricating steel building systems. The manufacturer shall be certified under the Metal Building Systems (MB) Certification Program, AISC FCD. Structural framing and covering shall be designed by a Professional Engineer licensed in the State of Massachusetts experienced in design of this work.

1.3.2.2 Installer

Erector shall have specialized experience in the erection of steel building systems for a period of at least 3 years. Framing shall be erected in accordance with MBMA Low Rise Manual, common industry practices and erection instructions describing the basic sequence of assembly, temporary bracing, shoring, and related information necessary for erection of the metal building including its structural framework and components. The erector shall furnish temporary guys and bracing where needed for squaring, plumbing, and securing the structural framing against loads acting on the exposed framing, such as wind loads and seismic forces, as well as loads due to erection equipment and erection operation. Bracing furnished by the manufacturer for the metal building system shall not be assumed to be adequate during erection. Structural members shall not be field cut or altered without approval of the metal building manufacturer. Welds, abrasions, and surfaces not shop primed shall be primed after erection.

1.3.2.3 Manufacturer's Representative

A representative designated by the building manufacturer, who is familiar

with the design of the building supplied and experienced in the erection of metal buildings similar in size to the one required under this contract, shall be present at the job site during construction, from the start of the structural framing erection until completion of the installation of the exterior covering, to assure that the building is erected properly.

1.4 DESIGN REQUIREMENTS

Criteria and definitions shall be in accordance with MBMA Low Rise Manual, except criteria for seismic loads which shall be in accordance with TI 809-04 and all other loads and load combinations in accordance with ASCE 7 and 780 CMR.

1.4.1 Dead Loads

The dead load shall consist of the weight of all permanent construction such as roof, framing, covering members and all other materials of the building system.

1.4.2 Collateral Loads

Collateral load of 15 pounds per square foot shall be applied to the entire structure to account for the weight of additional permanent materials other than the building system, such as sprinklers, mechanical systems, electrical systems, hung partitions, and ceilings. This allowance does not include the weight of hung equipment weighing 50 pounds or more. Equipment loads of 50 pounds or more shall be shown on the shop (detail) drawings and the structure (frame, purlins, girts) shall be strengthened as required. The Contractor is responsible for providing the building manufacturer the magnitude and approximate location of all concentrated loads greater than 50 pounds before design of the building commences.

1.4.3 Roof Live Loads

1.4.3.1 Uniform Loads

Uniform roof live loads, including maintenance traffic and construction loads, shall be determined and applied in accordance with ASCE 7 and 780 CMR.

1.4.3.2 Concentrated Loads

In addition to ASCE 7 and 780 CMR roof live loads, a minimum design concentrated load of 300 pounds shall be used to simulate a construction load on roof panels. The concentrated load shall be applied at the panel midspan and shall be resisted by a single standing seam metal roof panel, or a 24 inches wide corrugated metal panel, assumed to be acting as a beam. The undeformed shape of the panel shall be used to determine the section properties.

1.4.4 Roof Snow Loads

The design roof snow loads, including effects of drifting, shall be determined and applied in accordance with ASCE 7 and 780 CMR.

1.4.5 Wind Loads

Wind pressures shall be computed and applied in accordance with ASCE 7 and 780 CMR.

1.4.6 Seismic Loads

Seismic loads shall be computed in accordance with TI 809-04 and 780 CMR.

1.4.7 Foundations

Foundations shall be designed for an allowable soil bearing pressure on the order of 2000 psf, a minimum bottom of footing depth of 4 feet as measured from the finished grade, finished floor or bottom of any recessed area(s) or crawl space, whichever is lowest. A factor of safety of 1.5 for overturning, sliding and uplift, and a concrete compressive strength as specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. The resistance to lateral foundation loads by the use of hairpins shall be prohibited. The foundation design shall be performed by a Professional Engineer registered in the State of Massachusetts and submitted as part of the design analysis. The design shall be based on the building and loads calculated in accordance with the requirements specified and shown. All data including column reactions, collateral loads, and any other loads to be supported by the foundations shall be tabulated by the metal building supplier and furnished by the foundation engineer. The subsurface soil conditions in the vicinity of the existing building as well as the existing foundation design will be provided by the Contracting Officer for use by the engineer performing the foundation design.

1.4.8 Framing and Structural Members

Structural steel members and their connections shall be designed in accordance with AISC ASD Spec S335 or AISC Pub No. S342 L. Structural cold-formed steel framing members and their connections shall be designed in accordance with TI 809-07 and 780 CMR. Maximum deflection under applied live load, snow, or wind load shall not exceed 1/180th of the span length. Members with openings in their webs shall be designed with consideration of the additional stresses which will result due to the openings. Deflections of the steel framing above and along the side of commercially framed door openings shall be limited to a maximum allowable deflection of 1/360 of the opening width to ensure proper operation of the doors. The Contractor shall include the loads that the door transfers to the building frame in the design. Framed openings shall be designed to structurally replace the covering and framing displaced. The subpurlin and/or purlin spacing shall not exceed 30 inches on centers at the corner, edge and ridge zones, and 5 foot maximum on centers for the remainder of the roof. The maximum deflection of steel framing that provides lateral support for masonry veneer panels shall be 1/600 of the height of framing span.

1.4.9 Roofing and Siding

Except as otherwise specified, steel roofing and siding shall be designed in accordance with AISI Cold-Formed Mnl. Maximum deflection for wall and roof panels under applied live load, snow or wind loads shall not exceed 1/180th of the span length. The design analysis shall establish that the roof, when deflected under loading combinations, shall not result in ponding. Maximum deflections shall be based on sheets continuous across two or more supports with sheets unfastened and fully free to deflect. The calculated deflection from the concentrated load shall not exceed 1/180 of the span length. The methods for resisting lateral loads shall be cross-bracing, rigid frames, or wind columns.

1.4.10 Provisions for Gutters And Downspouts

Gutters and downspouts shall be designed according to the requirements of SMACNA Arch. Manual for storms which should be exceeded only once in 5 years and with adequate provisions for thermal expansion and contraction. Supports for gutters and downspouts shall be designed for the anticipated loads.

1.4.11 Provisions for Louvers

Louvers shall be adjustable type designed for a minimum net open area of 60%, to be rainproof, and to resist vibration when air is passed at the rate of 700 cubic feet per minute. In calculating free area, consideration shall be given to the blocking effect of louvers or screens protective openings. Screens used shall not be smaller than 1/4 inch mesh and shall be readily accessible for cleaning.

1.4.12 Ventilators

1.4.12.1 Continuous Ventilators

Continuous roof ventilators shall be ridge mounted gravity type, with dampers, designed for a minimum capacity of 3000 cubic feet of air per minute based on a wind velocity of 5 miles per hour and an exterior-interior temperature differential of 10 degrees F and without screens in place. Ventilators shall match roof slope. Steel parts shall match roof type and color finish.

1.5 DESIGN ANALYSIS

The design analysis shall be the design of a Professional Engineer licensed in the State of Massachusetts who is experienced in design of this type of work. The design shall include complete calculations for the building, its components, and the foundations and shall be submitted to the Contracting Officer. Conceptual level foundations shown on the drawings are based on loads derived from a representative set of similar building types. The Contractor shall obtain the services of a licensed Professional Engineer to provide a final design of the foundations. Formulas, design load cases, and references shall be identified. Assumptions and conclusions shall be explained, and cross-referencing shall be clear. Wind forces on various parts of the structure, both positive and negative, shall be calculated and shown in the design calculations. The controlling load case shall be indicated. Lateral forces due to seismic loading shall be calculated and tabulated for the various parts and portions of the building. Computer program based designs shall be accompanied by stress values and a letter of certification, signed by a Professional Engineer licensed in the State of Massachusetts, stating the design criteria and procedures used and attesting to the adequacy and accuracy of the design. A narrative of the computer program delineating the basic methodology shall be included. Computer program output shall be annotated and supplemented with sketches to verify the input and output. Critical load conditions used in the final sizing of the members shall be defined. The design analysis shall include the name and office phone number of the designer, who shall function as a point of contact to answer questions during the detail drawing review.

1.6 DELIVERY AND STORAGE

Materials shall be delivered to the site in a dry and undamaged condition and stored out of contact with the ground. Materials other than framing and structural members shall be covered with weathertight coverings and kept dry. Storage accommodations for roofing and siding shall provide good

air circulation and protection from surface staining.

1.7 WARRANTIES

The Metal Building System, composed of framing and structural members, roofing and siding, gutters and downspouts, accessories, fasteners, trim, and miscellaneous building closure items such as doors and windows (when furnished by the manufacturer) shall be warranted as described below against material and workmanship deficiencies, system deterioration caused by exposure to the elements and service design loads, leaks and wind uplift damage. Any emergency temporary repairs conducted by the owner shall not negate the warranties.

1.7.1 Prime Contractor's Weathertightness Warranty

The Metal Building System shall be warranted by the Contractor on a no penal sum basis for a period of five years against materials and workmanship deficiencies; system deterioration caused by exposure to the elements and/or inadequate resistance to specified service design loads, water leaks, and wind uplift damage. The Metal Building System covered under this warranty shall include but is not limited to the following: framing and structural members, roofing and siding panels and seams, interior or exterior gutters and downspouts, accessories, fasteners, trim, flashings and miscellaneous building closure items such as doors and windows (when furnished by the manufacturer), connectors, components, and fasteners, and other system components and assemblies installed to provide a weathertight system; and items specified in other sections of these specifications that become part of the metal building system. All material and workmanship deficiencies, system deterioration caused by exposure to the elements and/or inadequate resistance to specified service design loads, water leaks and wind uplift damage shall be repaired as approved by the Contracting Officer. See the attached Contractor's written warranty for issue resolution of warrantable defects. This warranty shall warrant and cover the entire cost of repair or replacement, including all material, labor, and related markups. The Contractor shall supplement this warranty with written warranties from the installer and/or system manufacturer, which shall be submitted along with Contractor's warranty. However, the Contractor is ultimately responsible for this warranty. The Contractor's written warranty shall be as outlined in attached **WARRANTY FOR METAL BUILDING SYSTEMS**, and start upon final acceptance of the facility. The Contractor shall provide a separate bond in an amount equal to the installed total metal building system cost in favor of the owner (Government) covering the Contractor's warranty responsibilities effective throughout the five year Contractor's warranty period for the entire metal building system as outlined above.

1.7.2 Manufacturer's Material and/or System Weathertightness Warranties

The Contractor shall furnish, in writing, the following manufacturer's material warranties to the Contracting Officer which cover all Metal Building System components:

a. A manufacturer's 20 year material warranty warranting that the specified aluminum, zinc-coated steel, aluminum-zinc alloy coated steel or aluminum-coated steel will not rupture, structurally fail, fracture, deteriorate, or become perforated under normal design atmospheric conditions and service design loads. Liability under this warranty shall be limited exclusively to the cost of either repairing or replacing nonconforming, ruptured, perforated,

or structurally failed securement system including fasteners and coil material.

b. A manufacturer's 20 year exterior material finish warranty on the factory colored finish warranting that the finish, under normal atmospheric conditions at the site, will not crack, peel, or delaminate; chalk in excess of a numerical rating of eight, as determined by ASTM D 4214 test procedures; or change colors in excess of five CIE or Hunter Lab color difference (delta E) units in accordance with ASTM D 2244. Liability under this warranty is exclusively limited to replacing the defective coated material.

1.8 COORDINATION MEETING

A coordination meeting shall be held within 45 days after contract award for mutual understanding of the metal building system contract requirements. This meeting shall take place at the building site and shall include representatives from the Contractor, the roofing/metal building system manufacturer, the roofing/metal building supplier, the erector, the designer, and the Contracting Officer. All items required by paragraph SUBMITTALS shall be discussed, including applicable standard manufacturer shop drawings, and the approval process. The Contractor shall coordinate time and arrangements for the meeting.

PART 2 PRODUCTS

2.1 BUILDING COMPONENTS

Each piece or part of the assembly shall be clearly and legibly marked to correspond with the drawings.

2.2 FRAMING AND STRUCTURAL MEMBERS

Steel 1/8 inch or more in thickness shall conform to ASTM A 36/A 36M, ASTM A 529/A 529M, ASTM A 572/A 572M, or ASTM A 588/A 588M. Uncoated steel less than 1/8 inch in thickness shall conform to ASTM A 570/A 570M, ASTM A 606, or ASTM A 607. Galvanized steel shall conform to ASTM A 653/A 653M, G 90 coating designation, 0.045 inch minimum thickness. Aluminum-zinc coated steel shall conform to ASTM A 792/A 792M, AZ 55 coating designation, 0.045 inch minimum thickness. Structural pipe shall conform to ASTM A 53/A 53M, ASTM A 252, ASTM A 500, ASTM A 501, or ASTM A 618. Holes for structural connections shall be made in the shop.

2.3 ROOFING AND SIDING

Roofing and siding shall be either steel or aluminum and shall have a factory color finish.

2.3.1 Roofing

Length of sheets shall be sufficient to cover the entire length of any unbroken roof slope unless otherwise approved. Width of sheets with interlocking ribs shall provide not less than 12 inches of coverage in place. Provisions shall be made for thermal expansion and contraction consistent with the type of system to be used. Panel shall have configurations for overlapping sheets. Roof deck assemblies shall be Class 90 as defined in UL 580. Exposed, penetrating fastener may be used. Height of corrugation at overlap of adjacent roof sheets shall be the building manufacturer's standard for the indicated roof slope.

2.3.2 Siding

Length of sheet shall be sufficient to cover the entire height of any unbroken height of wall surface unless otherwise approved. Width of sheets with interlocking ribs shall provide not less than 12 inches of coverage in place. Provisions shall be made for thermal expansion and contraction consistent with the type of system to be used. Siding shall have configurations for overlapping adjacent sheets or interlocking ribs for securing adjacent sheets. Siding shall be fastened to framework using concealed fasteners.

2.3.3 Steel Panels

Roofing and Siding shall be zinc-coated steel conforming to ASTM A 653/A 653M, G 90 coating designation; aluminum-zinc alloy coated steel conforming to ASTM A 792/A 792M, AZ 55 coating; or aluminum-coated steel conforming to ASTM A 463/A 463M, Type 2, coating designation T2 E5. Panels shall be 0.024 inch thick minimum, except that when the mid field of the roof is subject to design wind uplift pressures of 60 psf or greater or the steel covering is used as a diaphragm, the entire roof system shall have a minimum thickness of 0.030 inch. Prior to shipment, mill finish panels shall be treated to inhibit the formation of oxide corrosion. Panels that have become wet during shipment but have not started to oxidize shall be dried, and retreated in accordance with manufacturer's standard practice.

2.3.4 Factory Insulated Panels

Insulated wall and roof panels shall be factory-fabricated units with insulating core between metal face sheets, securely fastened together and uniformly separated with rigid spacers, facing of steel of composition and gauge specified for covering, constructed in a manner that will eliminate condensation on interior of panel. Panels shall have a factory color finish. Insulation shall be compatible with adjoining materials; nonrunning and nonsettling; capable of retaining its R-value for the life of the metal facing sheets; and unaffected by extremes of temperature and humidity. The assembly shall have a flame spread rating not higher than 25, and smoke developed rating not higher than 450 when tested in accordance with ASTM E 84. The insulation shall remain odorless, free from mold, and shall not become a source of food and shelter for insects. Panels shall be not less than 8 inches wide and shall be in one piece for unbroken wall heights.

2.3.5 Factory Color Finish

Panels shall have a factory applied finish on the exposed side. The exterior finish shall consist of a baked-on topcoat with an appropriate prime coat. The exterior coating shall be a nominal 1 mil thickness consisting of a topcoat of not less than 0.7 mil dry film thickness and the paint manufacturer's recommended primer of not less than 0.2 mil thickness. The interior color finish shall consist of a 0.2 mil thick prime coat. The exterior color finish shall meet the test requirements specified below.

2.3.5.1 Salt Spray Test

A sample of the sheets shall withstand a cyclic corrosion test for a minimum of 2016 hours in accordance with ASTM D 5894, including the scribe requirement in the test. Immediately upon removal of the panel from the test, the coating shall receive a rating of not less than 10, no

blistering, as determined by ASTM D 714; 10, no rusting, as determined by ASTM D 610; and a rating of 6, over 1/16 to 1/8 inch failure at scribe, as determined by ASTM D 1654.

2.3.5.2 Formability Test

When subjected to testing in accordance with ASTM D 522 Method B, 1/8 inch diameter mandrel, the coating film shall show no evidence of cracking to the naked eye.

2.3.5.3 Accelerated Weathering, Chalking Resistance and Color Change

A sample of the sheets shall be tested in accordance with ASTM D 4587, for 2000 total hours. The coating shall withstand the weathering test without cracking, peeling, blistering, loss of adhesion of the protective coating, or corrosion of the base metal. Protective coating that can be readily removed from the base metal with tape in accordance with ASTM D 3359, Test Method B, shall be considered as an area indicating loss of adhesion. Following the accelerated weathering test, the coating shall have a chalk rating not less than No. 8 in accordance with ASTM D 4214 test procedures, and the color change shall not exceed 5 CIE or Hunter Lab color difference (delta E) units in accordance with ASTM D 2244. For sheets required to have a low gloss finish, the chalk rating shall be not less than No. 6 and the color difference shall not be greater than 7 units.

2.3.5.4 Humidity Test

When subjected to a humidity cabinet test in accordance with ASTM D 2247 for 1000 hours, a scored panel shall show no signs of blistering, cracking, creepage or corrosion.

2.3.5.5 Impact Resistance

Factory-painted sheet shall withstand direct and reverse impact in accordance with ASTM D 2794 0.500 inch diameter hemispherical head indenter, equal to 1.5 times the metal thickness in mils, expressed in inch-pounds, with no loss of adhesion.

2.3.5.6 Abrasion Resistance Test

When subjected to the falling sand test in accordance with ASTM D 968, Method A, the coating system shall withstand a minimum of 100 liters of sand before the appearance of the base metal. The term "appearance of base metal" refers to the metallic coating on steel or the aluminum base metal.

2.3.5.7 Specular Gloss

Finished surfaces shall have a specular gloss value of greater than 70 at an angle of 20 degrees when measured in accordance with ASTM D 523.

2.3.5.8 Pollution Resistance

Coating shall show no visual effects when covered spot tested in a 10 percent hydrochloric acid solution for 24 hours in accordance with ASTM D 1308.

2.3.6 Accessories

Flashing, trim, metal closure strips and curbs, fascia, caps, diverters,

and similar metal accessories shall be the manufacturer's standard products. Exposed metal accessories shall be finished to match the building finish. Molded closure strips shall be bituminous-saturated fiber, closed-cell or solid-cell synthetic rubber or neoprene, or polyvinyl chloride premolded to match configuration of the roofing or siding and shall not absorb or retain water.

2.4 FASTENERS

Fasteners for steel wall and roof panels shall be zinc-coated steel, aluminum, corrosion resisting steel, or nylon capped steel, type and size specified below or as otherwise approved for the applicable requirements. Fasteners for attaching wall panels to supports shall provide both tensile and shear strength of not less than 750 lbs per fastener. Fasteners for accessories shall be the manufacturer's standard. Aluminum or corrosion resisting steel fasteners shall be used only with aluminum sheets. Exposed roof fasteners shall be gasketed or have gasketed washers on the exterior side of the covering to waterproof the fastener penetration. Washer material shall be compatible with the covering and have a minimum diameter of 3/8 inch for structural connections; and gasketed portion of the fasteners or washers shall be neoprene or other equally durable elastomeric material approximately 1/8 inch thick. Exposed wall fasteners shall be color finished or provided with plastic color caps to match the covering. Nonpenetrating fastener system for wall panels using concealed clips shall be manufacturer's standard for the system provided.

2.4.1 Screws

Screws shall be as recommended by the manufacturer to meet the design strength requirements.

2.4.2 End-Welded Studs

Automatic end-welded studs shall be shouldered type with a shank diameter of not less than 3/16 inch and cap or nut for holding covering against the shoulder.

2.4.3 Explosive Actuated Fasteners

Fasteners for use with explosive actuated tools shall have a shank of not less than 0.145 inch with a shank length of not less than 1/2 inch for fastening panels to steel and not less than 1 inch for fastening panels to concrete.

2.4.4 Blind Rivets

Blind rivets shall be aluminum with 3/16 inch nominal diameter shank or stainless steel with 1/8 inch nominal diameter shank. Rivets shall be threaded stem type if used for other than the fastening of trim. Rivets with hollow stems shall have closed ends.

2.4.5 Bolts

Bolts shall be not less than 1/4 inch diameter, shouldered or plain shank as required, with proper nuts.

2.5 GUTTERS AND DOWNSPOUTS

Gutters and downspouts shall be fabricated of aluminum, zinc-coated steel

or aluminum-zinc alloy coated steel and shall have manufacturer's standard finish. Minimum uncoated thickness of materials shall be 0.018 inch for steel and 0.032 inch for aluminum. All accessories necessary for the complete installation of the gutters and downspouts shall be furnished. Accessories shall include gutter straps, downspout elbows, downspout straps and fasteners fabricated from metal compatible with the gutters and downspouts.

2.6 LOUVERS

Louvers shall be fabricated of aluminum, zinc-coated steel, or aluminum-zinc alloy coated steel; shall have manufacturer's standard finish; and shall be furnished with insect screens. Minimum uncoated thickness of materials shall be 0.048 inch for steel and 0.064 inch for aluminum. Manually operated louvers shall be designed to be opened and closed from the operating floor.

2.7 CONTINUOUS ROOF VENTILATORS

Continuous roof ventilators shall be fabricated of aluminum, zinc-coated steel, or aluminum-zinc alloy coated steel, shall have manufacturer's standard finish, and shall be furnished with insect screens and chain or cable operated dampers. Minimum uncoated thickness of materials shall be 0.018 inch for steel and 0.032 inch for aluminum. Ventilators shall be furnished in 8 to 10 feet long sections braced at midlength.

2.8 DOORS

2.8.1 Hinged Doors

Hinged doors and frames shall receive a galvanic coating and factory primer and shall conform to the requirements of Section 08110 STEEL DOORS AND FRAMES. Exterior doors shall have top edges closed flush and sealed against water penetration. Hardware shall be as specified in Section 08700 BUILDERS' HARDWARE.

2.8.2 Overhead Doors Rolling Doors

Overhead rolling doors shall conform to the requirements of Section 08330 OVERHEAD ROLLING DOORS. Hardware shall be as specified in Section 08700 BUILDERS' HARDWARE.

2.9 WINDOWS

Windows shall conform to the requirements of Section 08510 STEEL WINDOWS.

2.10 INSULATION

Thermal resistance of insulation shall be not less than the following R-values:

Roof R-Value	19
Walls R-Value	11

R-values shall be determined at a mean temperature of 75 degrees F in accordance with ASTM C 518. Insulation shall be a standard product with the insulation manufacturer, factory marked or identified with insulation manufacturer's name or trademark and R-value. Identification shall be on individual pieces or individual packages. Insulation shall have a facing providing a permeability of 0.02 perm or less when tested in accordance

with ASTM E 96.

Facing and finishes shall be factory applied. Provide roof system insulation blocks to thermally separate roof from purlins. Facing shall consist of aluminum foil (0.0005 inch), fiberglass scrim reinforced 4/in x 3/in with tab reinforcement, 8/in. x 3/in., and 0.002 inch rigid vinyl film.

2.10.1 Rigid Board Insulation

2.10.1.1 Polyisocyanurate

Polyisocyanurate insulation shall conform to ASTM C 1289, Type I, Class 2 (having a minimum recovered material content of 9 percent by weight of core material in the polyisocyanurate portion). For impermeable faced polyisocyanurate (Ex: aluminum foil) the maximum design R-value per 1 inch of insulation used shall be 7.2 inch.

2.10.1.2 Polystyrene

Insulation shall conform to ASTM C 578, Type IV.

2.10.1.3 Mineral Fiber

Insulation shall conform to ASTM C 612.

2.10.1.4 Insulation Retainers

Retainers shall be type, size and design necessary to adequately hold the insulation and to provide a neat appearance. Metallic retaining members shall be nonferrous or have a nonferrous coating. Nonmetallic retaining members, including adhesives used in conjunction with mechanical retainers or at insulation seams, shall have a fire resistance classification not less than that permitted for the insulation.

2.11 SEALANT

Sealant shall be an elastomeric type containing no oil or asphalt. Exposed sealant shall be colored to match the applicable building color and shall cure to a rubber like consistency.

2.12 GASKETS AND INSULATING COMPOUNDS

Gaskets and insulating compounds shall be nonabsorptive and suitable for insulating contact points of incompatible materials. Insulating compounds shall be nonrunning after drying.

2.13 SHOP PRIMING

Ferrous surfaces shall be cleaned of oil, grease, loose rust, loose mill scale, and other foreign substances and shop primed. Primer coating shall be in accordance with the manufacturer's standard system.

2.14 SNOW GUARDS

Snow guards shall be provided to prevent a mass quantity of snow or ice from avalanching all at once off the roof. Snow guards shall be manufactured of case aluminum and shall adhere to the pan surface of the prefinished metal roof system using a high strength construction adhesive.

PART 3 EXECUTION

3.1 EARTHWORK AND FOUNDATION

Surfaces to receive concrete shall be clean, damp, and free from debris, frost, ice, and standing or running water. Prior to placement of concrete, the foundation shall be well drained and shall be satisfactorily graded and meet the compaction requirements of Section 02315 EXCAVATION, FILLING, AND BACKFILLING FOR STRUCTURES. Forms shall be in place, cleaned, coated, and adequately supported in accordance with Section 03100 STRUCTURAL CONCRETE FORMWORK. Reinforcing steel shall be in place, cleaned, tied, and adequately supported in accordance with Section 03200 CONCRETE REINFORCEMENT. Concrete materials shall meet the requirements of Section 03330 CAST-IN-PLACE STRUCTURAL CONCRETE. Upon approval from the Contracting Officer, the Contractor shall commence concrete placement in accordance with Section 03330 CAST-IN-PLACE STRUCTURAL CONCRETE.

3.2 ERECTION

Dissimilar materials which are not compatible when contacting each other shall be insulated from each other by means of gaskets or insulating compounds. Improper or mislocated drill holes in panels shall be plugged with an oversize screw fastener and gasketed washer; however, panels with an excess of such holes or with such holes in critical locations shall not be used. Exposed surfaces shall be kept clean and free from sealant, metal cuttings, excess material from thermal cutting, and other foreign materials. Exposed surfaces which have been thermally cut shall be finished smooth within a tolerance of 1/8 inch. Stained, discolored or damaged sheets shall be removed from the site. Welding of steel shall conform to AWS D1.1.

3.2.1 Framing Members and Anchor Bolts

Erection shall be in accordance with the approved erection instructions and drawings and with applicable provision of AISC ASD Spec S335. Framing members fabricated or modified on site shall be saw or abrasive cut; bolt holes shall be drilled. Onsite flame cutting of framing members, with the exception of small access holes in structural beam or column webs, will not be permitted. High-strength bolting shall conform to AISC Pub No. S329 using ASTM A 325 or ASTM A 490, ASTM A 490M bolts. Improper or mislocated bolt holes in structural members or other misfits caused by improper fabrication or erection, shall be repaired in accordance with AISC Pub No. S303. Concrete work is specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. Anchor bolts shall be accurately set by template while the concrete is in a plastic state. Uniform bearing under base plates and sill members shall be provided using a nonshrinking grout. Separate leveling plates under column base plates shall not be used. Members shall be accurately spaced to assure proper fitting of panels. As erection progresses, the work shall be securely fastened to resist the dead load and wind and erection stresses.

3.2.2 Roofing and Siding Installation

Siding shall be applied with the longitudinal configurations in the vertical position. Roofing shall be applied with the longitudinal configurations in the direction of the roof slope. Accessories shall be fastened into framing members, except as otherwise approved. Closure strips shall be provided as indicated and where necessary to provide weathertight construction. Fastener and fastener spacing shall be in

accordance with manufacture design.

3.2.3 Installation of Gutters and Downspouts

Gutters and downspouts shall be rigidly attached to the building. Spacing of cleats for gutters shall be 16 inches maximum. Spacing of brackets and spacers for gutters shall be 36 inches maximum. Supports for downspouts shall be spaced according to manufacturer's recommendations.

3.2.4 Louvers and Ventilators

The Contractor shall coordinate with the Contracting Officer prior to installing wall and roof penetrations for louvers and ventilators. Louvers and ventilators shall be rigidly attached to the supporting construction to assure a weather tight installation.

3.2.5 Doors and Windows

Doors and windows, including frames and hardware, shall be securely anchored to the supporting construction, shall be installed plumb and true, and shall be adjusted as necessary to provide proper operation. Joints at doors and windows shall be sealed according to manufacturer's recommendations to provide weathertight construction.

3.2.6 Insulation Installation

Insulation shall be installed as indicated and in accordance with manufacturer's instructions. Joints shall be tight and sealed as required by the manufacturer. Final appearance or installed insulation shall be free of unsightly sags and wrinkles.

3.2.7 Installation of Snow Guards

Recommended placement of snow guards consists of two groups of three staggered rows on 24-inch centers with one group at the eave and one group midway on roof slope. On long slopes, multiple groups with a maximum of 6 to 8 feet space separation is recommended. The Contractor shall determine final placement of snow guards in accordance with SMACNA Arch. Manual.

Before installing, all contact surfaces should be wiped with isopropyl alcohol only. Adhesive should then be applied to completely coat the underside of the unit before positioning it on the roof surface. After positioning, exert uniform pressure until adhesive is squeezed out around the entire perimeter of the snow guard pointing up joint to create a bead which is free of gaps or air pockets. Surebond's SB-190 sealant-adhesive is recommended.

3.3 FIELD PAINTING

Immediately upon detection, abraded or corroded spots on shop-painted surfaces shall be wire brushed and touched up with the same material used for the shop coat. Shop-primed ferrous surfaces exposed on the outside of the building and all shop-primed surfaces of doors and windows shall be painted with two coats of an approved exterior enamel. Factory color finished surfaces shall be touched up as necessary with the manufacturer's recommended touch-up paint.

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY
FOR
METAL BUILDING SYSTEM

FACILITY
DESCRIPTION: _____

BUILDING
NUMBER: _____

CORPS OF ENGINEERS CONTRACT
NUMBER: _____

CONTRACTOR

CONTRACTOR: _____

ADDRESS: _____

POINT OF
CONTACT: _____

TELEPHONE
NUMBER: _____

OWNER

OWNER: _____

ADDRESS: _____

POINT OF
CONTACT: _____

TELEPHONE
NUMBER: _____

CONSTRUCTION AGENT

CONSTRUCTION
AGENT: _____

ADDRESS: _____

POINT OF CONTACT: _____

TELEPHONE
NUMBER: _____

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY
FOR
METAL BUILDING SYSTEM
(continued)

THE METAL BUILDING SYSTEM INSTALLED ON THE ABOVE NAMED BUILDING IS WARRANTED BY [_____] FOR A PERIOD OF FIVE (5) YEARS AGAINST WORKMANSHIP AND MATERIAL DEFICIENCIES, WIND DAMAGE AND STRUCTURAL FAILURE WITHIN PROJECT SPECIFIED DESIGN LOADS, AND LEAKAGE. THE METAL BUILDING SYSTEM COVERED UNDER THIS WARRANTY SHALL INCLUDE, BUT SHALL NOT BE LIMITED TO, THE FOLLOWING: FRAMING AND STRUCTURAL MEMBERS, ROOFING AND SIDING PANELS AND SEAMS, INTERIOR OR EXTERIOR GUTTERS AND DOWNSPOUTS, ACCESSORIES, TRIM, FLASHINGS AND MISCELLANEOUS BUILDING CLOSURE ITEMS SUCH AS DOORS AND WINDOWS (WHEN FURNISHED BY THE MANUFACTURER), CONNECTORS, COMPONENTS, AND FASTENERS, AND OTHER SYSTEM COMPONENTS AND ASSEMBLIES INSTALLED TO PROVIDE A WEATHERTIGHT SYSTEM; AND ITEMS SPECIFIED IN OTHER SECTIONS OF THESE SPECIFICATIONS THAT BECOME PART OF THE METAL BUILDING SYSTEM. ALL MATERIAL AND WORKMANSHIP DEFICIENCIES, SYSTEM DETERIORATION CAUSED BY EXPOSURE TO THE ELEMENTS AND/OR INADEQUATE RESISTANCE TO SPECIFIED SERVICE DESIGN LOADS, WATER LEAKS AND WIND UPLIFT DAMAGE SHALL BE REPAIRED AS APPROVED BY THE CONTRACTING OFFICER

ALL MATERIAL DEFICIENCIES, WIND DAMAGE, STRUCTURAL FAILURE AND LEAKAGE ASSOCIATED WITH THE METAL BUILDING SYSTEM COVERED UNDER THIS WARRANTY SHALL BE REPAIRED AS APPROVED BY THE CONTRACTING OFFICER. THIS WARRANTY SHALL COVER THE ENTIRE COST OF REPAIR OR REPLACEMENT, INCLUDING ALL MATERIAL, LABOR, AND RELATED MARKUPS. THE ABOVE REFERENCED WARRANTY COMMENCED ON THE DATE OF FINAL ACCEPTANCE ON [_____] AND WILL REMAIN IN EFFECT FOR STATED DURATION FROM THIS DATE.

SIGNED, DATED, AND NOTARIZED (BY COMPANY PRESIDENT)

_____

(Company President) (Date)

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY
FOR
METAL BUILDING SYSTEM
(continued)

THE CONTRACTOR SHALL SUPPLEMENT THIS WARRANTY WITH WRITTEN WARRANTIES FROM THE MANUFACTURER AND/OR INSTALLER OF THE METAL BUILDING SYSTEM, WHICH SHALL BE SUBMITTED ALONG WITH THE CONTRACTOR'S WARRANTY. HOWEVER, THE CONTRACTOR WILL BE ULTIMATELY RESPONSIBLE FOR THIS WARRANTY AS OUTLINED IN THE SPECIFICATIONS AND AS INDICATED IN THIS WARRANTY.

EXCLUSIONS FROM COVERAGE

1. NATURAL DISASTERS, ACTS OF GOD (LIGHTNING, FIRE, EXPLOSIONS, SUSTAINED WIND FORCES IN EXCESS OF THE DESIGN CRITERIA, EARTHQUAKES, AND HAIL).

2. ACTS OF NEGLIGENCE OR ABUSE OR MISUSE BY GOVERNMENT OR OTHER PERSONNEL, INCLUDING ACCIDENTS, VANDALISM, CIVIL DISOBEDIENCE, WAR, OR DAMAGE CAUSED BY FALLING OBJECTS.

3. DAMAGE BY STRUCTURAL FAILURE, SETTLEMENT, MOVEMENT, DISTORTION, WARPAGE, OR DISPLACEMENT OF THE BUILDING STRUCTURE OR ALTERATIONS MADE TO THE BUILDING.

4. CORROSION CAUSED BY EXPOSURE TO CORROSIVE CHEMICALS, ASH OR FUMES GENERATED OR RELEASED INSIDE OR OUTSIDE THE BUILDING FROM CHEMICAL PLANTS, FOUNDRIES, PLATING WORKS, KILNS, FERTILIZER FACTORIES, PAPER PLANTS, AND THE LIKE.

5. FAILURE OF ANY PART OF THE BUILDING SYSTEM DUE TO ACTIONS BY THE OWNER WHICH INHIBIT FREE DRAINAGE FROM THE ROOF, AND GUTTERS AND DOWNSPOUTS; OR CONDITIONS WHICH CREATE PONDING WATER ON THE ROOF OR AGAINST THE BUILDING SIDING.

6. THIS WARRANTY APPLIES TO THE METAL BUILDING SYSTEM. IT DOES NOT INCLUDE ANY CONSEQUENTIAL DAMAGE TO THE BUILDING INTERIOR OR CONTENTS WHICH IS COVERED BY THE WARRANTY OF CONSTRUCTION CLAUSE INCLUDED IN THIS CONTRACT.

7. THIS WARRANTY CANNOT BE TRANSFERRED TO ANOTHER OWNER WITHOUT WRITTEN CONSENT OF THE CONTRACTOR AND THIS WARRANTY AND THE CONTRACT PROVISIONS WILL TAKE PRECEDENCE OVER ANY CONFLICTS WITH STATE STATUTES. REPORTS OF LEAKS AND BUILDING SYSTEM DEFICIENCIES SHALL BE RESPONDED TO WITHIN 48 HOURS OF RECEIPT OF NOTICE BY TELEPHONE OR IN WRITING FROM EITHER THE OWNER, OR CONTRACTING OFFICER. EMERGENCY REPAIRS, TO PREVENT FURTHER ROOF LEAKS, SHALL BE INITIATED IMMEDIATELY; A WRITTEN PLAN SHALL BE SUBMITTED FOR APPROVAL TO REPAIR OR REPLACE THIS SSSMR SYSTEM WITHIN SEVEN CALENDAR DAYS. ACTUAL WORK FOR PERMANENT REPAIRS OR REPLACEMENT SHALL BE STARTED WITHIN 30 DAYS AFTER RECEIPT OF NOTICE, AND COMPLETED WITHIN A REASONABLE TIME FRAME. IF THE CONTRACTOR FAILS TO ADEQUATELY RESPOND TO THE WARRANTY PROVISIONS, AS STATED

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY
FOR
METAL BUILDING SYSTEM
(Exclusions from Coverage Continued)

IN THE CONTRACT AND AS CONTAINED HEREIN, THE CONTRACTING OFFICER MAY HAVE THE METAL BUILDING SYSTEM REPLACED OR REPAIRED BY OTHERS AND CHARGE THE COST TO THE CONTRACTOR. IN THE EVENT THE CONTRACTOR DISPUTES THE EXISTENCE OF A WARRANTABLE DEFECT, THE CONTRACTOR MAY CHALLENGE THE OWNER'S DEMAND FOR REPAIRS AND/OR REPLACEMENT DIRECTED BY THE OWNER OR CONTRACTING OFFICER EITHER BY REQUESTING A CONTRACTING OFFICER'S DECISION, UNDER THE CONTRACT DISPUTES ACT, OR BY REQUESTING THAT AN ARBITRATOR RESOLVE THE ISSUE. THE REQUEST FOR AN ARBITRATOR MUST BE MADE WITHIN 48 HOURS OF BEING NOTIFIED OF THE DISPUTED DEFECTS. UPON BEING INVOKED THE PARTIES SHALL, WITHIN 10 DAYS JOINTLY REQUEST A LIST OF FIVE (5) ARBITRATORS FROM THE FEDERAL MEDIATION AND CONCILIATION SERVICE. THE PARTIES SHALL CONFER WITHIN 10 DAYS AFTER RECEIPT OF THE LIST TO SEEK AGREEMENT ON AN ARBITRATOR. IF THE PARTIES CANNOT AGREE ON AN ARBITRATOR, THE CONTRACTING OFFICER AND THE PRESIDENT OF THE CONTRACTOR'S COMPANY WILL STRIKE ONE (1) NAME FROM THE LIST ALTERNATIVELY UNTIL ONE NAME REMAINS. THE REMAINING PERSON SHALL BE THE DULY SELECTED ARBITRATOR. THE COSTS OF THE ARBITRATION, INCLUDING THE ARBITRATOR'S FEE AND EXPENSES, COURT REPORTER, COURTROOM OR SITE SELECTED ETC., SHALL BE BORNE EQUALLY BETWEEN THE PARTIES. EITHER PARTY DESIRING A COPY OF THE TRANSCRIPT SHALL PAY FOR THE TRANSCRIPT. A HEARING WILL BE HELD AS SOON AS THE PARTIES CAN MUTUALLY AGREE. A WRITTEN ARBITRATOR'S DECISION WILL BE REQUESTED NOT LATER THAN 30 DAYS FOLLOWING THE HEARING. THE DECISION OF THE ARBITRATOR WILL NOT BE BINDING; HOWEVER, IT WILL BE ADMISSIBLE IN ANY SUBSEQUENT APPEAL UNDER THE CONTRACT DISPUTES ACT. A FRAMED COPY OF THIS WARRANTY SHALL BE POSTED IN THE MECHANICAL ROOM OR OTHER APPROVED LOCATION DURING THE ENTIRE WARRANTY PERIOD.

-- End of Section --

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DIVISION 13 - SPECIAL CONSTRUCTION

SECTION 13405

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SECTION 13405

PROCESS CONTROL

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced and are referred to in the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(1995) Code for Electricity Metering
ANSI X3.64	(1979; R 1990) Additional Controls for Use with American National Standard Code for Information Interchange
ANSI X3.154	(1988; R 1994) Office Machines and Supplies - Alphanumeric Machines-Keyboard Arrangement

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 88	(1996) Seamless Copper Water Tube
ASTM D 635	(1997) Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position
ASTM D 638	(1997) Tensile Properties of Plastics
ASTM D 792	(1991) Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D 1238	(1995) Flow Rates of Thermoplastics by Extrusion Plastometer
ASTM D 1693	(1997a) Environmental Stress - Cracking of Ethylene Plastics

AMERICAL SOCIETY OF HEATING, REFRIGERATION AND AIR CONDITIONING ENGINEERS (ASHRAE)

ASHRAE Hdbk-IP	(1997) Handbook, Fundamentals I-P Edition

ASME INTERNATIONAL (ASME)

ASME-18	(1971; Int Supple 19.5, 1972; Errata) Fluid Meters, Their Theory and Application
ASME B31.8	(1995) Gas Transmission and Distribution Piping Systems

ASME BPV VIII Div 1	(1998) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division I - Basic Coverage

CODE OF FEDERAL REGULATIONS (CFR)

47 CFR 15	Radio Frequency Devices
47 CFR 68	Connection of Terminal Equipment to the Telephone Network

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

EIA ANSI/EIA/TIA-232-F	(1997) Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.90	(1989; R 1994) Relays and Relay Systems Associated with Electric Power Apparatus
IEEE C37.90.1	(1989; R 1994) Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems
IEEE C62.41	(1991; R 1995) Surge Voltages in Low-Voltage AC Power Circuits
IEEE Std 100	(1996) IEEE Standard Dictionary of Electrical and Electronic Terms
IEEE Std 142	(1991) IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems

INTERNATIONAL ELECTROMECHANICAL COMMISSION (IEC)

IEC 1131-3	Programmable Controllers - Part 3: Programming Language

INTERNATIONAL TELECOMMUNICATIONS UNION (ITU)

ITU V.42 bis	(1990) Data Compression Procedures for Data Circuit Terminating Equipment (DCE) Using Error-Correction Procedures

INSTRUMENTATION, SYSTEMS, AND AUTOMATION SOCIETY (ISA)

ISA S7.0.01	(1996) Quality Standards for Instrument Air

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(1993) Industrial Control and Systems
NEMA ICS 2	(1993) Industrial Control and Systems Controllers, Contactors, and Overload

	Relays Rated Not More Than 2,000 Volts AC or 750 Volts DC
NEMA ICS 3	(1993) Industrial Control and Systems Factory Built Assemblies
NEMA ICS 4	(1993) Industrial Control and Systems Terminal Blocks
NEMA 250	(1991) Enclosures for Electrical Equipment (100 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2002) National Electrical Code

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST SP 250	(1991) Calibration Service Users Guide

UNDERWRITERS LABORATORIES (UL)

UL 94	(1996; Rev thru Jul 1998) Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 508	(1993; Rev thru Oct 1997) Industrial Control Equipment
UL 1059	(1993; 3rd Edition) Standard for Terminal Blocks

1.2 CONTROL SYSTEM DESCRIPTION

The process instrumentation and control system shall be used to monitor and control the operation of process equipment as specified and in accordance with the sequence of control and control schematics shown on the drawings. The control system shall provide for operator interaction, overall control system supervision, and process equipment control and monitoring. The Contractor shall provide hardware configured and sized to support expansion as specified and shown on the drawings.

1.2.1 Control System General Requirements

The control system shall consist of a microprocessor based, Personal Computer (PC). The PC combined with a "Human Machine Interface" (HMI), which includes video display, key board and printer will provide the plant operator with complete control of all vital plant operation functions. The system video display graphics indicate a real time and continuously updated set of all parameters, possibly requiring operator intervention. The control system personal computer also serves as a data acquisition system for all system parameters thereby allowing plant operator or maintenance personnel a facility for equipment historical record keeping.

1.2.2 Control System Operation

The control system provided under this specification shall operate using direct digital control (DDC) algorithms or ladder logic type and supervisory control to provide the required sequences of operation. Input

data to the controller shall be obtained by using instruments and controls interfaced to mechanical, electrical, utility systems and other systems as shown and specified. All required setpoints, settings, alarm limits, and sequences of operation shall be as identified in the specifications. The number and location of control panels shown on drawings shall be provided as a minimum.

1.2.3 Control System Points

Inputs to and outputs from the control system shall be in accordance with the attached Input/Output (I/O) Summary. Each connected analog output (AO), analog input (AI), digital output (DO), digital input (DI), pulse accumulator (PA) input and other input or output device connected to the control system shall represent a "point" where referred to in this specification.

1.2.4 Symbols, Definitions, and Abbreviations

Symbols, definitions, and engineering unit abbreviations shall conform to IEEE Std 100, as applicable.

1.3 ENVIRONMENTAL CONDITIONS

The Main Control (I/O) Cabinet, HMI, and peripherals will be located in an air-conditioned control room environment. However, the equipment shall be able to operate safely and continuously within the specified accuracy and reliability's with the air conditioning/heating system out of service for a short duration (8 to 16 hours) with the approximate extreme conditions indicated below.

	Normal Conditions	Extreme Conditions
Temperature	70 to 78 degrees F	5 to 100 degrees F
Humidity (non-condensing)	60% RH	5 to 100% RH

1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation; GA
Wiring; GA

Detail drawings containing wiring, schematic, flow diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall include, as appropriate: product specific catalog cuts; a drawing index; a list of symbols; a series of drawings for each control system using abbreviations, symbols, nomenclature and identifiers as shown.

SD-03 Product Data

Instrumentation and Control System; GA

Manufacturer's descriptive and technical literature, performance charts and installation instructions. Product specific catalog cuts shall be in booklet form, indexed to the unique identifiers, and shall consist of data sheets that document compliance with the specification. Where multiple components are shown on a catalog cut, the application specific component shall be marked.

Meters and Sensors; GA

Manufacturer's descriptive and technical literature, catalog cuts, performance charts and installation instructions.

Training Manual; GA

Instruction manual within 60 days of Notice to Proceed.

Performance Verification Test (PVT); GA

The performance verification test procedure; it shall refer to the actions and expected results to demonstrate that the control system performs in accordance with the sequence of control. A list of the equipment to be used during the testing shall be included. The list shall also include manufacturer's name, model number, equipment function, the date of the latest calibration and the results of the latest calibration.

SD-06 Test Reports

Testing, Adjusting and Commissioning; GA
Performance Verification Test(PVT); GA

SD-07 Certificates

Sensor and Control Wiring; GA

SD-10 Operation and Maintenance Data

Instrumentation and Control System; GA

Six (6) complete copies of operating instructions outlining the step-by-step procedures required for system startup, operation and shutdown. The instructions shall include layout, wiring and control diagrams of the system as installed. The instructions shall include the manufacturer's name, model number, service manual, parts list and a brief description of all equipment and their basic operating features.

Six (6) complete copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs and trouble shooting guides.

1.5 EQUIPMENT REQUIREMENTS

1.5.1 Materials and Equipment

Materials and equipment shall be standard unmodified products of a manufacturer regularly engaged in the manufacturing of such products. Units of the same type of equipment shall be products of a single

manufacturer. Items of the same type and purpose shall be identical and supplied by the same manufacturer, unless replaced by a new version approved by the Contracting Officer.

1.5.2 Nameplates

Each major component of equipment shall have the manufacturer's name and address, and the model and serial number in a conspicuous place. Laminated plastic nameplates shall be provided for equipment devices and panels furnished. Each nameplate shall identify the device, such as pump "P-1" or valve "VLV-402". Labels shall be coordinate with the schedules and the process and instrumentation drawings. Laminated plastic shall be 1/8 inch thick, white with black center core. Nameplates shall be a minimum of 1 by 3 inches with minimum 1/4 inch high engraved block lettering. Nameplates for devices smaller than 1 by 3 inches shall be attached by a nonferrous metal chain. All other nameplates shall be attached to the device.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

Electrical equipment will conform to Section 16415 ELECTRICAL WORK, INTERIOR. Equipment and wiring must be in accordance with NFPA 70, with proper consideration given to environmental conditions such as moisture, dirt, corrosive agents, and hazardous area classification.

2.2 MONITORING AND CONTROL PARAMETERS

The control system shall be complete including sensors, field preamplifiers, signal conditioners, offset and span adjustments, amplifiers, transducers, transmitters, control devices, engineering units conversions and algorithms for the applications; and shall maintain the specified end-to-end process control loop accuracy from sensor to display and final control element. Control equipment shall be powered by a 120 vAc, single phase, 60 Hz power source, with local transformers included as needed for signal transmission and subsystem operation. Connecting conductors shall be suitable for installed service. Enclosures shall be rated for NEMA 12.

2.2.1 Transmitter

Unless indicated otherwise, each sensor shall be provided with a transmitter, selected to match the sensor. Except where specifically indicated otherwise on the drawings, the transmitter shall be provided with a four digit or analog visual display of the measured parameter and shall provide a 4 to 20 mAdc output signal proportional to the level of the measured parameter. Accuracy shall be plus or minus 1 percent of full scale reading with output error not exceeding plus or minus 0.5 percent of full scale. Transmitter shall be located where indicated, mounted integrally with the sensor, pipe mounted, wall mounted or installed in the control panel. The distance between the sensor and transmitter shall not exceed the manufacturer's recommendation. Field preamplifiers and signal conditioners shall be included when necessary to maintain the accuracy from sensor to the programmable logic controller or recorder.

2.2.2 Liquid Service

Sensors and meters in liquid service shall be rated for continuous duty service at fluid approach velocities from 2.5 ft/s to 10 ft/s with

correspondingly higher constriction velocities over a fluid temperature range from 32 degrees F to 120 degrees F at pressures up to 150 psi gage.

2.2.3 Flow Sensor

Liquid flow indication shall be provided in gallons per minute (gpm). Vapor flow indication shall be provided in cubic feet per minute. Pressure taps shall incorporate appropriate snubbers. Unless indicated otherwise, the flow transmitter shall produce a signal that is proportional to the volumetric flow rate, compensated for fluid temperature, and shall have an accuracy of plus or minus 1 percent of full flow. Flow transmitter shall be located within 15 feet of the flow element. The flow transmitter shall include a digital readout of the volumetric flow rate to 3 significant figures. The transmitter shall provide a 4-20 mAdc output signal to the programmable logic controller, proportional to the measured parameter.

2.2.3.1 Flow Nozzle

Flow nozzle shall be made of austenitic stainless steel. The inlet nozzle form shall be elliptical and the nozzle throat shall be the quadrant of an ellipse. The thickness of the nozzle wall and flange shall be such that the accuracy will not be degraded by distortion of the nozzle throat from strains caused by the pipeline temperature and pressure, flange bolting, or other methods of installing the nozzle in the pipeline. The outside diameter of the nozzle flange or the design of the flange facing shall be such that the nozzle throat shall be centered accurately in the pipe.

2.2.3.2 Flow Switch

Flow switch shall have a repetitive accuracy of plus or minus 10 percent of actual flow setting. Switch actuation shall be adjustable over the operating flow range. Flow switch for use in contaminated water system shall be rated for use and constructed of suitable materials for installation in the environment encountered. The flow switch shall have non flexible paddle with Form C snap action contacts, rated in accordance with NEMA ICS 1.

2.2.3.3 Magnetic Flowmeter

Magnetic flowmeter shall be non-intrusive and shall measure fluid flow through the use of a self generated magnetic field. The magnetic flow element shall be encapsulated in type 300 stainless steel. Flowmeter shall be capable of measuring clean or dirty flow up to a maximum flow velocity of 10 fps. The metering tube shall be constructed of 316 stainless steel. The maximum pressure drop across the meter and appurtenances shall be 5 psi at the maximum flow rate.

2.2.3.4 Positive Displacement Flowmeter

Output accuracy shall be plus or minus 2 percent of the flow range. The flow meter shall be a direct reading, gerotor, nutating disk or vane type displacement device rated for liquid service. A counter shall be mounted on top of the meter, and shall consist of a non-resettable mechanical totalizer for local reading, and a pulse transmitter for remote reading. The totalizer shall have a six digit register to indicate the volume passed through the meter in gallons. A sweep-hand dial will indicate down to 1 gallon. The pulse transmitter shall have a hermetically sealed reed switch which is activated by magnets fixed on gears of the counter. The meter shall have a bronze body with threaded or flanged connections as required

for the application. The maximum pressure drop at full flow shall be 5 psi gage.

2.2.4 Level Instrumentation

Pressure taps shall incorporate appropriate snubbers. Relays and housing shall be intrinsically safe or explosion proof as required by the NFPA hazard rating for compatibility with the contents of the tank or sump. The transmitter shall provide a 4-20 mAdc output signal to the programmable logic controller, proportional to the measured parameter.

2.2.4.1 Capacitance Type Level Sensor

Liquid level sensor shall produce a signal that is proportional to the measured level. Sensor shall be capacitance type. The transmitter shall have non-interacting zero and span adjustments, and shall have an accuracy of plus or minus 0.1 percent of calibrated span. Assemblies shall include wall bracket or mounting plate, austenitic stainless steel rods, stainless steel bolts and corrosion resistant housing.

2.2.4.2 Conductivity Switch

The switch shall detect the presence of a fluid by measuring the electrical resistance between a sensor and a ground electrode. Electrodes shall be constructed of 316 stainless steel. Electrodes shall be fully clad using polytetrafluoroethylene (PTFE). The conductivity switch shall be capable of 4 separate level set points. The switch shall be provided with a ground electrode. Electrode lengths shall be as necessary, based on the application and to meet the requirements of the control sequence. A relay switching point shall be provided for each sensor. Contacts shall be rated for a maximum of 240 vAc, 5 A. Switch shall have a maximum response time of 2 seconds. Assembly shall be flange mounted and suitable for the indicated environment.

2.2.4.3 Displacement Type Level Switch

Liquid level switch shall be displacement type, having a minimum of two tandem floats with each float independently activating a set of Form C contacts at two different level settings. Each switch shall have a narrow differential band. The mounting connections shall be threaded, flanged or surface mounted to suit the application. All surfaces in contact with the tank contents shall be austenitic stainless steel. The switch enclosure shall be explosion proof for use in a hazardous environment, complete with a sealed water tight junction box, terminal block, and mounting plate. Each set of contacts shall be snap action, dry contact type with one normally open and one normally closed, contact rated in accordance with NEMA ICS 1. The switch shall be actuated by a magnetically equipped stainless steel displacer. Repetitive accuracy shall be plus or minus 1/4 inch of actual displacer setting.

2.2.4.4 Mercury Float Switch

Float switch assemblies for use in liquid systems shall consist of wall bracket or mounting plate, galvanized steel rods, stainless steel bolts, explosion proof and corrosion resistant housing, and intrinsically safe relays. Each switch shall consist of two normally open mercury switches, encapsulated in epoxy resin. The float casing shall be polypropylene. The switch cable shall be oil resistant thermoplastic cable with 4 No. 18 gauge stranded copper conductors, rated for 600 Volt application.

2.2.4.5 Ultrasonic Sensor

The sensor shall be microprocessor based and shall provide continuous, non-contact level measurement of liquids and solids utilizing microwave pulsed time of flight measurement method. The sensor shall operate in a frequency band approved for industrial use. The sensor shall be capable of measuring in a range of 0 to 20 feet with an accuracy of plus or minus 1 percent of full scale. The sensor shall be capable of distinguishing between real echoes, reflections and background noise. The sensor shall automatically compensate for temperature changes. The sensor shall be capable of operating in a temperature range from minus 15 degrees F to 105 degrees F. Assembly shall be flange mounted of sufficient size to eliminate echoing and suitable for the installed environment indicated. Mounting assembly shall be suitable for service without requiring entry or drainage of the vessel where level is being measured.

2.2.5 Pressure Instrumentation

Pressure taps shall incorporate appropriate snubbers. The controller shall provide a 4-20 mAdc output signal to the programmable logic controller, proportional to the measured parameter. The controller shall be provided with an internal battery to maintain operation for a minimum of 12 hours if power is lost. Pressures shall be controlled to within plus or minus 5 percent of design pressures.

2.2.5.1 Pressure Sensor

The sensing element shall be either capsule, diaphragm, bellows, Bourdon tube, or solid state as applicable for the installation. The pressure transducer shall withstand up to 300 percent of rated pressure, with an accuracy of plus or minus 1.0 percent of full scale selected to put the design range of the measured pressure in the middle third of the transducer's range. Pressure shall be measured in pounds per square inch (psi) gage with a range, plus or minus 10 percent of design range. The transmitter output error shall not exceed 0.1 percent of calibrated span.

2.2.5.2 Pressure Switch

Sensors shall be diaphragm or Bourdon tube and shall be constructed of 316 stainless steel. Pressure switch shall have a repetitive accuracy of plus or minus 5.0 percent of the operating range and shall withstand up to 150 percent of rated pressure. Switch actuation set point shall be adjustable over the operating pressure range with a differential adjustment span of 20 to 40 percent of the range of the switch. The switch shall have Form C snap-action contacts rated in accordance with NEMA ICS 1.

2.2.5.3 Differential Pressure

The sensor/transmitter assembly accuracy shall be plus or minus 2 percent of full scale. The over pressure rating shall be a minimum of 300 percent of the operating pressure. Transmitter shall be suitable for installation with the low pressure connection removed.

2.2.5.4 Differential Pressure Switch

Each switch shall be an adjustable diaphragm, or bellows operated device, with taps for sensing lines for connection of pressure fittings designed to sense fluid pressure. The adjustable differential range shall be a maximum

of 0.5 inches water at the low end to a minimum of 6.0 inches water at the high end. Two Form C contacts rated in accordance with NEMA ICS 1 shall be provided.

2.2.6 Process Analytical Instrumentation

Probes shall be easily removable without interrupting service. Sampling pumps shall be included where necessary or applicable to the sensing device. For sensors integral to the electronic controller the sample may be drawn directly into the sensor or may be drawn through a sample tube. For sensors remotely located the sample may be drawn through a sample tube. Outdoor sample tubes shall be heat traced. Sensor and controller construction shall be suitable for operation in the monitored medium. The controller shall be provided with a minimum of two alarm lights. The first alarm light shall indicate when the lower (warning) detection level has been exceeded. The second alarm light hall indicate when the upper (alarm) detection level has been exceeded. The alarm levels shall be individually adjustable. The controller shall be provided with an audible warning horn that sounds when the upper detection level has been exceeded, and a warning horn silence button. The controller shall provide a 4-20 mAdc output signal to the programmable logic controller, proportional to the measured parameter. The controller shall be provided with an internal battery to maintain operation for a minimum of 12 hours if power is lost.

2.2.6.1 Water Turbidity

System shall be complete and include indicating meter, sensing element and a transmitter. System shall be industrial grade and suitable for measurement of turbidity by insertion of the sensing element into the pipeline, using a hot tap assembly. Sensor assembly shall be suitable for periodic removal for adjustment and cleaning without requiring shutdown of the process. Sensor shall be suitable for range from 0 to 200 Nephelometric turbidity units (NTU). The accuracy shall be plus or minus 2 percent of full scale reading. Range shall be field verified for the application and adjusted as required. Sensing element shall be constructed of 316 stainless steel and glass. Sensing element shall be unaffected by color in the fluid, pressure, temperature and rate of flow. Sensor shall have automatic zeroing and shall require no normal maintenance or periodic recalibration.

2.3 COMPRESSED AIR STATIONS

2.3.1 Air Compressor Assembly

The air compressor shall be a high-pressure compressing unit with electric motor. The compressor shall be equipped with a motor with totally enclosed belt guard, an operating-pressure switch, safety relief valves, gauges, intake filter and intake silencer and combination type magnetic starter with under voltage protection and thermal overload protection for each phase, and shall be supported by a steel base mounted on an air storage tank. The air compressor shall provide the compressed air required for control operation while operating not more than one-third of the time. The tank shall be of sufficient volume so that no more than six compressor starts per hour are required with the starting pressure switch differential set at 20 psi gage. The air storage tank shall be fabricated for a working pressure of not less than 200 psi gage and constructed and certified in accordance with ASME BPV VIII Div 1. The tank shall be provided with an automatic condensate drain trap with manual override feature.

2.3.2 Compressed Air Station Specialties

2.3.2.1 Refrigerated Dryer, Filters and Pressure Regulator

A refrigerated dryer shall be provided in the air outlet line of the air storage tank. The dryer shall be of the size required for the full delivery capacity of the compressor. The air shall be dried at a pressure of not less than 70 psi gage to a temperature not greater than 35 degrees F. The dryer shall be provided with an automatic condensate drain trap with manual override feature. The refrigerant used in the dryer shall be one of the fluorocarbon gases and have an ozone depletion potential of not more than 0.05. A 5 micron prefilter and coalescing-type oil removal filter with shut-off valves shall be provided in the dryer discharge. Each filter bowl shall be rated for 150 psi gage maximum working pressure. A pressure regulator with high side and low side pressure gauges and a safety valve shall be provided downstream of the filter. Pressure regulators of the relieving type shall not be used.

2.3.2.2 Coalescing Filter

A coalescing prefilter, together with an automatic drain valve, shall be provided for removal of liquids. The flow through the prefilter shall be from inside to outside and reduce an entrained quantity of 50 ppmv oil to 0.0013 ppmv effluent liquid oil and water and remove all particulates greater than 0.6 micron absolute. The prefilter housing (bowl) shall be fitted with a drain port to eliminate collected liquids and provide sufficient sump volume to prevent liquid re-entrainment, and an automatic drain valve with adjustable cycle and drain times. Prefilter pressure drop shall be less than 3 psi saturated. A particulate after filter, outside to inside flow, designed to remove desiccant fines shall be provided. The after filter cartridge shall have a particulate removal rating of 0.5 micron absolute. Both prefilter and after filter housings shall allow for service of elements without removing the entire assembly from the system. Filter life shall be stated and guaranteed by the vendor.

2.3.2.3 Flexible Pipe Connections

The flexible pipe connectors shall be designed for 150 psi gage and 250 degrees F service and shall be constructed of rubber, polytetrafluoroethylene (PTFE) resin or braided corrosion-resistant steel, bronze, monel or galvanized steel. The connectors shall be suitable for the service intended and may have threaded or soldered ends. The length of the connectors shall be as recommended by the manufacturer for the service intended.

2.3.2.4 Vibration Isolation Units

The vibration isolation units shall be standard products with published loading ratings and shall be single rubber-in-shear, double rubber-in-shear or spring type.

2.3.2.5 Compressed Air Piping

Control air delivered to the system shall conform to ISA S7.0.01. Air lines for pneumatic controls shall be seamless copper tubing or nonmetallic tubing. Nonmetallic tubing shall be compounded from polyethylene. Air lines concealed in walls shall be hard-drawn copper tubing or nonmetallic tubing in rigid conduit. Terminal single lines shall be hard-drawn copper tubing except when the run is less than 12 inches in length, flexible

polyethylene may be used. Nonmetallic tubing will not be used for applications where the tubing could be subjected to a temperature exceeding 130 degrees F. Fittings for nonmetallic tubing shall be for instrument service and may be brass or acetyl resin of the compression or barbed push-on type. Tubing shall be as follows:

a. Copper tubing shall conform to ASTM B 88 and shall have sweat fittings and valves. Exposed tubing shall be hard drawn in exposed areas and hard-drawn or annealed in concealed areas. Only tool made bends shall be used. Fittings for copper tubing shall be brass or copper solder joint type except at connections to the apparatus, where fittings shall be brass compression type. Tubing shall be rack mounted where multiple tubes run in parallel. Multiple tubes may be bundled when concealed.

b. Tubing shall be flame resistant, multiple polyethylene tubing in an extruded PVC protective sheath, or unsheathed polyethylene tubing in rigid metal, intermediate metal, or electrical metallic tubing conduit for areas where tubing is exposed. Tubing shall have barbed fittings and valves, and shall conform to the following: Burst pressure shall be 550 psi gage at 75 degrees F to 175 psi gage at 150 degrees F, mini mum. Stress crack resistance in accordance with ASTM D 1693 shall be 200 hours, minimum. Tensile strength in accordance with ASTM D 638 shall be 2000 psi, minimum. Average density in accordance with ASTM D 792 shall be 57 pounds per cubic foot. Average flow rate in accordance with ASTM D 1238 shall be 0.30 decigram per minute.

c. Plastic tubing shall have the burning characteristics of linear low density polyethylene tubing, shall be self extinguishing when tested in accordance with ASTM D 635, shall have UL 94 V-2 flammability classification, and shall withstand stress cracking when tested in accordance with ASTM D 1693. Polyethylene tubing shall not be used for smoke removal systems.

2.3.3 Barrier Jacket

Plastic tubing bundles shall be provided with mylar barrier and flame retardant polyethylene jacket. Each tube shall be numbered.

2.4 PROGRAMMABLE LOGIC CONTROLLER (PLC)

2.4.1 PLC General Requirements

PLCs shall be micro-processor based, capable of receiving discrete and analog inputs and, through programming, shall be able to control discrete and analog output functions, perform data handling operations and communicate with external devices. PLCs shall meet the requirements of Class A computing devices, and shall be labeled as set forth in 47 CFR 15 and shall be able to withstand conducted susceptibility test as outlined in NEMA ICS 1, NEMA ICS 2, NEMA ICS 3, and IEEE C37.90.1. PLCs shall function properly at temperatures between 32 and 122 degrees F at 5 to 95 percent relative humidity non-condensing and shall tolerate storage temperatures between minus 40 and plus 140 degrees F at 5 to 95 percent relative humidity non-condensing.

2.4.2 Modular PLC

PLCs shall be based on a modular, field expandable design allowing the

system to be tailored to the process control application. The system shall be expandable through the use of additional hardware and/or user software. As a minimum, the PLC shall include a mounting backplane, power supply module, central processing unit (CPU) module, communications module, and input/output (I/O) module. The modules shall be grouped together in a mounting rack or cabinet. The mounting rack backplane shall provide the communications mechanism to fully integrate the individual modules located within the rack. Modules shall plug directly into the backplane. The use of wire connectors between modules will not be allowed. The rack size shall be as needed to hold the equipment necessary while performing the required control functions. The system configuration shall allow for the removal and/or installation of modules under power.

2.4.2.1 Central Processing Unit (CPU) Module

The CPU module shall be a self contained, microprocessor based unit that provides time of day, scanning, application (ladder rung logic) program execution, storage of application programs, storage of numerical values related to the application process and logic, I/O bus traffic control, peripheral and external device communications and self diagnostics.

2.4.2.2 Communications Module

The communications module shall allow peer-to-peer communication with other PLCs and shall allow the PLC to communicate with the central station, or workstation. The communication module shall utilize the manufacturer's standard communication architecture and protocol, ethernet architecture and protocol or a combination of these. The communication module shall allow programming of the PLC to be done locally through the use of a laptop computer or from the central station or remote workstation.

2.4.2.3 Power Supply Module

One or more power supply modules shall be provided as necessary to power other modules installed in the same cabinet. Power supply modules shall plug directly into the backplane. Auxiliary power supplies may be used to supply power to remote cabinets or modules.

a. Power supply modules shall use AC power with a nominal voltage of 120 vAc plus or minus 5 percent. The power supply module shall monitor the incoming line voltage level and shall provide over current and over voltage protection. If the voltage level is detected as being out of range the power supply module shall continue to provide power for an adequate amount of time to allow for a safe and orderly shutdown. Power supply modules shall be capable of withstanding a power loss for a minimum of 20 milliseconds while still remaining in operation and providing adequate power to all connected modules.

b. Each power supply module shall be provided with an on-off switch integral to the module. If the manufacturer's standard power supply module is not provided with an on-off switch, a miniature toggle type switch shall be installed near the PLC and shall be clearly labeled as to its function.

c. Power supply modules shall be provided with an indicating light which shall be lit when the module is operating properly.

2.4.2.4 Input/Output (I/O) Modules

Modules shall be self contained, microprocessor based units that provide an interface to field devices. The module shall be located in the same mounting rack as the other PLC components. The unit shall plug directly into the backplane of the mounting rack. Each module shall contain visual indication to display the on-off status of individual inputs or outputs.

2.4.3 Program Storage/Memory Requirements

The CPU shall utilize the manufacturer's standard non-volatile memory for the operating system. The controller shall have electronically erasable, programmable, read only memory (EEPROM) for storage of user programs and battery backed RAM for application memory. The EEPROM shall be loaded through the controller keypad, central station or through the use of a laptop computer. The CPU memory capacity shall be based on the system's control requirements. The memory capacity shall be sized such that, when the system is completely programmed and functional, no more than 50 percent of the memory allocated for these purposes is used.

2.4.4 Input/Output Characteristics

Each controller shall allow for analog input, analog output, discrete input and discrete output. The number and type of inputs and outputs for the system shall be as shown on the drawings and shall comply with the sequence of control. The system capacity shall include a minimum of 20 percent spare input and output points (no less than two points) for each point type provided. During normal operation, a malfunction in any input/output channel shall affect the operation of that channel only and shall not affect the operation of the CPU or any other channel. Analog input circuits shall be available in 4-20 mA. Discrete input circuits shall be available in 79-132 vAc. All input circuits shall have a minimum optical isolation of 1500 VRMS and shall be filtered to guard against high voltage transients from the externally connected devices. Analog output circuits shall be available in 4-20 mA. Discrete output circuits shall be available in 79-132 vAc. All output circuits shall have a minimum optical isolation of 1500 VRMS and shall be filtered to guard against high voltage transients from the externally connected devices.

2.4.5 Wiring Connections

Wiring connections shall be heavy duty, self lifting, pressure type screw terminals to provide easy wire insertion and secure connections. The terminals shall accept two #14 AWG wires. A hinged protective cover shall be provided over the wiring connections. The cover shall have write-on areas for identification of the external circuits.

2.4.6 On-Off Switch

Each controller shall be provided with an integral on-off power switch. If the controller is not provided with a manufacturer's standard on-off switch, a miniature toggle type switch shall be installed in the control panel near the controller and shall be clearly labeled as to its function.

2.4.7 Diagnostics

Each PLC shall have diagnostic routines implemented in firmware. The CPU shall continuously perform self-diagnostic routines that will provide information on the configuration and status of the CPU, memory, communications and input/output. The diagnostic routines shall be

regularly performed during normal system operation. A portion of the scan time of the controller shall be dedicated to performing these housekeeping functions. In addition, a more extensive diagnostic routine shall be performed at power up and during normal system shutdown. The CPU shall log input/output and system faults in fault tables which shall be accessible for display. When a fault affects input/output or communications modules the CPU shall shut down only the hardware affected and continue operation by utilizing the healthy system components. All faults shall be annunciated at the PLC. Diagnostic software shall be useable in conjunction with the portable tester.

2.4.8 Accuracy

Controllers shall have an accuracy of plus or minus 0.25 percent of input span.

2.5 PLC SOFTWARE

All PLC software described in this specification shall be furnished as part of the complete control system.

2.5.1 Operating System

Each PLC shall be provided with the manufacturer's standard operating system software package. The PLC shall maintain a point database in its memory that includes all parameters, constraints and the latest value or status of all points connected to the PLC. Execution of the PLC application programs shall use the data in memory resident files. The operating system shall support a full compliment of process control functions. It shall be possible to define these functions using a mix of function blocks, ladder logic diagrams, sequential function charts and text programming. Programming methods and interactions shall be based on IEC 1131-3. A combination of the programming methods shall be possible within a single controller. The operating system shall allow loading of software locally or from the central station and data files from the portable tester. It shall also support data entry and diagnostics using an operator interface panel attached directly to the PLC. Each PLC shall be capable of operating in stand alone mode.

2.5.1.1 Startup

The PLC shall have startup software that causes automatic commencement of operation without human intervention, including startup of all connected I/O functions. A PLC restart program based on detection of power failure at the PLC shall be included in the PLC software. The restart program shall include start time delays between successive commands to prevent demand surges or overload trips.

2.5.1.2 Failure Mode

Upon failure for any reason, each PLC shall perform an orderly shutdown and force all PLC outputs to a predetermined (failure mode) state, consistent with the failure modes shown and the associated control device.

2.5.2 Functions

The controller operating system shall be able to scan inputs, control outputs, and read and write to its internal memory in order to perform the required control as indicated in the sequence of control on the drawings.

The controller shall periodically perform self diagnostics to verify that it is functioning properly.

2.5.2.1 Analog Monitoring

The system shall measure and transmit all analog values including calculated analog points.

2.5.2.2 Logic (Virtual)

Logic (virtual) points shall be software points entered in the point database which are not directly associated with a physical I/O function. Logic (virtual) points shall be analog or digital points created by calculation from any combination of digital and analog points, or other data having all the properties of real points, including alarms, without the associated hardware. Logic (virtual) points shall be defined or calculated and entered into the database by the Contractor. The calculated analog point shall have point identification in the same format as any other analog point.

2.5.2.3 State Variables

If an analog point represents more than two (up to 8) specific states, each state shall be nameable. For example, a level sensor shall be displayed at its measured engineering units plus a state variable with named states usable in programs or for display such as low alarm/low/normal/high/high alarm.

2.5.2.4 Analog Totalization

Any analog point shall be operator assignable to the totalization program. Up to eight analog values shall be totalized within a selectable time period.

2.5.2.5 Trending

Any analog or calculated point shall be operator assignable to the trend program. Up to eight points shall be sampled at individually assigned intervals, selectable between 1 minute and 2 hours. A minimum of the most recent 128 samples of each trended point shall be stored. The sample intervals shall be able to be defined, modified, or deleted online.

2.5.3 Alarm Processing

Each PLC shall have alarm processing software for AI, DI, and PA alarms for all real and virtual points connected to that PLC.

2.5.3.1 Digital Alarms

Digital alarms are those abnormal conditions indicated by DIs as specified and shown. The system shall automatically suppress analog alarm reporting associated with a digital point when that point is turned off.

2.5.3.2 Analog Alarms

Analog alarms are those conditions higher or lower than a defined value, as measured by an AI. Analog readings shall be compared to predefined high and low limits, and alarmed each time a value enters or returns from a limit condition. Unique high and low limits shall be assigned to each

analog point in the system. In control point adjustment (CPA) applications, key the limit to a finite deviation traveling with the setpoint. The system shall automatically suppress analog alarm reporting associated with an analog point when that analog point is turned off.

2.5.3.3 Pulse Accumulator (PA) Alarms

Pulse accumulator alarms are those conditions calculated from totalized values of accumulator inputs or PA input rates that are outside defined limits as specified and shown. PA totalized values shall be compared to predefined limits and alarmed each time a value enters a limit condition. Unique limits shall be assigned to each PA point in the system.

2.5.4 Constraints

2.5.4.1 Equipment Constraints Definitions

Each control point in the database shall have PLC resident constraints defined and entered by the Contractor, including as applicable: maximum starts (cycles) per hour; minimum off time; minimum on time; high limit (value in engineering units); and low limit (value in engineering units).

2.5.4.2 Constraints Checks

All control devices connected to the system shall have the PLC constraints checked and passed before each command is issued. Each command point shall have unique constraints assigned. High and low "reasonableness" values or one differential "rate-of-change" value shall be assigned to each AI. Each individual point shall be capable of being selectively disabled by the operator from the central station.

2.5.5 Control Sequences and Control Loops

Specific functions to be implemented are defined in individual system control sequences and database tables shown on the drawings, and shall include, as applicable, the following functions: PI control shall provide proportional control and proportional plus integral control; two position control shall provide control for a two state device by comparing a set point against a process variable and an established dead band; floating point control shall exercise control when an error signal exceeds a selected dead band, and shall maintain control until the error is within the dead band limits; signal selection shall allow the selection of the highest or lowest analog value from a group of analog values as the basis of control and shall include the ability to cascade analog values so that large numbers of inputs can be reduced to one or two outputs; signal averaging shall allow the mathematical calculation of the average analog value from a group of analog values as the basis of control and shall include the ability to "weight" the individual analog values so that the function output can be biased as necessary to achieve proper control; reset function shall develop an AO based on up to two AIs and one operator specified reset schedule.

2.5.6 Plant Control Logic

A description of the control logic for the water treatment system is provided in Attachment #1.

2.5.7 Command Priorities

A scheme of priority levels shall be provided to prevent interaction of a command of low priority with a command of higher priority. Override commands entered by the operator shall have higher priority than those emanating from applications programs.

2.5.8 Resident Application Software

The Contractor shall provide resident applications programs developed in accordance with paragraph Graphical Object Oriented Programming to achieve the sequences of operation, parameters, constraints, and interlocks necessary to provide control of the process systems connected to the control system. All application programs shall be resident in the PLC and shall execute in the PLC, and shall coordinate with each other, to insure that no conflicts or contentions remain unresolved.

2.5.8.1 Program Inputs and Outputs

The Contractor shall use program inputs listed for each application program to calculate the required program outputs. Where specific program inputs are not available, a "default" value or virtual point appropriate for the equipment being controlled and the proposed sequence of operation shall be provided to replace the missing input, thus allowing the application program to operate.

2.5.8.2 Failure Mode

In the event of a PLC failure, the controlled equipment shall continue to function in the failure mode shown on the drawings.

2.6 CONTROL PANELS

2.6.1 Components

2.6.1.1 Enclosures

The enclosure for each control panel shall conform to the requirements of NEMA 250 for the types specified. Finish color shall be the manufacturer's standard, unless otherwise indicated. Damaged surfaces shall be repaired and refinished using original type finish. Enclosures for installation in mechanical equipment rooms shall be Type NEMA 12; other locations shall be as otherwise specified or shown. Enclosures for equipment installed outdoors shall be Type 4 or as shown. Enclosure shall be provided with a single, continuously hinged exterior door with print pocket, 3-point latching mechanism and key lock and a single, continuously hinged interior door.

2.6.1.2 Controllers

Controllers shall be in accordance with paragraph Programmable Logic Controller (PLC).

2.6.1.3 Standard Indicator Light

Indicator lights shall comply with NEMA ICS 1, NEMA ICS 2 and UL 508. Lights shall be heavy duty, round and shall mount in a 0.875 inch mounting hole. Indicator lights shall be LED type and shall operate at 120 vAc or 24 vDc. Long life bulbs shall be used. Indicator light shall be provided with a legend plate labeled as shown on the drawings. Lens color shall be as indicated on the drawings. Lights shall be push to test (lamp) type.

2.6.1.4 Selector Switches

Selector switches shall comply with NEMA ICS 1, NEMA ICS 2 and UL 508. Selector switches shall be heavy duty, round and shall mount in a 0.875 inch mounting hole. The number of positions shall be as indicated on the drawings. Switches shall be illuminated. Switches shall be rated for 600 volts, 10 amperes continuous. Selector switches shall be provided with a legend plate labeled as shown on the drawings. Where indicated or required, dual auxiliary contacts shall be provided for the automatic position to provide position sensing at the central station or workstation. Auxiliary contacts shall be rated for 120 vAc, 1A as a minimum. Where indicated on the drawings, switches shall be key operated. All keys shall be identical.

2.6.1.5 Push Buttons

Push buttons shall comply with NEMA ICS 1, NEMA ICS 2 and UL 508. Push buttons shall be heavy duty, round and shall mount in a 0.875 inch mounting hole. The number and type of contacts shall be as indicated on the drawings or required by the Sequence of Control. Push buttons shall be rated for 600 volts, 10 amperes continuous. Push buttons shall be provided with a legend plate labeled as shown on the drawings.

2.6.1.6 Relays

Relays shall comply with IEEE C37.90. Relays shall be as required by the Sequence of Control. Relay coil shall be 120 vAc and shall be provided with matching mounting socket. Power consumption shall not be greater than 3 watts.

2.6.1.7 Terminal Blocks

Terminal blocks shall comply with NEMA ICS 4 and UL 1059. Terminal blocks for conductors exiting control panels shall be two-way type with double terminals, one for internal wiring connections and the other for external wiring connections. Terminal blocks shall be made of bakelite or other suitable insulating material with full deep barriers between each pair of terminals. A terminal identification strip shall form part of the terminal block and each terminal shall be identified by a number in accordance with the numbering scheme on the approved wiring diagrams.

2.6.1.8 Autodialer

Autodialer shall be a self contained, programmable device capable of automatic operation. The unit shall automatically dial preprogrammed number(s) to report alarm(s) or other specified conditions. The autodialer shall automatically redial upon receipt of a busy signal. The number of redials shall be an operator definable parameter. The unit shall be capable of dialing a minimum of three phone numbers. The unit shall communicate over voice grade phone lines.

2.6.1.9 Alarm Horns

Alarm horns shall be provided where indicated on the drawings. Horns shall be vibrating type and shall comply with UL 508. Horns shall provide 100 dB at 10 feet. Exterior mounted horns shall be weather proof by design or shall be mounted in a weather proof enclosure that does not reduce the effectiveness of the horn.

2.6.2 Panel Assembly

Control panels shall be factory assembled and shipped to the jobsite as a single unit. Panels shall be fabricated as indicated and devices shall be mounted as shown or required. Each panel shall be fabricated as a bottom-entry connection point for control system electrical power, control system wiring, communications system wiring to other control panels, and operators workstation.

2.6.3 Electrical Requirements

Each panel shall be powered by a dedicated 120 volts ac circuit, with a fuse, sized as recommended by the equipment manufacturer, and a disconnect switch located inside the panel. Wiring shall terminate inside the panel on terminal blocks. Electrical work shall be as specified in Section 16415 ELECTRICAL WORK, INTERIOR and as shown on the drawings.

2.6.4 Power Line Conditioner

Each control panel shall be provided with a power line conditioner to provide both voltage regulation and noise rejection. The power line conditioner shall be of the ferro-resonant design, with no moving parts and no tap switching, while electrically isolating the secondary from the power line side. The power line conditioner shall be sized for 125 percent of the actual connected kva load. Characteristics of the power line conditioner shall be as follows:

2.6.4.1 85 Percent Load

At 85 percent load, the output voltage shall not deviate by more than plus or minus 1 percent of nominal voltage when the input voltage fluctuates between minus 20 percent to plus 10 percent of nominal voltage.

2.6.4.2 Load Changes

During load changes of zero to full load, the output voltage shall not deviate by more than plus or minus 3 percent of nominal voltage. Full correction of load switching disturbances shall be accomplished within 5 cycles, and 95 percent correction shall be accomplished within 2 cycles of the onset of the disturbance.

2.6.5 Grounding

Control panel enclosures shall be equipped with a solid copper ground bus or equivalent. The ground bus shall be securely anchored to the enclosure so as to effectively ground the entire structure. Clamp-type terminals sized large enough to carry the maximum expected current shall be provided on the ground bus for grounding cables. Where a definite circuit ground is required, a single wire not less than #10 AWG shall run independently to the panel ground bus and shall be fastened to the ground bus with a bolted terminal lug. Cases of instruments, relays and other devices shall be effectively grounded through the enclosures steel structure unless otherwise indicated. Insulated wiring having a continuous rated current of not less than the circuit fuse rating shall be used for grounding. Grounding terminals of power receptacles shall be solidly grounded to the panel enclosure.

2.6.6 Convenience Outlet

A 120 volt ac, 20 amp, ground fault interruption (GFI) type duplex convenience outlet shall be provided inside the panel. The outlet circuit shall be separate from the panel power circuit.

2.6.7 Panel Interior Light

Eachcontrol panel shall be provided with a 60 watt incandescent light. The light shall be operated by a manual on-off switch mounted on the interior door of the enclosure. The light shall be powered by the same circuit as the convenience outlet.

2.7 CENTRAL STATION AND OPERATORS WORKSTATION EQUIPMENT

2.7.1 Central Station and Operators Workstation Computer

Computer shall be a standard desk top configuration, unmodified digital computer of modular design. Computing devices, as defined in 47 CFR 15, supplied as part of the control system shall be certified to comply with the requirements of Class B computing devices and shall be labeled as set forth in 47 CFR 15.

2.7.1.1 Minimum Processor Operating Speed

Minimum processor operating speed shall be 1 GHz.

2.7.1.2 RAM Memory

Ram memory shall be 128 MB, expandable to a minimum of 512 MB.

2.7.1.3 Minimum Power Supply

Minimum power supply shall have a capacity of 250 watts.

2.7.1.4 Real Time Clock (RTC)

Real time clock accurate to within plus or minus one minute per month. Battery backed for a minimum of 3 months.

2.7.1.5 Serial Ports

Two EIA ANSI/EIA/TIA-232-F ports. Data transmission rate shall be software adjustable between 9600 and 57,600 bps.

2.7.1.6 Parallel Port

One enhanced parallel port.

2.7.1.7 SVGA Color Monitor

SVGA color monitor shall be no less than 17 inches, with a minimum resolution of 1280 by 1024 pixels, noninterlaced, and a maximum dot pitch of 0.28 millimeters. The video output card shall support at least 256 colors at a resolution of 1280 by 1024 at a minimum refresh rate of 70 Hz.

2.7.1.8 Keyboard

A 101 key, 64 character standard ASCII character set based on ANSI X3.64 and ANSI X3.154.

2.7.1.9 Hard Disk

Hard disk with a minimum of 10 gigabytes of formatted storage.

2.7.1.10 Floppy Disk Drives

One high density floppy disk drive and controller in 3-1/2 inch diameter size shall be provided.

2.7.1.11 Zip Drive

One zip drive and controller with 100 megabyte of formatted storage shall be provided.

2.7.1.12 Modem

Modem shall operate on analog telephone lines 56K kbps, full duplex using asynchronous communications. It shall have an error detection, auto answer/autodial, and call progress detection. The modem shall meet the requirements of ITU V.42 bis for error correction and ITU V.42 bis for data compression standards. Model shall be suitable for operating on ISDN circuits in conformance with 47 CFR 68.

2.7.1.13 Mouse

Mouse: minimum resolution of 400 dots per inch.

2.7.1.14 CD Drive

CD drive: ROM with storage capacity of 650 megabytes of formatted storage, 40X speed.

2.7.1.15 Network Interface Card

Network interface card shall be provided for LAN equipment functions and for serving devices as shown on the drawings. The network interface card shall use a 16 bit interface to the data bus; it shall be supplied with an on-board RJ45 connector and transceiver for direct connection to the LAN. It shall also have an auxiliary unit input port for performing diagnostics. On-board buffer of at least 16K bytes shall be included to prevent the loss of data packages.

2.7.2 Printer

A laser printer shall installed at the central station computer. The printer shall meet the following requirements: The input interface shall be a parallel port connection. Resolution shall be a minimum of 600 by 600 dots per inch. Printing speed shall be a minimum of 4 pages per minute. The data buffer size shall be a minimum of 10 megabytes. The size for paper and other media shall be 8.5 X 11 inches. The paper cassette shall have a 250 sheet minimum capacity.

2.7.3 Uninterruptible Power Supply (UPS)

A self contained UPS suitable for installation and operation at the central station shall be provided. The unit shall be sized to provide a minimum of 10 minutes of operation of the central station computer. The UPS shall incorporate surge suppression, noise filtering (normal and common mode)

short circuit protection and voltage regulation (brownout and overvoltage protection). UPS shall be complete with all necessary power supplies, transformers, batteries, and accessories and shall include visual indication of normal power operation, UPS operation, abnormal operation and visual and audible indication of low battery power. The UPS shall comply with the Federal Communications Commission Standard 15J part A for radio noise emissions.

2.7.4 Portable Tester/Programmable Device

A portable tester/programmable device shall be provided and shall be connectable to any PLC. The portable tester/workstation shall consist of a portable computer with a nominal 10 inch active color matrix liquid crystal display, capable of displaying up to 256 colors at a minimum resolution of 640 x 480 pixels, 64 bit microprocessor operating at a minimum of 700 MHz. The portable tester/workstation shall have, as a minimum, 6 GB hard drive, 32 megabytes of memory, integral pointing device, serial and parallel ports, color VGA video port for an external color monitor, 3.5 inch floppy disk drive, modem, PCMCIA type 3 slot, rechargeable battery, battery charger and a compatible network adapter. The portable tester/workstation shall be provided with the proper cables, connectors, adapters and software required to connect to and be compatible with the PLCs. Connection may be made directly to the PLCs or to the communications network. The tester/work station shall be capable of performing all workstation functions contingent on proper password level. The communication and programmable device shall connect to the PLC directly for readout of variables, override, control, servicing, troubleshooting and adjustment of control parameters. The device shall communicate in English language for inquiry, reporting and programming purposes.

2.8 CENTRAL STATION SOFTWARE

The central station software shall provide the communication, programming and control capabilities necessary to support all specified points and functions, plus a minimum expansion of 50 percent of the current number of points, complete with their point database. The central station shall be online at all times and shall perform all required functions as specified. The central station software shall be one or more standard software modules. Where multiple modules are used the modules shall be capable of sharing data and operating together seamlessly. Software shall be windowing type using icons and pull down menus. The system shall support multiple user operation with multiple tasks for each user and shall support operation and management of all peripheral devices.

2.8.1 Graphical Operations

2.8.1.1 Graphical User Interface

The central station shall be provided with an object-oriented, mouse driven, graphical user interface. The graphical user interface shall include a set of desktop utilities including the following: file management; shell tool; calculator; text editor; and icon editor.

2.8.1.2 Display Information

The central station shall display information necessary to support all requirements specified, including: operator commands; alarm notification; reports; system graphics as specified and as shown, incorporating dynamic data; and curve plotting.

2.8.1.3 System Graphics Implementation

System graphics displays shall be hierarchical displays which integrate dynamic data into the display. System graphics shall reflect actual system configuration. Each system schematic shall be included as a separate display. Different colors, textures, and use of inverted video shall be used for various components and dynamic data. The displays shall include standard and/or custom symbols. A library of callable display symbols containing symbols for all necessary equipment and control devices shall be furnished. Symbols shall conform to ASHRAE Hdbk-IP where applicable. Data associated with a display shall be updated within 5 seconds of the digital status change or the analog change in excess of the analog change differential. Any dynamic data which is not current, due to PLC communications failure, PLC failure, or point out of service, shall be highlighted or flagged.

2.8.1.4 Display Editor

The display editor shall enable the user to create, modify, save and delete displays and symbols. Within the display shall be dynamic fields. The function of linking the dynamic fields with the database shall be handled by a separate software module which shall be executed automatically as the last step of the database generation and modification procedure.

2.8.1.5 Graphical Object Oriented Programming

The system shall include a graphical object oriented programming function which shall be used to create all control sequences utilized in the control panels. This function shall reside in the central station to create, modify, and test software for control panel resident programs. The graphical object oriented programming function shall provide programming elements to be connected together to create a logic diagram. The diagram shall be compilable to produce executable code for the control panel. The graphical object oriented programming function shall include elements necessary to create logic diagrams that represent sequences of operation. Program elements shall be able to be combined into a custom template which can then be used as a standard function. Program checkout and debug facilities shall include display of dynamic and/or simulated system variables and points on the programming screens. The user shall be able to fix or force values of variables to enable program checkout during debugging. The programming shall allow for the use of the portable tester for loading files directly into the control panel, uploading of existing control panel programming and database information and downloading of control panel programming and database information.

2.8.1.6 Charting

The user shall be able to display data in chart formats, and the system shall support the presentation of data: 1) with time on the X-axis (horizontal) and amplitude on the Y-axis (vertical) for trend charts; and 2) in bar chart form with a minimum of 360 15-minute divisions and 31 1-day divisions to be displayed on the X-axis.

2.8.1.7 System Menus and Displays

The user shall be able to call up the following displays by dedicated function key, pull down menu or by icon and shall be able to page forward and backward on linked multiple page displays. The system menu and index

displays shall also contain icons which can be used to call up subsequent displays.

a. System Menu (list of all graphics and menus).

b. Index (list of all PLCs).

c. Alarm Summary (list of all uncleared alarms).

d. Abnormal Summary (list of all devices not in normal state; keeps track of alarm conditions which have been cleared).

e. Data Communications Summary (listing of availability for each communication channel, by statistically processing the number of transmission errors, outages, and other abnormal conditions for each channel).

2.8.1.8 Hard-Copy Screen Request

The central station shall be able to obtain a hard copy of the monitor display being viewed. This shall be an exact "snapshot" of the data and device symbols shown on the selected monitor.

2.8.2 Command Software

The software shall provide for defining and selecting points, parameters, graphics, report generation, and all other functions associated with operation. The operator commands shall be usable from central station computer and workstation keyboards with individual operator passwords as specified.

2.8.2.1 Command Input

Command menus shall utilize full words and acronyms selected to allow operators to use the system without extensive training or data processing backgrounds. The system shall prompt the operator.

2.8.2.2 Command Input Errors

The system shall supervise operator inputs to ensure they are correct for proper execution. Operator input assistance shall be provided whenever a command cannot be executed because of operator input errors.

2.8.2.3 Special Functions

The system shall support the following special functions by using a mouse, in addition to all other commands specified:

a. Help shall produce a display of all commands available to the operator. The help command, followed by a specific command, shall produce context sensitive listing with a short explanation of the purpose, use, and system reaction to that command.

b. Start/Enable shall manually start equipment and enable monitoring and control of points.

c. Stop/Disable shall manually stop equipment and disable monitoring and control components.

d. Display Diagram shall display diagrams of specific utility systems or other systems.

e. Diagram Development shall facilitate development of diagrams of specific utility systems or other systems.

f. Auto/Override shall override automatic operation of a point or return a point to automatic operation.

g. Print Report shall allow the operator to print reports.

h. Confirm Action shall allow the operator to confirm that the desired command sequence has been correctly entered and is to be executed.

i. Cancel Action shall perform the opposite function of the confirm action, at any time prior to executing confirm action.

j. Memo Pad shall allow the operator to create, store and retrieve pop-up notes.

2.8.2.4 Operator's Commands

The operator's commands shall provide the means for entry of control and monitoring commands, and for retrieval of information. The operator's commands shall perform such tasks as requesting a display of any digital, analog, or accumulator point, or any group of related points, startup and shutdown selected systems or devices, modifying, adjusting, enabling or defining a point or point parameters.

2.8.2.5 Level of Addressing

Four levels of addressing for identification shall be provided as follows:

a. Point. The individual sensor or control device within a unit.

b. Unit. The unit that a point is associated with, such as a blower.

c. Sub-system. The sub-system that a point is located in or near.

d. System. The system that a sub-system is located in or near.

2.8.2.6 System Access Control

A minimum of 4 passwords shall be usable with the control system software. The system shall maintain an ASCII disk file logging all operators logged onto the system, alarm acknowledgments, commands issued and all database modifications for each password. Each password shall be definable as to the functions that the operator can perform.

2.8.3 Alarms

The software shall notify an operator of the occurrence of an alarm condition. The control system alarm history shall be stored in an ASCII file and shall be recallable by the operator using the report generator. Alarm messages shall take precedence over other functions. A minimum of the most recent 25 system alarms shall be directly available at the central station computer. Operator acknowledgment of one alarm shall not be considered as acknowledgment of any other alarm nor shall it inhibit

reporting of subsequent alarms. Alarm data to be displayed and stored shall include: identification of the alarm; date and time to the nearest second of occurrence; device or sensor type; limit exceeded (if analog); engineering units; current value or status; alarm class; and alarm messages.

2.8.3.1 Digital Alarms

Digital alarms shall be subject to immediate reporting, within the alarm response time, at the central station.

2.8.3.2 Analog Alarms

These alarms shall be subject to immediate reporting, within the alarm response time, at the central station. The control panel analog readings shall be compared to predefined high and low limits, and alarmed to the central station each time a value enters or returns from a limit condition. The program shall automatically change the high or low limits, or both, of any analog point, based on time scheduled operations as specified, allowing for a time interval before the new alarm limit becomes effective. For those applications where setpoint adjustments are made, the alarm limit shall be keyed to a finite deviation traveling with the setpoint.

2.8.3.3 Alarm Messages

A unique message with a field of 60 characters shall be provided for each alarm. Assignment of messages to a point shall be an operator editable function. Secondary messages shall be assignable by the operator for printing to provide further information, such as telephone lists or maintenance functions, and shall be editable by the operator.

2.8.3.4 Alarm Classes

Classes of alarms, which will be identified for each item, include class 1 and class 2 alarm conditions. Class 1 (Critical) shall include display, print, and audible alarm at occurrence and at return-to-normal. Acknowledgment of class 1 alarms by the operator shall be required at occurrence and at return-to-normal. Class 2 (Informational) shall include display, print, and audible alarm at occurrence and at return-to-normal. No acknowledgment of class 2 alarms is required unless otherwise shown.

2.8.4 Pop-up Note Function

A pop-up note function shall be included with the central station, providing the operator a capability of noting any data which may be associated with alarms or with any other event. A note created by an operator shall be automatically called up when any other workstation calls up the associated point, alarm, or alarm summary. The pop-up note function shall also support free form entry of data which can be used by any workstation operators as general reminders or instructions.

2.8.5 Real Time Clock Synchronization

The system shall synchronize each central station computer, real time clock, within one second and at least once per day automatically, without operator intervention and without requiring system shutdown. The central station computer shall automatically initiate a call once per day to the NIST clock to obtain the correct time and date and update the real time clock. The central station computer shall generate a report showing the time difference.

2.8.6 System Reaction

Under system normal heavy load, no more than 10 seconds shall lapse from the time a digital status alarm or analog alarm occurs at a PLC until the change is displayed at the central station and operator's workstation. The total system response time from initiation of a control action command to display of the resulting status change shall not exceed 20 seconds under system normal heavy load conditions, assuming a zero response time for operation of the PLC's control device. The alarm printer shall continue to print out all occurrences, including time of occurrence, to the nearest second. All system normal heavy load conditions shall be introduced to the system via AIs and DIs.

2.8.6.1 Occurrence

System normal heavy load conditions are defined as the occurrence throughout the system of a total of three status changes, three digital alarms, three analog high or low limit alarms, and three analog quantity changes within the high and low limits during a single 1-second interval. This number of similar occurrences shall repeat on a continuous basis during successive 1-second intervals for a period of 2 minutes.

2.8.6.2 Location

System normal heavy load conditions, as specified, shall have 50% of the changes and alarms, including no less than one of each type, occurring at a single PLC with the remaining changes and alarms distributed among the remaining PLCs.

2.8.7 Report Generator

Software shall be provided to generate and format standard and custom reports for displaying, printing, and storing on disk. Reports shall use database values and parameters, values calculated using the real time static database or historical data base; with the reports subsequently stored on hard disk or zip drive. Dynamic operation of the system shall not be interrupted to generate a report. The report shall contain the time and date when the sample was taken, and the time and date when the report was printed.

2.8.7.1 Periodic Automatic Report

The system shall allow for specifying, modifying, or inhibiting the report to be generated, the time the initial report is to be generated, the time interval between reports, end of period, and the output peripheral.

2.8.7.2 Request Report Mode

The system shall allow for the operator to request, at any time, an immediate printout of any report.

2.8.8 Data Interchange

Software shall be provided to format and store on a removable diskette the data, trends, profiles, reports and logs as specified in a defined, standard format such as ASCII text or DIF for export and further processing by other software and/or computer systems.

2.8.9 Control Panel and DTS Circuit Alarms

The system shall supervise each control panel, I/O function and DTS circuit for alarm reporting, including: control panel not responding; control panel responding (return to normal); control panel to central station DTS circuit high error rate; control panel to control panel DTS circuit high error rate; control panel/central station real time clock error more than 15 seconds (adjustable); control panel intrusion alarm; control panel offline; control panel online (return to normal); control panel failure (self-diagnostics); point not responding to command; and point change of state without command.

2.8.10 Central Station Database

The central station database shall be stored on disk and in memory. The static database shall be downloadable as required to control panels in the system.

2.8.10.1 Database Definition Process

Software shall be provided to define and modify each point in the database using operator commands. The definition shall include all physical parameters and constraints associated with each point. Each database item shall be callable for display or printing, including EEPROM, ROM and RAM resident data. Each point shall be defined and entered into central station database by the Contractor.

2.8.10.2 Dynamic Database

The dynamic database includes those variables which change with time or conditions including all DIs, AIs, PAs, and virtual (logic) points.

2.8.10.3 Dynamic Database Update

The dynamic database shall be updated from the field, allowing the operator to select update times from 0.1 seconds to 2.0 seconds.

2.8.10.4 Static Database

The static database includes those fixed parameters and constraints from all PLCs which define the characteristics of the system and I/O functions such as alarm limits, start/stop times, point names, PLC channel addresses, and sensor spans.

2.8.10.5 Central Station Static Database Update

A copy of each control panels static database shall be updated automatically once per day, each time an authorized change is submitted or upon demand from the central station database.

2.8.10.6 Workstation Access to Dynamic Data

Any workstation with proper access password and connected to the central station via the DTS, or via a dial-up telephone circuit, shall have access to the central station's dynamic data. Display of data shall commence within 5 seconds.

2.8.11 Historical Data Storage and Retrieval

A historical data storage and retrieval function shall be provided at the central station to collect and store dynamic data. This function shall be in addition to other data storage requirements. The function shall have the capability to collect and store alarm status changes, point values, events and operator commands, and system responses. The storage function shall also have the capability to collect and store multiple sets of analog data at pre-specified sampling rates. This function shall have the capability to retain historical data on hard disk for pre-specified time periods, up to forty five days using last day roll over, for short-term analysis, and then output the data to the zip drive for long-term retention. The operator shall also be able to selectively recall short-term data stored on hard disk. Retrieval and printing of the contents of any selected historical data file shall be available using the data retrieval and report generation program. The output of the report generation program shall be capable of being viewed on the screen, printed in a report, or stored.

2.8.12 Trending

Any analog or calculated point shall be operator assignable to the trend program. Points shall be sampled at individually assigned intervals, selectable between one minute and 24 hours. The system shall automatically store the accumulated trend data to an ASCII disk file. The size of the trend data file shall be limited only by available disk space. The program shall print portions of the file as selected by the operator.

2.8.13 Analog Monitoring

The system shall measure, transmit, and display analog values, including calculated analog points. Differential measurements shall be displayed as positive or negative values with respect to their reference points shown. An analog change in value is defined as a change exceeding a preset differential value as specified. Each analog change in value shall be operator selectable and settable to provide for a minimum reporting change in value of one-half the specified end-to-end accuracy of the measured variable. Displays and reports shall express analog values in proper engineering units with sign. The Contractor shall provide 128 different sets of engineering unit conversions. Each engineering conversion unit shall include range, span, and conversion equation.

2.8.14 Analog Totalization

Any analog or calculated point shall be operator assignable to the totalization program. The analog totalization time period shall be defined uniquely for each point. At the end of the period, totals shall be stored on disk for future reference. Totalization shall then restart from zero for the next time period. The program shall keep track of the peak and total value measured during the current period and for the previous period. The operator shall be able to initiate a summary of totalization information on a point, unit, sub-system or system. The operator shall be able to set or reset each totalized value individually. The operator shall be able to define, modify, or delete the time period online.

2.8.15 LAN Software

A network operating system shall be supplied as part of the LAN software. The network operating system shall support network device access to the central station. The system shall provide workstation access to the central station as a virtual terminal. The network shall provide network

access to shared peripherals. The LAN software shall provide for transparent communication with any node on the system. The LAN software shall support the following:

2.8.15.1 Access Control

Access control to the central station computer and workstations. Operators shall be able to perform all specified functions, given the proper passwords, including database definition/modification, graphic creation/modification, and trending.

2.8.15.2 Multiple Sessions

Support operation in multiple sessions.

2.8.15.3 Other Functions and Configurations

Other functions and configurations shown.

2.9 DATA COMMUNICATION REQUIREMENTS

Control system data communications shall support the specified functions and control system configuration shown on the drawings.

2.9.1 Central Station/Workstation

Each workstation shall be able to communicate with the central station as a virtual terminal. The workstation shall be able to initiate uploads or downloads of programs and resident data, including parameters of connected systems PLCs and devices, constraints and programs in the central station.

2.9.2 Central Station/PLC

The central station shall be able to initiate an upload or download of PLC data programs.

2.9.3 Modem Communication

Communication with other computer systems shall be accomplished using a modem and dialup circuit. The central station or workstation shall be able to initiate upload or download of data files, however, answering incoming calls shall not be possible (for system security reasons).

2.9.4 Error Detection and Retransmission

Asynchronous transmission system shall use cyclic code error detection methods. The predicted undetected error rate shall not exceed 1 bit in 1 billion. A message shall be in error if one bit is received incorrectly. The system shall retransmit messages with detected errors. Where a LAN is not utilized for data transmission, a 2-digit decimal number shall be operator assignable to each communication link representing the number of retransmission attempts. When the number of consecutive retransmission attempts equals the assigned quantity, the central station shall close down transmission to that particular device, and print an alarm message. The operator shall manually reopen any communications line after automatic closedown, subject to the same error checking and automatic closedown procedures in effect before the first automatic closedown. The system shall monitor the frequency of data transmission errors for display and logging.

2.10 CONSUMABLE SUPPLIES

The Contractor shall provide the following consumable supplies, after the endurance test, to the Contracting Officer. These extraordinary supplies shall not be used during system installation or testing.

CONSUMABLE SUPPLIES

blank zip cartridges	10 each
diskettes 3-1/2 inch	2 boxes of 10 each
laser printer toner cartridges	2 each
color printer ink cartridges	2 per color
dot matrix printer ribbons	2 each
color printer paper	2 boxes
alarm printer fanfold paper	1 box

2.11 FACTORY TEST

The control system shall be tested at the factory prior to shipment. Certification of a comprehensive Y2K compliance testing program is required. Written notification of planned testing shall be given to the Contracting Officer at least 21 days prior to testing, and in no case shall notice be given until after the Contractor has received written approval from the Contracting Officer of the test procedures.

2.11.1 Factory Test Setup

The Contractor shall assemble and integrate the factory test setup as specified to prove that performance of the system satisfies all requirements of this project, including system communications requirements in accordance with the approved test procedures. The factory test shall take place during regular daytime working hours on weekdays. Equipment used shall be the same equipment that is to be delivered to the site. The factory test setup shall include the following:

	Factory Test
central station equipment	one each of the components
workstation	one of each type
control panel	not less than two control panels: at least one of each type used in the system plus at least one per DTS type
test set	one of each type
portable tester	one of each type
communications circuits	one of each type and speed to be utilized in the proposed system including bridges, modems, encoder/decoders, transceivers and

	Factory Test
	repeaters.
surge protection equipment	for power, communications, I/O functions and networks
I/O functions	sufficient to demonstrate the I/O capability and system normal operation
software	software required for proper operation of the proposed system including application programs and sequences of operation

2.11.2 Factory Test Procedure

Test procedures shall define the tests required to ensure that the system meets technical, operational, and performance requirements. The test procedures shall define location of tests, milestones for the tests, and identify simulation programs, equipment, personnel, facilities, and supplies required. The test procedures shall provide for testing all control system capabilities and functions specified and shown. The procedures shall cover actual equipment and sequences to be used by the Contractor for the specified project and shall consist of detailed instructions for test setup, execution, and evaluation of test results. The test reports shall document results of the tests. Reports shall be delivered to the Contracting Officer within 7 days after completion of each test. Surge testing need not be conducted if the Contractor can provide acceptable documented proof that such testing has been satisfactorily demonstrated to the Contracting Officer with identical surge protection applied. The procedures shall include the following:

	Test Procedure
equipment	block diagram
hardware and software	descriptions
commands	operator commands
I/O functions	test database points with failure modes
passwords	required for each operator access level
each type of digital and analog point in the test database	description
test equipment	list
surge protection	circuit diagrams
inputs required (I/O point values and status) and corresponding expected results of each set of input values	for each application program
default values	for the application program inputs not implemented or provided for in the contract

Test Procedure

documents for the application programs to be tested.

2.11.3 Factory Test Report

Original copies of data produced during the factory test, including results of each demonstration procedure, shall be delivered to the Contracting Officer at the conclusion of the test, prior to Government approval of the factory test. The report shall be arranged so that commands, responses, and data acquired are correlated to allow logical interpretation of the data.

PART 3 EXECUTION

3.1 EQUIPMENT INSTALLATION REQUIREMENTS

3.1.1 Installation

The Contractor shall install system components and appurtenances in accordance with the manufacturer's instructions and shall provide necessary interconnections, services, and adjustments required for a complete and operable system. Instrumentation and communication equipment and cable grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation. The Contractor shall adjust or replace devices not conforming to the required accuracies. Factory sealed devices shall be replaced (rather than adjusted). Wiring in exposed areas, including low voltage wiring, shall be installed in metallic raceways or EMT conduit as specified in Section 16415 ELECTRICAL WORK, INTERIOR. Wiring in air plenum areas installed without conduit shall be plenum-rated per NFPA 70.

3.1.1.1 Isolation, Penetrations of Buildings and Clearance from Equipment

Dielectric isolation shall be provided where dissimilar metals are used for connection and support. Penetrations through and mounting holes in the building exteriors shall be made watertight. Holes in concrete, brick, steel and wood walls shall be drilled or core drilled with proper equipment; conduits installed through openings shall be sealed with materials which are compatible with existing materials. Openings shall be sealed with materials which meet the requirements of NFPA 70. Installation shall provide clearance for control-system maintenance. Control system installation shall not interfere with the clearance requirements for mechanical and electrical system maintenance.

3.1.1.2 Device Mounting

Devices shall be installed in accordance with manufacturers' recommendations and as shown. Control devices to be installed in piping shall be provided with required gaskets, flanges, thermal compounds, insulation, piping, fittings, and manual valves for shutoff, equalization, purging, and calibration. Any deviations shall be documented by the Contractor and submitted to the Contracting Officer for approval prior to mounting. Damaged insulation shall be replaced or repaired after devices are installed to match existing work. Damaged galvanized surfaces shall be repaired by touching up with zinc paint.

3.1.1.3 Pneumatic Tubing

Tubing shall be concealed in finished areas. Tubing may be run exposed in unfinished areas, such as mechanical equipment rooms. For tubing to be enclosed in concrete, rigid metal or intermediate metal conduit shall be provided. Tubing shall be installed parallel or perpendicular to building walls throughout. Maximum spacing between tubing supports shall be 5 feet. Each tubing system shall be tested pneumatically at 1.5 times the working pressure for 24 hours, with a maximum pressure drop of 1.0 psig with compressed air supply turned off. Joint leaks shall be corrected by remaking the joint. Caulking of joints will not be permitted. Tubing and two insulated copper phone wires for installation checkout may be run in the same conduit. Tubing and electrical power conductors shall not be run in the same conduit; however, control circuit conductors may be run in the same conduit as polyethylene tubing.

3.1.2 Sequences of Operation

The Contractor shall study the operation and sequence of local equipment controls, as a part of the conditions report, and note any deviations from the described sequences of operation on the contract drawings. The Contractor shall make necessary adjustments to make the equipment operate in an optimum manner and shall fully document changes made.

3.2 INSTALLATION OF EQUIPMENT

The Contractor shall install equipment as specified, as shown and as required in the manufacturer's instructions for a complete and fully operational control system.

3.2.1 Control Panels

Control panels shall be located as indicated on the drawings. Devices located in the control panels shall be as shown on the drawings or as needed to provide the indicated control sequences.

3.2.2 Flow Measuring Device

Fluid flow instruments shall be installed in accordance with ASME-18, unless otherwise indicated in the specification. The minimum straight unobstructed piping for the flowmeter installation shall be 10.0 pipe diameters upstream and 5.0 pipe diameters downstream. Meters for gases and vapors shall be installed in vertical piping, and meters for liquids shall be installed in horizontal piping, unless otherwise recommended by the manufacturer or indicated in the specifications.

3.2.2.1 Flow Nozzle

Flow nozzles flanges shall be installed so that the pressure taps are in a horizontal plane with the centerline of the pipe. Flow nozzles shall be installed for ease of accessibility for periodic maintenance. Differential pressure sensors shall be installed as close to the flow nozzle as possible.

3.2.2.2 Flow Switch

Flow switches shall be installed in such a manner as to minimize disturbance of the flow of fluid while maintaining reliable operation of the switch.

3.2.2.3 Magnetic Flowmeter

Meter shall be installed in vertical piping so that the flow tube remains full of the process fluid under all operating conditions. A minimum of five pipe diameters straight run upstream of the flowmeter and two pipe diameters straight run downstream of the flowmeter shall be provided.

3.2.2.4 Positive Displacement Flow Meters

Flow meters shall be installed horizontally, and aligned correctly in the direction of flow.

3.2.3 Level Instruments

3.2.3.1 Capacitance Liquid Level Sensors

The sensing probes shall be located close to, and parallel with, the tank or sump wall.

3.2.3.2 Conductivity Switch

Level switches shall be installed vertically and in accordance with the manufacturer's instructions. Switches shall be accessible for maintenance and calibration. In applications where switches cannot be directly mounted to a tank by the threaded or flanged connection, a mounting bracket shall be provided for connection to the inside tank wall, maintaining the minimum recommended distance from the tank fill opening.

3.2.3.3 Displacement Type Liquid Level Switch

Level switches shall be installed in accordance with the manufacturer's instructions. Switches shall be accessible for maintenance and calibration. In applications where switches cannot be directly mounted to a tank by the threaded or flanged connection, a mounting bracket shall be provided for connection to the inside tank wall.

3.2.3.4 Mercury Float Switches

Switches shall be mounted in accordance with manufacturer's published instructions. Procedures shall be those used for equipment in hazardous locations.

3.2.3.5 Ultrasonic Sensor

Sensor shall be installed vertically in the top of the tank and in accordance with the manufacturer's instructions. Switches shall be accessible for maintenance and calibration. In applications where switches cannot be directly mounted to a tank by the threaded or flanged connection, a mounting bracket shall be provided for connection to the inside tank wall. Sensor shall be positioned to maximize the return echo signal and minimize vessel obstructions in the sensors line of sight. The minimum recommended distance from the tank fill opening and from the side of the tank shall be maintained.

3.2.4 Pressure Instruments

Pressure sensors and pressure transducers shall be verified by calibration. All pressure taps shall incorporate appropriate snubbers. Pressure sensors and pressure switches shall have valves for isolation, venting, and taps for calibration. Pressure switches and pressure transducers installed

on liquid or steam lines shall have drains. Pressure transducers, differential pressure sensors and differential pressure switches shall have nulling valves. Pressure switches shall be adjusted to the proper setpoint and shall be verified by calibration. Switch contact ratings and duty shall be selected for the application.

3.2.5 Process Analytical Instrumentation

3.2.5.1 PH and ORP Sensor

Pipe mounted flow sensor shall be located in a threaded tee or fitting to allow removal from the pipe. Submersible sensor shall be completely immersed in the fluid being monitored using an ensemble that will allow for removal of the sensor from the fluid for replacement. The sensor shall be located in an area of continuous flow. The transmitter shall be located at the sensor. The transmitter shall be mounted to allow the digital readout to be easily viewed.

3.2.6 Instrument Shelters

Instrument shelters shall be installed in the location shown with the bottom 4.0 feet above the supporting surface using legs and secured rigidly to minimize vibrations from winds. Instrument shelters shall be oriented with door facing North. Instruments located in shelters shall be mounted in the 3-dimensional center of the open space of the shelter.

3.2.7 Output Devices

Output devices (transducers, relays, contactors, or other devices) which are not an integral part of the control panel, shall be mounted in an enclosure mounted adjacent to the control panel, unless otherwise shown. Where H-O-A and/or override switches on the drawings or required by the control sequence, the switches shall be installed so that the control system controls the function through the automatic position and other controls work through the hand position.

3.2.8 Enclosures

All enclosure penetrations shall be from the bottom of the enclosure, and shall be sealed to preclude entry of water using a silicone rubber sealant.

3.2.9 Transformers

Transformers for control voltages below 120 vAc shall be fed from the nearest power panel or motor control center, using circuits provided for the purpose. The Contractor shall provide a disconnect switch on the primary side and a fuse on the secondary side. Transformers shall be enclosed in a steel cabinet with conduit connections.

3.3 WIRE, CABLE AND CONNECTING HARDWARE

3.3.1 LAN Cables and Connecting Hardware

LAN cables and connecting hardware shall be installed as specified.

3.3.2 Metering and Sensor Wiring

Metering and sensor wiring shall be installed in accordance with the requirements of ANSI C12.1, NFPA 70, and Section 16415 ELECTRICAL WORK,

INTERIOR.

3.3.2.1 Power Line Surge Protection

Control panels shall be protected from power line surges. Protection shall meet the requirements of IEEE C62.41. Fuses shall not be used for surge protection.

3.3.2.2 *Sensor and Control Wiring Surge Protection*

Digital and analog inputs shall be protected against surges induced on control and sensor wiring. Digital and analog outputs shall be protected against surges induced on control and sensor wiring installed outdoors and as shown. Fuses shall not be used for surge protection. The inputs and outputs shall be tested in both the normal and common mode using the following two waveforms: The first waveform shall be 10 microseconds by 1000 microseconds with a peak voltage of 1500 volts and a peak current of 60 amperes. The second waveform shall be 8 microseconds by 20 microseconds with a peak voltage of 1000 volts and a peak current of 500 amperes.

3.4 SOFTWARE INSTALLATION

The Contractor shall load software required for an operational control system, including databases (for points specified and shown), operational parameters, and system, command, and application programs. The Contractor shall adjust, tune, debug, and commission all software and parameters for controlled systems to assure proper operation in accordance with the sequences of operation and database tables.

3.5 FIELD TESTING AND ADJUSTING EQUIPMENT

The Contractor shall provide personnel, equipment, instrumentation, and supplies necessary to perform site testing. The Contracting Officer will witness the PVT, and written permission shall be obtained from the Contracting Officer before proceeding with the testing. Original copies of data produced, including results of each test procedure, during PVT shall be turned over to the Contracting Officer at the conclusion of each phase of testing prior to Government approval of the test. The test procedures shall cover actual equipment and functions specified for the project.

3.5.1 Testing, Adjusting and Commissioning

After successful completion of the factory test as specified, the Contractor will be authorized to proceed with the installation of the system equipment, hardware, and software. Once the installation has been completed, the Contractor shall test, adjust, and commission each control loop and system in accordance with NIST SP 250 and shall verify proper operation of each item in the sequences of operation, including hardware and software. The Contractor shall calibrate field equipment, including control devices, adjust control parameters and logic (virtual) points including control loop setpoints, gain constants, constraints, and verify data communications before the system is placed online. Ground rods installed by the Contractor shall be tested as specified in IEEE Std 142. The Contractor shall calibrate each instrumentation device connected to the control system control network by making a comparison between the reading at the device and the display at the workstation, using a standard at least twice as accurate as the device to be calibrated. The Contractor shall check each control point within the control system control network by making a comparison between the control command at the central station and

field-controlled device. The Contractor shall deliver trend logs/graphs of all points showing to the Contracting Officer that stable control has been achieved. Points on common systems shall be trended simultaneously. One log shall be provided showing concurrent samples taken once a minute for a total of 4 hours. One log shall be provided showing concurrent samples taken once every 30 minutes, for a total of 24 hours. The Contractor shall verify operation of systems in the specified failure modes upon Control system network failure or loss of power, and verify that systems return to control system control automatically upon a resumption of control system network operation or return of power. The Contractor shall deliver a report describing results of functional tests, diagnostics, calibrations and commissioning procedures including written certification to the Contracting Officer that the installed complete system has been calibrated, tested, adjusted and commissioned and is ready to begin the PVT. The report shall also include a copy of the approved PVT procedure.

3.5.2 Performance Verification Test (PVT)

The Contractor shall prepare test procedures for the PVT. The test procedure shall describe all tests to be performed and other pertinent information such as specialized test equipment required and the length of the PVT. The test procedures shall explain, in detail, step-by-step actions and the expected results, to demonstrate compliance with all the requirements of the drawings and this specification. The test procedure shall be site specific and based on the inputs and outputs, required calculated points and the sequence of control. The Contractor shall demonstrate that the completed Control system complies with the contract requirements. All physical and functional requirements of the project including communication requirements shall be demonstrated and shown. The Contractor shall demonstrate that each system operates as required in the sequence of operation. The PVT as specified shall not be started until after receipt by the Contractor of written permission by the Contracting Officer, based on the Contractor's written report including certification of successful completion of testing, adjusting and commissioning as specified, and upon successful completion of training as specified. Upon successful completion of the PVT, the Contractor shall deliver test reports and other documentation as specified to the Contracting Officer.

3.5.3 Endurance Test

The Contractor shall use the endurance test to demonstrate the overall system reliability of the completed system. The endurance test shall be conducted in phases. The endurance test shall not be started until the Contracting Officer notifies the Contractor in writing that the PVT is satisfactorily completed, training as specified has been completed, outstanding deficiencies have been satisfactorily corrected, and that the Contractor has permission to start the endurance test. The Contractor shall provide an operator to man the system 8 hours per day during daytime operations, including weekends and holidays, during Phase I endurance testing, in addition to any Contracting Officer personnel that may be made available. The Contracting Officer may terminate testing at any time when the system fails to perform as specified. Upon termination of testing by the Contracting Officer or by the Contractor, the Contractor shall commence an assessment period as described for Phase II. Upon successful completion of the endurance test, the Contractor shall deliver test reports and other documentation, as specified, to the Contracting Officer prior to acceptance of the system.

3.5.3.1 Phase I (Testing)

The test shall be conducted 24 hours per day, 7 days per week, for 7 consecutive calendar days, including holidays, and the system shall operate as specified. The Contractor shall make no repairs during this phase of testing unless authorized by the Contracting Officer in writing.

3.5.3.2 Phase II (Assessment)

After the conclusion of Phase I, the Contractor shall identify failures, determine causes of failures, repair failures, and deliver a written report to the Contracting Officer. The report shall explain in detail the nature of each failure, corrective action taken, results of tests performed, and shall recommend the point at which testing should be resumed. After delivering the written report, the Contractor shall convene a test review meeting at the job site to present the results and recommendations to the Contracting Officer. The meeting shall not be scheduled earlier than 5 business days after receipt of the report by the Contracting Officer. As a part of this test review meeting, the Contractor shall demonstrate that failures have been corrected by performing appropriate portions of the performance verification test. The Contracting Officer reserves the right to cancel the test review meeting if no failures or deficiencies occur during the Phase I testing. If the Contracting Officer chooses to do so, the Contractor will be notified in writing. Based on the Contractor's report and the test review meeting, the Contracting Officer will determine if retesting is necessary and the restart point. The Contracting Officer reserves the right to require that the Phase I test be totally or partially rerun. The Contractor shall not commence any required retesting until after receipt of written notification by the Contracting Officer. After the conclusion of any retesting which the Contracting Officer may require, the Phase II assessment shall be repeated as if Phase I had just been completed.

3.5.3.3 Exclusions

The Contractor will not be held responsible for failures resulting from the following: Outage of the main power supply in excess of the capability of any backup power source, provided that the automatic initiation of all backup sources was accomplished and that automatic shutdown and restart of the control system performed as specified. Failure of a Contracting Officer furnished communications link, provided that the PLC automatically and correctly operates in the stand-alone mode as specified, and that the failure was not due to Contractor furnished equipment, installation, or software. Failure of existing equipment, provided that the failure was not due to Contractor furnished equipment, installation, or software.

3.6 MANUFACTURER'S FIELD SERVICES

The Contractor shall obtain the services of a manufacturer's representative experienced in the installation, adjustment, and operation of the equipment specified. The representative shall supervise the installing, adjusting, and testing of the equipment.

3.7 INSTRUMENTATION AND CONTROL SYSTEM

Control drawings shall be provided for equipment furnished and for interfaces to equipment at each respective equipment location. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation and procedures for safely starting and stopping the system manually shall be prepared in typed

form, and posted beside the diagrams. Diagrams and instructions shall be submitted prior to posting.

3.8 FIELD TRAINING

Field training oriented to the specific system shall be provided for designated personnel. A copy of the training manual for each trainee plus two additional copies shall be delivered to the Contracting Officer. Manuals shall include an agenda, the defined objectives for each lesson, and a detailed description of the subject matter for each lesson. The Contractor shall furnish audiovisual equipment and other training supplies and materials. Copies of the audiovisuals shall be delivered with the printed training manuals. The Contracting Officer reserves the right to videotape training sessions for later use. A training day is defined as 8 hours of classroom instruction, excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility. Approval of the Contractor's training schedule shall be obtained from the Contracting Officer at least 30 days before the training.

3.8.1 Preliminary Operator Training

Prior to the start of field testing, preliminary operator training shall be taught at the project site for 2 consecutive training days. Upon completion of this course, each student, using appropriate documentation, should be able to perform elementary operations with guidance and describe the general hardware architecture and functionality of the system. This course shall include: general system architecture; functional operation of the system, including workstations; operator commands; application programs, control sequences, and control loops; database entry and modification; reports generation; alarm reporting; diagnostics; and historical files.

3.8.2 Maintenance Training

A minimum period of two training days shall be provided by a factory representative or a qualified Contractor trainer for designated personnel on maintenance of the equipment. The training shall include: physical layout of each piece of hardware, calibration procedures, preventive maintenance procedures, schedules, troubleshooting, diagnostic procedures and repair instructions.

-- End of Section --

ATTACHMENT #1

LIST OF EQUIPMENT, INSTRUMENTATION AND CONTROLS

List of Equipment, Instrumentation and Controls
New Bedford Harbor (OU#1) Water Treatment Plant

CLARIFIER SYSTEM (100 Series)

Equipment

P-101A /B/C	Clarifier Feed Pumps
SM-101	Static Mixer
CL-101	Inclined Plate Clarifier System
MX-101	Flash Mix Tank Mixer
MX-102	Flocculation Tank Mixer
DP-101	Clarifier Slurry Transfer Pump
DP-102	Slurry Recycle Pump
DP-103	Slurry Transfer Pump
TK-101	Slurry Holding Tank

Instrumentation and Controls

LE-101	Equalization Basin (CDF Cell #2) Level Element
LSLL-101	Low-Low Level Switch within CDF Cell 2. Shuts down Clarifier Feed Pumps (P-101 A/B/C) and sends an alarm (LALL-101)
LSL-101	Low Level Switch within CDF Cell #2. Stops Clarifier Feed Pumps (P-101 A/B/C)
LSH-101	High Level Switch within CDF Cell #2. Starts Clarifier Feed Pumps (P-101 A/B/C)
LSHH-101	High-High Level Switch within CDF Cell #2. Sends alarm (LAHH-101)
LALL-101	Low-Low Level Alarm and shut off switch (LSLL-101)
LAHH-101	High-High Level Alarm
FE-101	Clarifier Feed Flow Element
FIT-101	Clarifier Feed Flow Transmitter
FQIR-101	Clarifier Feed Flow Totalizer/Recorder
FIC-101	Clarifier Feed Indicating Controller
PI-101	Clarifier Feed Pump (P-101 A) Effluent Line Pressure
PI-102	Clarifier Feed Pump (P-101 B) Effluent Line Pressure
PI-103	Clarifier Feed Pump (P-101 C) Effluent Line Pressure
PIT-101	Pressure Indicating Transmitter for Clarifier Effluent Line
PSH-101	Clarifier Feed Pump Effluent Line High Pressure Switch
PAH-101	High Pressure Alarm for Clarifier Feed Pump Effluent Line and Shutoff Switch (PSH-101).

LSL-102	Low Level Switch within Slurry Holding Tank (TK-101). Stops the Slurry Transfer Pump (DP-103).
LSH-102	High Level Switch within TK-101. Starts Slurry Transfer Pump (DP-103)
LSHH-102	High-High Level Switch within TK-101. Stops Clarifier Sludge Pump (DP-101)
LAHH-102	High-High Level Alarm
PI-104	Pressure Indicator Clarifier Slurry Pump (DP-101) Effluent line
PI-105	Pressure Indicator Slurry Recycle Pump (DP-102) Effluent Line
PI-106	Pressure Indicator Slurry Transfer Pump (DP-103) Effluent Line
PCV-101	Pressure Control Valve for Clarifier Slurry Pump (DP-101)
SV-101	Solenoid Valve for Clarifier Slurry Pump (DP-101)
PCV-102	Pressure Control Valve for Slurry Recycle Pump (DP-102)
SV-102	Solenoid Valve for Slurry Recycle Pump (DP-102)
PCV-103	Pressure Control Valve for Slurry Transfer Pump (DP-103)
SV-103	Solenoid Valve for Slurry Transfer Pump (DP-103)

CHEMICAL FEED SYSTEM (200 Series)

Equipment

TK-201	Alum Storage Tank
TK-202	Alum Feed Tank
CF-201	Polymer Addition System
MP-201A	Alum Metering Pump
MP-201B	Alum Metering Pump
MP-202A	Polymer Metering Pump
MP-202B	Polymer Metering Pump
MP-203	Algaecide Metering Pump
DP-201	Alum Transfer Pump
DP-202	Alum Recycle Pump

Instrumentation and Controls

PCV-201/202	Pressure Control Valves for Alum Metering Pump (MP-201 A/B)
PCV-203/204	Pressure Control Valves for Polymer Metering Pump (MP-202 A/B)
PCV-205	Pressure Control Valve for Algaecide Metering Pump (MP-203)
PCV-206	Pressure Control Valve for Alum Recirculation Pump (DP-202)
PCV-207	Pressure Control Valve for Alum Transfer Pump (DP-201)

LSHH-201	High-High Level Switch with TK-201. Send alarm (LAHH-201) and shuts down DP-201
LAHH-201	High-High Level Alarm
LSL-201	Low Level Switch within Alum Feed Tank (TK-201). Starts alum transfer pump (DP-201)
LSH-201	High Level Switch within Alum Feed Tank (TK-101). Stops alum transfer pump (DP-201)
LSLL-201	Low-Low Level Switch within Alum Feed Tank (TK-201). Send alarm (LALL-201).
LALL-201	Low-Low Level Alarm within TK-201

SAND FILTRATION SYSTEM (300)

Equipment

P-301A/B/C	Sand Filtration System Feed Pumps
SF-301/302	Sand Filtration Systems

Instrumentation and Controls

LE-301	Filtration Feed Basin (CDF Cell #2) Level Element
LSLL-301	Low-Low Level Switch within CDF Cell #3. Shuts down Filtration Feed Pumps (P-301) and sends an alarm (LALL-301)
LSL-301	Low Level Switch within CDF Cell #3. Stops Filtration Feed Pumps (P-301)
LSH-301	High Level Switch within CDF Cell #3. Starts Filtration Feed Pumps (P-301)
LSHH-301	High-High Level switch within CDF Cell #3. Sends alarm (LAHH-301) and stops Clarifier Feed pumps (P-101)
LALL-301	Low-Low Level Alarm for CDF Cell #3 and shut off switch (LSLL-301) for Filtration Feed Pumps (P-301)
LAHH-301	High-High Level Alarm for CDF Cell #3
FE-301	Filtration Feed Flow element. Measures flow to sand filtration system
FIT-301	Filtration Feed Flow Transmitter
FQIR-301	Filtration Feed Totalizer/Recorder
FIC-301	Filtration Feed Flow Controller
PI-301	Pressure Indicator Filtration Feed Pump (P-301 A) Effluent Line
PI-302	Pressure Indicator Filtration Feed Pump (P-301 B) Effluent Line
PI-303	Pressure Indicator Filtration Feed Pump (P-301 C) Effluent Line
PIT-301	Pressure Indicating Tranmitter Filtration Effluent Line
PSH-301	High Pressure Switch for Filtration Feed Pump (P-301) Effluent Line
PAH-301	High Pressure Alarm for Filtration Feed Pump (P-301) effluent line
PI-3xx	Pressure Indicators Sand Filtration Vessels Influent SF-301/302
PI-3xx	Pressure Indicators Sand Filtration Vessels Effluent SF-301/302

DPSH-3xx	High Differential Pressure Switches Sand Filtration Vessels SF-301/302
DPAH-3xx	High Differential Pressure Alarms SF-301/302
AE-301	Sand Filtration System Influent Turbidity Element
AIT-301	Sand Filtration System Influent Turbidity Transmitter
AR-301	Sand Filtration System Turbidity Recorder

POLISHING FILTER SYSTEM (Series 400)

Equipment

PF-401	Polishing Filtration System (Two vessels)
PF-402	Polishing Filtration System (Three vessels)

Instrumentation and Controls

PI-401	Pressure Indicator Polishing Filtration System Influent
PIT-401	Pressure Indicating Transmitter
PSH-401	High Pressure Switch Polishing Filtration System Influent
PAH-401	High pressure Alarm Polishing Filtration System Influent
PDIT-401	Pressure Differential Indicating Transmitter PF-401A
PDIT-402	Pressure Differential Indicating Transmitter PF-401B
PDIT-403	Pressure Differential Indicating Transmitter PF-402A
PDIT-404	Pressure Differential Indicating Transmitter PF-402B
PDIT-405	Pressure Differential Indicating Transmitter PF-402C
PDSH-401	High Pressure Differential Switch PF-401A
PDSH-402	High Pressure Differential Switch PF-401B
PDSH-403	High Pressure Differential Switch PF-402A
PDSH-404	High Pressure Differential Switch PF-402B
PDSH-405	High Pressure Differential Switch PF-402C
PDAH-401	High Pressure Differential Alarm PF-401A
PDAH-402	High Pressure Differential Alarm PF-401B
PDAH-403	High Pressure Differential Alarm PF-402A
PDAH-404	High Pressure Differential Alarm PF-402B
PDAH-405	High Pressure Differential Alarm PF-402C
AE-401	Polishing Filtration System Influent Turbidity Element
AIT-401	Polishing Filtration System Influent Turbidity Transmitter
AR-401	Polishing Filtration System Turbidity Recorder
FCV-401	Flow Control Valve

LIQUID PHASE CARBON ADSORPTION SYSTEM (Series 500)

Equipment

L-501A	Liquid Phase Carbon Adsorption System 501, Primary Vessel
L-501B	Liquid Phase Carbon Adsorption System 501, Secondary Vessel
LC-502A	Liquid Phase Carbon Adsorption System 502, Primary Vessel
LC-502B	Liquid Phase Carbon Adsorption System 502, Secondary Vessel
LC-503A	Liquid Phase Carbon Adsorption System 503, Primary Vessel
LC-503B	Liquid Phase Carbon Adsorption System 503, Secondary Vessel

Instrumentation And Controls

PIT-501	Pressure Indicating Transmitter Influent to LC-501
PIT-502	Pressure Indicating Transmitter Influent to LC-502
PIT-503	Pressure Indicating Transmitter Influent to LC-503
PI-501	Pressure Indicator Effluent to LC-501A
PI-502	Pressure Indicator Effluent to LC-501B
PI-503	Pressure Indicator Effluent to LC-502A
PI-504	Pressure Indicator Effluent to LC-502B
PI-505	Pressure Indicator Effluent to LC-503A
PI-506	Pressure Indicator Effluent to LC-503B
PSH-501	High Pressure Switch for influent to LC-501
PSH-502	High Pressure Switch for influent to LC-502
PSH-503	High Pressure Switch for influent to LC-503
PSHH-501	High-High Pressure Switch for influent to LC-501
PSHH-502	High-High Pressure Switch for influent to LC-502
PSHH-503	High-High Pressure Switch for influent to LC-503
PAH-501	High Pressure Alarm for influent to LC-501
PAH-502	High Pressure Alarm for influent to LC-502
PAH-503	High Pressure Alarm for influent to LC-503
PAHH-501	High-High Pressure Alarm for influent to LC-501
PAHH-502	High-High Pressure Alarm for influent to LC-502
PAHH-503	High-High Pressure Alarm for influent to LC-503
PDSH-501	High Pressure Differential Switch for LC-501A
PDSH-502	High Pressure Differential Switch for LC-501B
PDSH-503	High Pressure Differential Switch for LC-502A
PDSH-504	High Pressure Differential Switch for LC-502B
PDSH-505	High Pressure Differential Switch for LC-503A
PDSH-506	High Pressure Differential Switch for LC-503B
PDAH-501	High Pressure Differential Alarm for LC-501A

PDAH-502	High Pressure Differential Alarm for LC-501B
PDAH-503	High Pressure Differential Alarm for LC-502A
PDAH-504	High Pressure Differential Alarm for LC-502B
PDAH-505	High Pressure Differential Alarm for LC-503A
PDAH-506	High Pressure Differential Alarm for LC-503B
FE-501	WTP Effluent flow element
FIT-501	WTP Effluent flow transmitter
FQIR-501	WTP Effluent Flow Totalizer/Recorder

SUMP PUMPS (Series 600)

Equipment

P-601A	Sump Pump #1
P-601B	Sump Pump #2

Instrumentation and Controls

LSL-601	Low Level Switch. Starts P-601 A/B
LSH-601	High Level Switch. Stops P-601 A/B
LSHH-601	High-High Level Switch
LAHH-601	High-High Level Alarm.

AIR COMPRESSOR SYSTEM (Series 700)

Equipment

AC-701	Air Compressor

Instrumentation and Controls

PI-701	Pressure Indicator for Air Compressor Effluent Line
PSL-701	Low Pressure Switch for Air Compressor Vessel (AC-701)
PSH-701	High Pressure Switch for Air Compressor Vessel (AC-701)
PAH-701	High Pressure Alarm for Air Compressor Vessel (AC-701)
PAH-701	High Pressure Alarm for air compressor system
PALL	Low-Low Pressure Alarm for air compressor system

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DIVISION 13 - SPECIAL CONSTRUCTION

SECTION 13850

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SECTION 13850

FIRE DETECTION AND ALARM SYSTEM

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI S3.41	(1990; R 1996) Audible Emergency Evacuation Signal

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991; R 1995) Surge Voltages in Low-Voltage AC Power Circuits

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1999) National Electrical Code
NFPA 72	(1996; Errata Oct 96, Dec 96; TIA 96-1, 96-2, 96-3) National Fire Alarm Code
NFPA 90A	(1996) Installation of Air Conditioning and Ventilating Systems

UNDERWRITERS LABORATORIES (UL)

UL 6	(1997) Rigid Metal Conduit
UL 38	(1994; Rev Nov 1994)) Manually Actuated Signaling Boxes for Use with Fire-Protective Signaling Systems
UL 228	(1997) Door Closers-Holders, With or Without Integral Smoke Detectors
UL 268	(1996; Rev thru Jun 1998) Smoke Detectors for Fire Protective Signaling Systems
UL 268A	(1998) Smoke Detectors for Duct Applications
UL 464	(1996; Rev May 1997) Audible Signal Appliances
UL 521	(1993; Rev Oct 1994) Heat Detectors for Fire Protective Signaling Systems

UL 797	(1993; Rev thru Mar 1997) Electrical Metallic Tubing
UL 864	(1996) Control Units for Fire-Protective Signaling Systems
UL 1242	(1996; Rev Mar 1998) Intermediate Metal Conduit
UL 1971	(1995; Rev thru May 1997) Signaling Devices for the Hearing Impaired

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fire Alarm Reporting System; GA

Detail drawings, prepared and signed by a Registered Professional Engineer or a NICET Level 3 Fire Alarm Technician, consisting of a complete list of equipment and material, including manufacturer's descriptive and technical literature, catalog cuts, and installation instructions. Note that the contract drawings show layouts based on typical detectors. The Contractor shall check the layout based on the actual detectors to be installed and make any necessary revisions in the detail drawings. The detail drawings shall also contain complete wiring and schematic diagrams for the equipment furnished, equipment layout, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Detailed point-to-point wiring diagram shall be prepared and signed by a Registered Professional Engineer or a NICET Level 3 Fire Alarm Technician showing points of connection. Diagram shall include connections between system devices, appliances, control panels, supervised devices, and equipment that is activated or controlled by the panel.

SD-03 Product Data

Storage Batteries; GA

Substantiating battery calculations for supervisory and alarm power requirements. Ampere-hour requirements for each system component and each panel component, and the battery recharging period shall be included.

Voltage Drop; FIO

Voltage drop calculations for notification appliance circuits to indicate that sufficient voltage is available for proper appliance operation.

Spare Parts; FIO

Spare parts data for each different item of material and equipment specified, not later than 2 months prior to the date of beneficial occupancy. Data shall include a complete list of parts and supplies with the current unit prices and source of supply and a list of the parts recommended by the manufacturer to be replaced after 1 year of service.

Technical Data and Computer Software; GA

Technical data which relates to computer software.

Training; GA

Lesson plans, operating instructions, maintenance procedures, and training data, furnished in manual format, for the training courses. The operations training shall familiarize designated government personnel with proper operation of the fire alarm system. The maintenance training course shall provide the designated government personnel adequate knowledge required to diagnose, repair, maintain, and expand functions inherent to the system.

Testing; GA

Detailed test procedures, prepared and signed by a Registered Professional Engineer or a NICET Level 3 Fire Alarm Technician, for the fire detection and alarm system 60 days prior to performing system tests.

SD-06 Test Reports

Testing; GA

Test reports, in booklet form, showing field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall document readings, test results and indicate the final position of controls. The Contractor shall include the NFPA 72 Certificate of Completion and NFPA 72 Inspection and Testing Form, with the appropriate test reports.

SD-07 Certificates

Equipment; GA

Certified copies of current approvals or listings issued by an independent test lab if not listed by UL, FM or other nationally recognized testing laboratory, showing compliance with specified NFPA standards.

Qualifications; GA

Proof of qualifications for required personnel. The installer shall submit proof of experience for the Professional Engineer, fire alarm technician, and the installing company.

SD-10 Operation and Maintenance Data

Technical Data and Computer Software; GA

Six (6) copies of operating instructions outlining step-by-step procedures required for system startup, operation, and shutdown. The instructions shall include the manufacturer's name, model number, service manual, parts list, and complete description of equipment and their basic operating features. Six (6) copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The instructions shall include conduit layout, equipment layout and simplified wiring, and control diagrams of the system as installed. The instructions shall include the information provided in paragraph TECHNICAL DATA AND COMPUTER SOFTWARE. The instructions shall include complete procedures for system revision and expansion, detailing both equipment and software requirements. Original and backup copies of all software delivered for this project shall be provided, on each type of media utilized. Instructions shall be approved prior to training.

1.3 GENERAL REQUIREMENTS

1.3.1 Standard Products

Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that can provide service within 24 hours of notification.

1.3.2 Nameplates

Major components of equipment shall have the manufacturer's name, address, type or style, voltage and current rating, and catalog number on a noncorrosive and nonheat-sensitive plate which is securely attached to the equipment.

1.3.3 Keys and Locks

Locks shall be keyed alike. Four keys for the system shall be provided.

1.3.4 Tags

Tags with stamped identification number shall be furnished for keys and locks.

1.3.5 Verification of Dimensions

After becoming familiar with details of the work, the Contractor shall verify dimensions in the field and shall advise the Contracting Officer of any discrepancy before performing the work.

1.3.6 Compliance

The fire detection and alarm system and the central reporting system shall be configured in accordance with NFPA 72; exceptions are acceptable as directed by the Contracting Officer. The equipment furnished shall be compatible and be UL listed, FM approved, or approved or listed by a nationally recognized testing laboratory in accordance with the applicable NFPA standards.

1.3.7 Qualifications

1.3.7.1 Engineer and Technician

a. Registered Professional Engineer with verification of experience and at least 4 years of current experience in the design of the fire protection and detection systems.

b. National Institute for Certification in Engineering Technologies (NICET) qualifications as an engineering technician in fire alarm systems program with verification of experience and current NICET certificate.

c. The Registered Professional Engineer may perform all required items under this specification. The NICET Fire Alarm Technician shall perform only the items allowed by the specific category of certification held.

1.3.7.2 Installer

The installing Contractor shall provide the following: Fire Alarm Technicians to perform the installation of the system. A Fire Alarm Technician with a minimum of 4 years of experience shall perform/supervise the installation of the fire alarm system. Fire Alarm technicians with a minimum of 2 years of experience shall be utilized to assist in the installation and terminate fire alarm devices, cabinets and panels. An electrician shall be allowed to install wire or cable and to install conduit for the fire alarm system. The Fire Alarm technicians installing the equipment shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.3.7.3 Design Services

Installations requiring designs or modifications of fire detection, fire alarm, or fire suppression systems shall require the services and review of a qualified fire protection engineer. For the purposes of meeting this requirement, a qualified fire protection engineer is defined as an individual meeting one of the following conditions:

a. An engineer having a Bachelor of Science or Masters of Science Degree in Fire Protection Engineering from an accredited university engineering program, plus a minimum of 2 years' work experience in fire protection engineering.

b. A registered professional engineer (P.E.) in fire protection engineering.

c. A registered PE in a related engineering discipline and member grade status in the National Society of Fire Protection Engineers.

d. An engineer with a minimum of 10 years' experience in fire protection engineering and member grade status in the National Society of Fire Protection Engineers

1.4 SYSTEM DESIGN

1.4.1 Operation

The fire alarm and detection system shall be a complete, supervised fire alarm reporting system. The system shall be activated into the alarm mode

by actuation of any alarm initiating device. The system shall remain in the alarm mode until the initiating device is reset and the fire alarm control panel is reset and restored to normal. Alarm initiating devices shall be connected to initiating device circuits (IDC), Style D, in accordance with NFPA 72. Alarm notification appliances shall be connected to notification appliance circuits (NAC), Style Z in accordance with NFPA 72. A looped conduit system shall be provided so that if the conduit and all conductors within are severed at any point, all IDC, or NAC will remain functional. The conduit loop requirement is not applicable to the signal transmission link from the local panels (at the protected premises) to the Supervising Station (fire station, fire alarm central communication center). Textual, audible, and visual appliances and systems shall comply with NFPA 72. Fire alarm system components requiring power, except for the control panel power supply, shall operate on 24 Volts dc.

1.4.2 Operational Features

The system shall have the following operating features:

a. Monitor electrical supervision of alarm IDC and NAC. Smoke detectors shall have combined alarm initiating and power circuits.

b. Monitor electrical supervision of the primary power (ac) supply, battery voltage, placement of alarm zone module (card, PC board) within the control panel, and transmitter tripping circuit integrity.

c. A trouble buzzer and trouble light emitting diode (LED) to activate upon a single break, open, or ground fault condition which prevents the required normal operation of the system. The trouble signal shall also operate upon loss of primary power (ac) supply, low battery voltage, removal of alarm zone module (card, PC board), and disconnection of the circuit used for transmitting alarm signals off-premises. A trouble alarm silence switch shall be provided which will silence the trouble buzzer, but will not extinguish the trouble indicator LED. Subsequent trouble and supervisory alarms shall sound the trouble signal until silenced. After the system returns to normal operating conditions, the trouble buzzer shall again sound until the silencing switch returns to normal position, unless automatic trouble reset is provided.

d. A one person test mode. Activating an initiating device in this mode will activate an alarm for a short period of time, then automatically reset the alarm, without activating the transmitter during the entire process.

e. A transmitter disconnect switch to allow testing and maintenance of the system without activating the transmitter but providing a trouble signal when disconnected and a restoration signal when reconnected.

f. Evacuation alarm silencing switch which, when activated, will silence alarm devices, but will not affect the zone indicating LED/LCD nor the operation of the transmitter. This switch shall be over-ridden upon activation of a subsequent alarm from an unalarmed zone and the NAC devices will be activated.

g. Electrical supervision for circuits used for supervisory signal

services (i.e., sprinkler systems, valves, etc.). Supervision shall detect any open, short, or ground.

h. Confirmation or verification modules for smoke detection initiating circuits. The modules shall interrupt the transmission of an alarm signal to the system control panel for a factory preset period. This interruption period shall be adjustable from 1 to 60 seconds and be factory set at 20 seconds. Immediately following the interruption period, a confirmation period shall be in effect during which time an alarm signal, if present, will be sent immediately to the control panel. Fire alarm devices, other than smoke detectors, will be prohibited on circuits controlled by confirmation or verification modules.

i. The fire alarm control panel shall provide supervised relays for HVAC shutdown. An override at the HVAC panel shall not be provided.

j. Provide one person test mode - Activating an initiating device in this mode will activate an alarm for a short period of time, then automatically reset the alarm, without activating the transmitter during the entire process.

k. The fire alarm control panel shall provide the required modules to monitor and control the fire sprinkler system, or other fire protection extinguishing system.

1.4.3 Alarm Functions

An alarm condition on a circuit shall automatically initiate the following functions:

a. Transmission of a signal over the station telephonic fire reporting system.

b. Visual indications of the alarmed zone on the fire alarm control panel annunciator.

c. Continuous sounding or operation of alarm notification appliances throughout the building as required by ANSI S3.41.

d. Closure of doors held open by electromagnetic devices.

e. Operation of the smoke control system.

f. Deactivation of the air handling units throughout the building.

g. Shutdown of power to the data processing equipment in the alarmed zones.

1.4.4 Primary Power

Operating power shall be provided as required by paragraph Power Supply for the System. Transfer from normal to emergency power or restoration from emergency to normal power shall be fully automatic and not cause transmission of a false alarm. Loss of ac power shall not prevent transmission of a signal via the fire reporting system upon operation of any initiating circuit.

1.4.5 Battery Backup Power

Battery backup power shall be through use of rechargeable, sealed-type storage batteries and battery charger.

1.5 TECHNICAL DATA AND COMPUTER SOFTWARE

Technical data and computer software (meaning technical data which relates to computer software) which is specifically identified in this project, and which may be defined/required in other specifications, shall be delivered in accordance with the CONTRACT CLAUSES, and in accordance with the Contract Data Requirements List, DD Form 1423. Data delivered shall be identified by reference to the particular specification paragraph against which it is furnished. Data to be submitted shall include complete system, equipment, and software descriptions. Descriptions shall show how the equipment will operate as a system to meet the performance requirements of this contract. The data package shall also include the following:

(1) Identification of programmable portions of system equipment and capabilities.

(2) Description of system revision and expansion capabilities and methods of implementation detailing both equipment and software requirements.

(3) Provision of operational software data on all modes of programmable portions of the fire alarm and detection system.

(4) Description of Fire Alarm Control Panel equipment operation.

(5) Description of auxiliary and remote equipment operations.

(6) Library of application software.

(7) Operation and maintenance manuals described under SD-10 in the SUBMITTALS paragraph.

1.6 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variation, dirt, dust, and any other contaminants.

PART 2 PRODUCTS

2.1 CONTROL PANEL

Control panel shall comply with the applicable requirements of UL 864. Panel shall be modular, installed in a surface mounted steel cabinet with hinged door and cylinder lock. Control panel shall be a clean, uncluttered, and orderly assembled panel containing components and equipment required to provide the specified operating and supervisory functions of the system. The panel shall have prominent rigid plastic, phenolic or metal identification plates for LEDs, zones, controls, meters, fuses, and switches. Nameplates for fuses shall also include ampere rating. Separate alarm and trouble LEDs shall be provided for each zone alarm. These LEDs shall be located on the exterior of the cabinet door or be visible through the cabinet door. Control panel switches shall be within the locked cabinet. A suitable means (single operation) shall be provided for testing the control panel visual indicating devices (meters or

LEDs). Meters and LEDs shall be plainly visible when the cabinet door is closed. Signals and LEDs shall be provided to indicate by zone any alarm, supervisory or trouble condition on the system. Each IDC shall be powered and supervised so that a signal on one zone does not prevent the receipt of signals from other zones. Loss of power, including batteries, shall not require the reloading of a program. Upon restoration of power, startup shall be automatic, and shall not require any manual operation. The loss of primary power or the sequence of applying primary or emergency power shall not affect the transmission of alarm, supervisory or trouble signals. Visual annunciators shall be provided for each active zone and spare zone. One (1) spare zone shall be provided. Each LED shall provide specific identification of the zone by means of a permanently attached rigid plastic, phenolic, or metal sign with either raised or engraved letters. Zone identification shall consist of a word description of the zone. Cabinets shall be provided with ample gutter space to allow proper clearance between the cabinet and live parts of the panel equipment. If more than one modular unit is required to form a control panel, the units shall be installed in a single cabinet large enough to accommodate units. Cabinets shall be painted red.

2.1.1 Remote System Trouble Audible/Visual Appliance

Audible appliance shall have a minimum sound level output rating of 85 dBA at 10 feet and operate in conjunction with the panel's integral trouble signal. The audible device shall be silenced by the system trouble silence switch located at the remote location, but shall not extinguish the visual indicator. A rigid plastic, phenolic or metal identification sign which reads "Fire Alarm System Trouble" shall be provided at the audible appliance. The visual appliance located with the audible appliance shall not be extinguished until the trouble has been cleared.

2.1.2 Circuit Connections

Circuit conductors entering or leaving the panel shall be connected to screw-type terminals with each conductor and terminal marked for identification.

2.1.3 System Expansion and Modification Capabilities

Any equipment and software needed by qualified technicians to implement future changes to the fire alarm system shall be provided as part of this contract.

2.2 STORAGE BATTERIES

Storage batteries shall be provided and shall be 24 Vdc sealed, lead-calcium type requiring no additional water. The batteries shall have ample capacity, with primary power disconnected, to operate the fire alarm system for a period of 72 hours. Following this period of battery operation, the batteries shall have ample capacity to operate all components of the system, including all alarm signaling devices in the total alarm mode for a minimum period of 15 minutes. Batteries shall be located at the bottom of the panel. Batteries shall be provided with overcurrent protection in accordance with NFPA 72. Separate battery cabinets shall have a lockable, hinged cover similar to the fire alarm panel. The lock shall be keyed the same as the fire alarm control panel. Cabinets shall be painted to match the fire alarm control panel.

2.3 BATTERY CHARGER

Battery charger shall be completely automatic, 24 Vdc with high/low charging rate, capable of restoring the batteries from full discharge (18 Volts dc) to full charge within 48 hours. A pilot light indicating when batteries are manually placed on a high rate of charge shall be provided as part of the unit assembly, if a high rate switch is provided. Charger shall be located in control panel cabinet or in a separate battery cabinet.

2.4 MANUAL FIRE ALARM STATIONS

Manual fire alarm stations shall conform to the applicable requirements of UL 38. Manual stations shall be connected into signal line circuits. Stations shall be installed on surface mounted outlet boxes. Manual stations shall be mounted at 48 inches. Stations shall be double action type. Stations shall be finished in red, with raised letter operating instructions of contrasting color. Stations requiring the breaking of glass or plastic panels for operation are not acceptable. Stations employing glass rods are not acceptable. The use of a key or wrench shall be required to reset the station. Gravity or mercury switches are not acceptable. Switches and contacts shall be rated for the voltage and current upon which they operate. Stations shall have a separate screw terminal for each conductor. Surface mounted boxes shall be matched and painted the same color as the fire alarm manual stations.

2.5 FIRE DETECTING DEVICES

Fire detecting devices shall comply with the applicable requirements of NFPA 72, NFPA 90A, UL 268, UL 268A, and UL 521. The detectors shall be provided as indicated. Detector base shall have screw terminals for making connections. No solder connections will be allowed. Detectors located in concealed locations (above ceiling, raised floors, etc.) shall have a remote visible indicator LED/LCD. Installed devices shall conform to the NFPA 70 hazard classification of the area where devices are to be installed.

2.5.1 Heat Detectors

Heat detectors shall be designed for detection of fire by combination fixed temperature and rate-of-rise principle. Heat detector spacing shall be rated in accordance with UL 521. Detectors located in areas subject to moisture, exterior atmospheric conditions, or hazardous locations as defined by NFPA 70, shall be types approved for such locations. Heat detectors located in attic spaces or similar concealed spaces below the roof shall be intermediate temperature rated.

2.5.1.1 Combination Fixed-Temperature and Rate-of-Rise Detectors

Detectors shall be designed for surface outlet box mounting and supported independently of wiring connections. Contacts shall be self-resetting after response to rate-of-rise principle. Under fixed temperature actuation, the detector shall have a permanent external indication which is readily visible. Detector units located in boiler rooms, showers, or other areas subject to abnormal temperature changes shall operate on fixed temperature principle only. The UL 521 test rating for the fixed temperature portion shall be 135 degrees F. The UL 521 test rating for the Rate-of-Rise detectors shall be rated for 50 by 50 ft.

2.5.2 Smoke Detectors

Smoke detectors shall be designed for detection of abnormal smoke

densities. Smoke detectors shall be ionization or photoelectric type. Detectors shall contain a visible indicator LED that shows when the unit is in alarm condition. Detectors shall not be adversely affected by vibration or pressure. Detectors shall be the plug-in type in which the detector base contains terminals for making wiring connections. Detectors that are to be installed in concealed (above false ceilings, etc.) locations shall be provided with a remote indicator LED suitable for mounting in a finished, visible location.

2.5.2.1 Ionization Detectors

Ionization detectors with a dual chamber shall be responsive to both invisible and visible particles of combustion. One chamber shall be a reference chamber and the second a sampling chamber. Detectors containing radium shall not be provided. Detectors shall not cause an alarm condition due to anticipated fluctuations in relative humidity. The sensitivity of the detector shall be field adjustable to compensate for operating conditions. Detector shall require no replacement or readjustment to restore it to normal operation after an alarm condition. Each detector shall be capable of withstanding ambient air velocity up to 300 fpm in accordance with UL 268.

2.5.2.2 Photoelectric Detectors

Detectors shall operate on a light scattering concept using an LED light source. Failure of the LED shall not cause an alarm condition. Detectors shall be factory set for sensitivity and shall require no field adjustments of any kind. Detectors shall have an obscuration rating in accordance with UL 268.

2.6 NOTIFICATION APPLIANCES

Audible appliances shall conform to the applicable requirements of UL 464. Devices shall be connected into notification appliance circuits. Devices shall have a separate screw terminal for each conductor. Audible appliances shall generate a unique audible sound from other devices provided in the building and surrounding area. Surface mounted audible appliances shall be painted red. Recessed audible appliances shall be installed with a grill that is painted red.

2.6.1 Alarm Horns

Horns shall be surface mounted, with the matching mounting back box grille and vibrating type suitable for use in an electrically supervised circuit. Horns shall produce a sound rating of at least 85 dBA at 10 feet. Horns used in exterior locations shall be specifically listed or approved for outdoor use and be provided with metal housing and protective grilles.

2.6.2 Visual Notification Appliances

Visual notification appliances shall conform to the applicable requirements of UL 1971. Appliances shall have clear high intensity optic lens, xenon flash tubes, and output white light. Strobe flash rate shall be between 1 to 3 flashes per second and a minimum of 75 candela. Strobe shall be surface mounted.

2.6.3 Combination Audible/Visual Notification Appliances

Combination audible/visual notification appliances shall provide the same

requirements as individual units, except that they shall mount as a unit in standard backboxes. Units shall be factory assembled. Any other audible notification appliance employed in the fire alarm systems shall be approved by the Contracting Officer.

2.7 FIRE DETECTION AND ALARM SYSTEM PERIPHERAL EQUIPMENT

2.7.1 Electromagnetic Door Hold-Open Devices

Devices shall be attached to the walls unless otherwise indicated. Devices shall comply with the appropriate requirements of UL 228. Devices shall operate on 24 Volt dc power. Compatible magnetic component shall be attached to the door. Under normal conditions, the magnets shall attract and hold the doors open. When magnets are de-energized, they shall release the doors. Magnets shall have a holding force of 25 pounds. Devices shall be UL or FM approved. Housing for devices shall be brushed aluminum or stainless steel. Operation shall be fail safe with no moving parts. Electromagnetic door hold-open devices shall not be required to be held open during building power failure.

2.7.2 Conduit

Conduit and fittings shall comply with UL 6, UL 1242 and UL 797.

2.7.3 Wiring

Wiring shall conform to NFPA 70. Wiring for 120 Vac power shall be No. 12 AWG minimum. Wiring for Fire Alarm circuits shall be No. 16 AWG minimum. Voltages shall not be mixed in any junction box, housing, or device, except those containing power supplies and control relays. Wiring shall conform to NFPA 70. System field wiring shall be solid copper and installed in metallic conduit or electrical metallic tubing, except rigid plastic conduit may be used under slab-on-grade. Conductors shall be color coded. Conductors used for the same functions shall be similarly color coded. Wiring code color shall remain uniform throughout the circuit. Pigtail or T-tap connections to initiating device circuits, supervisory alarm circuits, and notification appliance circuits are prohibited.

2.7.4 Special Tools and Spare Parts

Software, connecting cables and proprietary equipment, necessary for the maintenance, testing, and reprogramming of the equipment shall be furnished to the Contracting Officer. Two spare fuses of each type and size required shall be furnished. Two percent of the total number of each different type of detector, but no less than two each, shall be furnished. Spare fuses shall be mounted in the fire alarm panel.

PART 3 EXECUTION

3.1 INSTALLATION

All work shall be installed as shown and in accordance with the manufacturer's diagrams and recommendations, unless otherwise specified. Smoke detectors shall not be installed until construction is essentially complete and the building has been thoroughly cleaned.

3.1.1 Power Supply for the System

A single dedicated circuit connection for supplying power from a branch

circuit to each building fire alarm system shall be provided. The power shall be supplied as shown on the drawings. The power supply shall be equipped with a locking mechanism and marked in red with the words "FIRE ALARM CIRCUIT CONTROL".

3.1.2 Wiring

Conduit size for wiring shall be in accordance with NFPA 70. Wiring for the fire alarm system shall not be installed in conduits, junction boxes, or outlet boxes with conductors of lighting and power systems. Not more than two conductors shall be installed under any device screw terminal. The wires under the screw terminal shall be straight when placed under the terminal then clamped in place under the screw terminal. The wires shall be broken and not twisted around the terminal. Circuit conductors entering or leaving any mounting box, outlet box enclosure, or cabinet shall be connected to screw terminals with each terminal and conductor marked in accordance with the wiring diagram. Connections and splices shall be made using screw terminal blocks. The use of wire nut type connectors in the system is prohibited. Wiring within any control equipment shall be readily accessible without removing any component parts. The fire alarm equipment manufacturer's representative shall be present for the connection of wiring to the control panel.

3.1.3 Control Panel

The control panel and its assorted components shall be mounted so that no part of the enclosing cabinet is less than 12 inches nor more than 78 inches above the finished floor. Manually operable controls shall be between 36 and 42 inches above the finished floor. Panel shall be installed to comply with the requirements of UL 864.

3.1.4 Detectors

Detectors shall be located and installed in accordance with NFPA 72. Detectors shall be connected into signal line circuits or initiating device circuits as indicated on the drawings. Detectors shall be at least 12 inches from any part of any lighting fixture. Detectors shall be located at least 3 feet from diffusers of air handling systems. Each detector shall be provided with appropriate mounting hardware as required by its mounting location. Detectors which mount in open space shall be mounted directly to the end of the stubbed down rigid conduit drop. Conduit drops shall be firmly secured to minimize detector sway. Where length of conduit drop from ceiling or wall surface exceeds 3 feet, sway bracing shall be provided. Detectors installed in concealed locations (above ceiling, raised floors, etc.) shall have a remote visible indicator LED/LCD in a finished, visible location.

3.1.5 Notification Appliances

Notification appliances shall be mounted 80 inches above the finished floor or 6 inches below the ceiling, whichever is lower.

3.2 OVERVOLTAGE AND SURGE PROTECTION

3.2.1 Power Line Surge Protection

All equipment connected to alternating current circuits shall be protected from surges per IEEE C62.41 B3 combination waveform and NFPA 70. Fuses shall not be used for surge protection. The surge protector shall be rated

for a maximum let thru voltage of 350 Volts ac (line-to-neutral) and 350 Volt ac (neutral-to-ground).

3.2.2 Low Voltage DC Circuits Surge Protection

All IDC, NAC, and communication cables/conductors, except fiber optics, shall have surge protection installed at each point where it exits or enters a building. Equipment shall be protected from surges per IEEE C62.41 B3 combination waveform and NFPA 70. The surge protector shall be rated to protect the 24 Volt dc equipment. The maximum dc clamping voltages shall be 36 V (line-to-ground) and 72 Volt dc (line-to-line).

3.3 GROUNDING

Grounding shall be provided by connecting to building ground system.

3.4 TESTING

The Contractor shall notify the Contracting Officer at least 10 days before the preliminary and acceptance tests are to be conducted. The tests shall be performed in accordance with the approved test procedures in the presence of the Contracting Officer. The control panel manufacturer's representative shall be present to supervise tests. The Contractor shall furnish instruments and personnel required for the tests.

3.4.1 Preliminary Tests

Upon completion of the installation, the system shall be subjected to functional and operational performance tests including tests of each installed initiating and notification appliance, when required. Tests shall include the meggering of system conductors to determine that the system is free from grounded, shorted, or open circuits. The megger test shall be conducted prior to the installation of fire alarm equipment. If deficiencies are found, corrections shall be made and the system shall be retested to assure that it is functional. After completing the preliminary testing the Contractor shall complete and submit the NFPA 72, Certificate of Completion.

3.4.2 Acceptance Test

Acceptance testing shall not be performed until the Contractor has completed and submitted the Certificate of Completion. Testing shall be in accordance with NFPA 72. The recommended tests in NFPA 72 shall be considered mandatory and shall verify that previous deficiencies have been corrected. The Contractor shall complete and submit the NFPA 72, Inspection and Testing Form. The test shall include all requirements of NFPA 72 and the following:

a. Test of each function of the control panel.

b. Test of each circuit in both trouble and normal modes.

c. Tests of each alarm initiating devices in both normal and trouble conditions.

d. Tests of each control circuit and device.

e. Tests of each alarm notification appliance.

f. Tests of the battery charger and batteries.

g. Complete operational tests under emergency power supply.

h. Visual inspection of wiring connections.

i. Opening the circuit at each alarm initiating device and notification appliance to test the wiring supervisory feature.

j. Ground fault.

k. Short circuit faults.

l. Stray voltage.

m. Loop resistance.

3.5 TRAINING

Training course shall be provided for the operations and maintenance staff. The course shall be conducted in the building where the system is installed or as designated by the Contracting Officer. The training period for systems operation shall consist of 1 training days (8 hours per day) and shall start after the system is functionally completed but prior to final acceptance tests. The instructions shall cover items contained in the operating and maintenance instructions.

-- End of Section --

DIVISION 14 – CONVEYING SYSTEMS
NOT IN USE

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DIVISION 15 - MECHANICAL

SECTION 15050

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SECTION 15050

BASIC MECHANICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 117	(1997) Operating Salt Spray (Fog) Apparatus

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(1997) National Electrical Safety Code

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(1998; Errata 1999) Motors and Generators
NEMA MG 10	(1994) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors
NEMA MG 11	(1977; R 1992) Energy Management Guide of Selection and Use of Single-Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1999) National Electrical Code

1.2 RELATED REQUIREMENTS

This section applies to all sections of Division 15, "Mechanical" of this project specification, unless specified otherwise in the individual section.

1.3 QUALITY ASSURANCE

1.3.1 Material and Equipment Qualifications

Provide materials and equipment that are standard products of manufacturers regularly engaged in the manufacture of such products, which are of a similar material, design and workmanship. Standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.

1.3.2 Alternative Qualifications

Products having less than a two-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown.

1.3.3 Service Support

The equipment items shall be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations shall be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.3.4 Manufacturer's Nameplate

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.3.5 Modification of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

1.3.5.1 Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions shall be considered mandatory, the word "should" shall be interpreted as "shall." Reference to the "code official" shall be interpreted to mean the "Contracting Officer." For Navy owned property, references to the "owner" shall be interpreted to mean the "Contracting Officer." For leased facilities, references to the "owner" shall be interpreted to mean the "lessor." References to the "permit holder" shall be interpreted to mean the "Contractor."

1.3.5.2 Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, shall be applied appropriately by the Contracting Officer as authorized by his administrative cognizance and the FAR.

1.4 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

1.5 ELECTRICAL REQUIREMENTS

Furnish motors, controllers, disconnects and contactors with their respective pieces of equipment. Motors, controllers, disconnects and contactors shall conform to and have electrical connections provided under Section 16403, "Motor Control Centers, Switchboards and Panelboards." Furnish internal wiring for components of packaged equipment as an integral part of the equipment. Extended voltage range motors will not be permitted. Controllers and contactors shall have a maximum of 120 volt control circuits, and shall have auxiliary contacts for use with the controls furnished. When motors and equipment furnished are larger than sizes indicated, the cost of additional electrical service and related work shall be included under the section that specified that motor or equipment. Power wiring and conduit for field installed equipment shall be provided under and conform to the requirements of Section 16415, "Electrical Work, Interior."

1.6 ELECTRICAL INSTALLATION REQUIREMENTS

Electrical installations shall conform to IEEE C2, NFPA 70, and requirements specified herein.

1.6.1 New Work

Provide electrical components of mechanical equipment, such as motors, motor starters (except starters/controllers which are indicated as part of a motor control center), control or push-button stations, float or pressure switches, solenoid valves, integral disconnects, and other devices functioning to control mechanical equipment, as well as control wiring and conduit for circuits rated 100 volts or less, to conform with the requirements of the section covering the mechanical equipment. Extended voltage range motors shall not be permitted. The interconnecting power wiring and conduit, control wiring rated 120 volts (nominal) and conduit, and the electrical power circuits shall be provided under Division 16, except internal wiring for components of package equipment shall be provided as an integral part of the equipment. When motors and equipment furnished are larger than sizes indicated, provide any required changes to the electrical service as may be necessary and related work as a part of the work for the section specifying that motor or equipment.

1.6.2 Modifications to Existing Systems

Where existing mechanical systems and motor-operated equipment require modifications, provide electrical components under Division 16.

1.6.3 High Efficiency Motors

1.6.3.1 High Efficiency Single-Phase Motors

Unless otherwise specified, single-phase fractional-horsepower alternating-current motors shall be high efficiency types corresponding to the applications listed in NEMA MG 11.

1.6.3.2 High Efficiency Polyphase Motors

Unless otherwise specified, polyphase motors shall be selected based on high efficiency characteristics relative to the applications as listed in NEMA MG 10. Additionally, polyphase squirrel-cage medium induction motors with continuous ratings shall meet or exceed energy efficient ratings in accordance with Table 12-6C of NEMA MG 1.

1.6.4 Three-Phase Motor Protection

Provide controllers for motors rated one one horsepower and larger with electronic phase-voltage monitors designed to protect motors from phase-loss, undervoltage, and overvoltage. Provide protection for motors from immediate restart by a time adjustable restart relay.

1.7 INSTRUCTION TO GOVERNMENT PERSONNEL

When specified in other sections, furnish the services of competent instructors to give full-instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system. Instructors shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work.

Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with the equipment or system.

When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

1.8 ACCESSIBILITY

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 PAINTING OF NEW EQUIPMENT

New equipment painting shall be factory applied or shop applied, and shall be as specified herein, and provided under each individual section.

3.1.1 Factory Painting Systems

Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors shall withstand 500 hours in a salt-spray fog test. Salt-spray fog test shall be in accordance with ASTM B 117, and for that test the acceptance criteria shall be as follows: immediately after completion of the test, the paint shall show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen shall show no signs of rust creepage beyond 0.125 inch on either side of the scratch mark.

The film thickness of the factory painting system applied on the equipment shall not be less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 120 degrees F, the factory painting system shall be designed for the temperature service.

3.1.2 Shop Painting Systems for Metal Surfaces

Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except metal surfaces subject to temperatures in excess of 120 degrees F shall be cleaned to bare metal.

Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat shall be aluminum or light gray.

a. Temperatures Less Than 120 Degrees F: Immediately after cleaning, the metal surfaces subject to temperatures less than 120 degrees F shall receive one coat of pretreatment primer applied to a minimum dry film thickness of 0.3 mil, one coat of primer applied to a minimum dry film thickness of one mil; and two coats of enamel applied to a minimum dry film thickness of one mil per coat.

b. Temperatures Between 120 and 400 Degrees F: Metal surfaces subject to temperatures between 120 and 400 degrees F shall receive two coats of 400 degrees F heat-resisting enamel applied to a total minimum thickness of 2 mils.

c. Temperatures Greater Than 400 Degrees F: Metal surfaces subject to temperatures greater than 400 degrees F shall receive two coats of 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of 2 mils.

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SECTION 15080

THERMAL INSULATION FOR MECHANICAL SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. At the discretion of the Government, the manufacturer of any material supplied will be required to furnish test reports pertaining to any of the tests necessary to assure compliance with the standard or standards referenced in this specification.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 167	(1999) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 580/A 580M	(1998) Stainless Steel Wire
ASTM B 209	(1996) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM C 195	(1995) Mineral Fiber Thermal Insulating Cement
ASTM C 449/C 449M	(1995) Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement
ASTM C 533	(1995) Calcium Silicate Block and Pipe Thermal Insulation
ASTM C 534	(1999) Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C 547	(1995) Mineral Fiber Pipe Insulation
ASTM C 552	(1991) Cellular Glass Thermal Insulation
ASTM C 553	(1992) Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C 591	(1994) Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C 610	(1995) Molded Expanded Perlite Block and Pipe thermal Insulation

ASTM C 612	(1993) Mineral Fiber Block and Board Thermal Insulation
ASTM C 647	(1995) Properties and Tests of Mastics and Coating Finishes for Thermal Insulation
ASTM C 665	(1998) Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
ASTM C 795	(1998el) Thermal Insulation for Use in Contact With Austenitic Stainless Steel
ASTM C 916	(1985; R 1996e1) Adhesives for Duct Thermal Insulation
ASTM C 920	(1998) Elastomeric Joint Sealants
ASTM C 921	(1989; R 1996) Determining the Properties of Jacketing Materials for Thermal Insulation
ASTM C 1126	(1998) Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation
ASTM C 1136	(1995) Flexible, Low Permeance Vapor Retarders for Thermal Insulation
ASTM E 84	(1999) Surface Burning Characteristics of Building Materials
ASTM E 96	(1995) Water Vapor Transmission of Materials

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application

MIDWEST INSULATION CONTRACTORS ASSOCIATION (MICA)

MICA Insulation Stds	(1993) National Commercial & Industrial Insulation Standards

1.2 SYSTEM DESCRIPTION

Field-applied insulation and accessories on mechanical systems shall be as specified herein; factory-applied insulation is specified under the piping or equipment to be insulated. Field applied insulation materials required for use on Government-furnished items as listed in the SPECIAL CONTRACT REQUIREMENTS shall be furnished and installed by the Contractor.

1.3 GENERAL QUALITY CONTROL

1.3.1 Standard Products

Materials shall be the standard products of manufacturers regularly engaged in the manufacture of such products and shall essentially duplicate items

that have been in satisfactory use for at least 2 years prior to bid opening.

Construction/fabrication materials shall contain no hazardous materials. Asbestos, lead, cadmium, mercury, PCBs, and other hazardous material shall not be used.

Suspect/Counterfeit Items (S/CIs) shall not be used.

1.3.2 Installer's Qualifications

Qualified installers shall have successfully completed three or more similar type jobs within the last 5 years.

1.3.3 Surface Burning Characteristics

Unless otherwise specified, insulation not covered with a jacket shall have a flame spread index no higher than 75 and a smoke developed index no higher than 150. Insulation systems which are located in air plenums, in ceiling spaces, and in attic spaces shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Insulation materials located exterior to the building perimeter are not required to be fire-rated. Flame spread and smoke developed indexes shall be determined by ASTM E 84. Insulation shall be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket shall be tested as a composite material. Jackets, facings, and adhesives shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E 84.

1.3.4 Identification of Materials

Packages or standard containers of insulation, jacket material, cements, adhesives, and coatings delivered for use, and samples required for approval shall have manufacturer's stamp or label attached giving the name of the manufacturer and brand, a description of the material, and Material Safety Data Sheets (MSDSs).

1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Samples

Thermal Insulation Materials; GA.

A complete list of materials, including manufacturer's descriptive technical literature, performance data, catalog cuts, and installation instructions. The product number, k-value, thickness and furnished accessories for each mechanical system requiring insulation shall be included. Materials furnished under this section of the specification shall be submitted at one time.

After approval of materials and prior to applying insulation a booklet shall be prepared and submitted for approval. The booklet shall contain marked-up MICA Insulation Stds plates (or detail

drawings showing the insulation material and insulating system) for each pipe or piece of equipment required to be insulated per this specification. The MICA plates shall be marked up showing the materials to be installed in accordance with the requirements of this specification for the specific insulation application. The Contractor shall submit all MICA Plates required to show the entire insulating system, including Plates required to show insulation penetrations, vessel bottom and top heads, legs, and skirt insulation as applicable. If the Contractor elects to submit detailed drawings instead of marked-up MICA Plates, the detail drawings shall show cut-away, section views, and details indicating each component of the insulation system and showing provisions for insulating jacketing, and sealing portions of the equipment. For each type of insulation installation on the drawings, provide a label which identifies each component in the installation (i.e., insulation, adhesive, vapor retarder, jacketing, tape, mechanical fasteners, etc.) Indicate insulation by type and manufacturer. Three copies of the booklet shall be submitted at the jobsite to the Contracting Officer. One copy of the approved booklet shall remain with the insulation Contractor's display sample and two copies shall be provided for Government use.

1.5 STORAGE

Materials shall be delivered in the manufacturer's unopened containers. Materials delivered and placed in storage shall be provided with protection from weather, humidity, dirt, dust and other contaminants. Insulation material and supplies that become dirty, dusty, wet, or otherwise contaminated may be rejected by the Contracting Officer.

PART 2 PRODUCTS

2.1 GENERAL MATERIALS

Materials shall be compatible and shall not contribute to corrosion, soften, or otherwise attack surfaces to which applied in either the wet or dry state. Materials to be used on stainless steel surfaces shall meet ASTM C 795 requirements. Materials shall be asbestos free and conform to the following:

2.1.1 Adhesives

2.1.1.1 Acoustical Lining Insulation Adhesive

Adhesive shall be a nonflammable, fire-resistant adhesive conforming to ASTM C 916, Type I.

2.1.1.2 Mineral Fiber Insulation Cement

Cement shall be in accordance with ASTM C 195.

2.1.1.3 Lagging Adhesive

Lagging is the material used for thermal insulation, especially around a cylindrical object. This may include the insulation as well as the cloth/material covering the insulation. Lagging adhesives shall be nonflammable and fire-resistant and shall have a flame spread rating no higher than 25 and a smoke developed rating no higher than 50 when tested in accordance with ASTM E 84. Adhesive shall be pigmented red and be

suitable for bonding fibrous glass cloth to faced and unfaced fibrous glass insulation board; for bonding cotton brattice cloth to faced and unfaced fibrous glass insulation board; for sealing edges of and bounding fibrous glass tape to joints of fibrous glass board; for bonding lagging cloth to thermal insulation; or for attaching fibrous glass insulation to metal surfaces. Lagging adhesives shall be applied in strict accordance with the manufacturer's recommendations.

2.1.2 Contact Adhesive

Adhesive may be dispersed in a nonhalogenated organic solvent or, dispersed in a nonflammable organic solvent which shall not have a fire point below 200 degrees F. The adhesive shall not adversely affect, initially or in service, the insulation to which it is applied, nor shall it cause any corrosive effect on metal to which it is applied. Any solvent dispersing medium or volatile component of the adhesive shall have no objectionable odor and shall not contain any benzene or carbon tetrachloride. The dried adhesive shall not emit nauseous, irritating, or toxic volatile matters or aerosols when the adhesive is heated to any temperature up to 212 degrees F. The adhesive shall be nonflammable and fire resistant.

2.1.3 Caulking

ASTM C 920, Type S, Grade NS, Class 25, Use A.

2.1.4 Corner Angles

Nominal 0.016 inch aluminum 1 x 1 inch with factory applied kraft backing. Aluminum shall be ASTM B 209, Alloy 3003, 3105, or 5005.

2.1.5 Finishing Cement

Mineral fiber hydraulic-setting thermal insulating cement ASTM C 449/C 449M. All cements that may come in contact with Austenitic stainless steel must include testing per ASTM C 795.

2.1.6 Fibrous Glass Cloth and Glass Tape

Fibrous glass cloth and glass tape shall have flame spread and smoke developed ratings of no greater than 25/50 when measured in accordance with ASTM E 84. Tape shall be 4 inch wide rolls.

2.1.7 Staples

Outward clinching type ASTM A 167, Type 304 or 316 stainless steel

2.1.8 Jackets

ASTM C 921, Type I, maximum moisture vapor transmission 0.02 perms, (measured before factory application or installation), minimum puncture resistance 50 Beach units on all surfaces, where a minimum puncture resistance of 25 Beach units is acceptable. Minimum tensile strength, 35 pound/inch width. ASTM C 921, Type II, minimum puncture resistance 25 Beach units, tensile strength minimum 20 pound/inchwidth. Jackets used on insulation exposed in finished areas shall have white finish suitable for painting without sizing. Based on the application, insulation materials which require factory applied jackets are mineral fiber, cellular glass, and phenolic foam. All non-metallic jackets shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in

accordance with ASTM E 84.

2.1.8.1 White Vapor Retarder All Service Jacket (ASJ)

For use on hot/cold pipes or equipment vapor retarder jackets used on insulation exposed in finished areas shall have white finish suitable for painting without sizing.

2.1.8.2 Aluminum Jackets

Aluminum jackets shall be corrugated, embossed or smooth sheet, 0.016 inch nominal thickness; ASTM B 209, Temper H14, Temper H16, Alloy 3003, 5005, or 3105 with factory applied moisture retarder. Corrugated aluminum jacket shall not be used outdoors. Aluminum jacket securing bands shall be Type 304 stainless steel, 0.015 inch thick, 1/2 inch wide for pipe under 12 inch diameter and 3/4 inch wide for pipe over 12 inch and larger diameter. Aluminum jacket circumferential seam bands shall be 2 x 0.016 inch aluminum matching jacket material. Bands for insulation below ground shall be 3/4 x 0.020 inch thick stainless steel, or fiberglass reinforced tape. The jacket may, at the option of the Contractor, be provided with a factory fabricated Pittsburgh or "Z" type longitudinal joint. When the "Z" joint is used, the bands at the circumferential joints shall be designed by the manufacturer to seal the joints and hold the jacket in place.

2.1.8.3 Polyvinyl Chloride (PVC) Jackets

Polyvinyl chloride (PVC) jacket and fitting covers shall have high impact strength, UV resistant rating or treatment and moderate chemical resistance with minimum thickness 0.030 inch.

2.1.9 Vapor Retarder Coating

The vapor retarder coating shall be fire and water resistant and appropriately selected for either outdoor or indoor service. Color shall be white. The water vapor permeance of the compound shall be determined according to procedure B of ASTM E 96 utilizing apparatus described in ASTM E 96. The coating shall be a nonflammable, fire resistant type. All other application and service properties shall be in accordance with ASTM C 647.

2.1.9.1 Vapor Retarder Required

ASTM C 1136, Type I, maximum moisture vapor transmission 0.02 perms, minimum puncture resistance 50 Beach units on all surfaces, where Type II, maximum moisture vapor transmission 0.02 perms, a minimum puncture resistance of 25 Beach units is acceptable.

2.1.9.2 Vapor Retarder Not Required

ASTM C 1136, Type III, maximum moisture vapor transmission 0.10 perms, minimum puncture resistance 50 Beach units on all surfaces, where Type IV, maximum moisture vapor transmission 0.10, a minimum puncture resistance of 25 Beach units is acceptable.

2.1.10 Wire

Soft annealed ASTM A 580/A 580M Type 302, 304 or 316 stainless steel, 16 or 18 gauge.

2.2 PIPE INSULATION MATERIALS

Pipe insulation materials shall meet the following requirements:

2.2.1 Aboveground Cold Pipeline

Insulation for minus 30 degrees to plus 60 degrees F for outdoor, indoor, exposed or concealed applications, shall be as follows:

a. Cellular Glass: ASTM C 552, Type II, and Type III. Supply the insulation with manufacturer's recommended factory applied jacket.

b. Flexible Cellular Insulation: ASTM C 534, Type I or II. Type II shall have vapor retarder skin on both sides of the insulation.

c. Phenolic Insulation: ASTM C 1126, Type III. Phenolic insulations shall comply with ASTM C 795 and with the ASTM C 665 paragraph Corrosiveness. Supply the insulation with manufacturer's recommended factory applied jacket.

d. Mineral Fiber: ASTM C 547

e. Polyisocyanurate Insulation: ASTM C 591, Type I. Supply the insulation with manufacturer's recommended factory applied jacket.

2.2.2 Aboveground Hot Pipeline

Insulation for above 60 degrees F, for outdoor, indoor, exposed or concealed applications shall meet the following requirements. Supply the insulation with manufacturers recommended factory applied jacket.

a. Mineral Fiber: ASTM C 547, Types I, II or III, supply the insulation with manufacturers recommended factory applied jacket.

b. Calcium Silicate: ASTM C 533, Type I indoor only, or outdoors above 250 degrees F pipe temperature.

c. Cellular Glass: ASTM C 552, Type II and Type III. Supply the insulation with manufacturers recommended factory applied jacket.

d. Flexible Cellular Insulation: ASTM C 534, Type I or II to 200 degrees F service.

e. Phenolic Insulation: ASTM C 1126 Type III to 250 F service shall comply with ASTM C 795. Supply the insulation with manufacturers recommended factory applied jacket.

f. Perlite Insulation: ASTM C 610

g. Polyisocyanurate Insulation: ASTM C 591, Type 1, to 300 degrees F service. Supply the insulation with manufacturer's recommended factory applied jacket.

2.2.3 Above Ground Dual Temperature Pipeline - Outdoor, Indoor - Exposed or Concealed

Not used.

2.2.4 Below ground Pipeline Insulation

For below ground pipeline insulation the following requirements shall be met.

2.2.4.1 Cellular Glass

ASTM C 552, Type II.

2.3 DUCT INSULATION MATERIALS

Not used.

2.4 EQUIPMENT INSULATION MATERIALS

Equipment insulation materials shall be limited to those listed herein and shall meet the following requirements:

2.4.1 Cold Equipment Insulation

For temperatures below 60 degrees F.

2.4.1.1 Cellular Glass

ASTM C 552, Type I, Type III, or Type IV as required.

2.4.1.2 Flexible Cellular Insulation

ASTM C 534, Type II.

2.4.1.3 Phenolic Foam

ASTM C 1126 Type II shall comply with ASTM C 795.

2.4.1.4 Polyisocyanurate Foam

ASTM C 591, Type I. Supply the insulation with manufacturer's factory applied jacket.

2.4.2 Hot Equipment Insulation

For temperatures above 60 degrees F.

2.4.2.1 Rigid Mineral Fiber

ASTM C 612, Type IA, IB, II, III, IV, or V as required for temperature encountered to 1800 degrees F.

2.4.2.2 Flexible Mineral Fiber

ASTM C 553, Type I, II, III, IV, V, VI or VII as required for temperature encountered to 1200 degrees F.

2.4.2.3 Calcium Silicate

ASTM C 533, Type I, indoors only, or outdoors above 250 degrees F. Pipe shape may be used on diesel engine exhaust piping and mufflers to 1200 degrees F.

2.4.2.4 Cellular Glass

ASTM C 552, Type I, Type III, or Type IV as required.

2.4.2.5 Flexible Cellular Insulation

ASTM C 534, Type II, to 200 degrees F.

2.4.2.6 Phenolic Foam

ASTM C 1126 Type II to 250 degrees F shall comply with ASTM C 795.

2.4.2.7 Molded Expanded Perlite

ASTM C 610.

2.4.2.8 Polyisocyanurate Foam

ASTM C 591, Type I. Supply the insulation with manufacturer's recommended factory applied jacket.

PART 3 EXECUTION

3.1 APPLICATION - GENERAL

3.1.1 Installation

Except as otherwise specified, material shall be installed in accordance with the manufacturer's written instructions. Insulation materials shall not be applied until tests specified in other sections of this specification are completed. Material such as rust, scale, dirt and moisture shall be removed from surfaces to receive insulation. Insulation shall be kept clean and dry. Insulation shall not be removed from its shipping containers until the day it is ready to use and shall be returned to like containers or equally protected from dirt and moisture at the end of each workday. Insulation that becomes dirty shall be thoroughly cleaned prior to use. If insulation becomes wet or if cleaning does not restore the surfaces to like new condition, the insulation will be rejected, and shall be immediately removed from the jobsite. Joints shall be staggered on multi layer insulation. Mineral fiber thermal insulating cement shall be mixed with demineralized water when used on stainless steel surfaces. Insulation, jacketing and accessories shall be installed in accordance with MICA Insulation Stds standard plates except where modified herein or on the drawings.

3.1.2 Firestopping

Where pipes pass through fire walls, fire partitions, above grade floors, and fire rated chase walls, the penetration shall be sealed with fire stopping materials as specified in Section 07840 FIRESTOPPING.

3.1.3 Painting and Finishing

Painting shall be as specified in Section 09900 PAINTING, GENERAL.

3.1.4 Installation of Flexible Cellular Insulation

Flexible cellular insulation shall be installed with seams and joints sealed with a contact adhesive. Flexible cellular insulation shall not be used on surfaces greater than 200 degrees F. Seams shall be staggered when applying multiple layers of insulation. Insulation exposed to weather and

not shown to have jacketing shall be protected with two coats of UV resistant finish as recommended by the manufacturer after the adhesive is dry.

3.1.5 Welding

No welding shall be done on piping or equipment without written approval of the Contracting Officer.

3.1.6 Pipes/Equipment which Require Insulation

Insulation is required on all pipes or equipment, except for omitted items, as specified.

3.2 PIPE INSULATION INSTALLATION

3.2.1 Pipe Insulation

3.2.1.1 General

Pipe insulation shall be installed on aboveground hot and cold pipeline systems as specified below to form a continuous thermal retarder, including straight runs, fittings and appurtenances unless specified otherwise. Installation shall be with full length units of insulation and using a single cut piece to complete a run. Cut pieces or scraps abutting each other shall not be used. Pipe insulation shall be omitted on the following:

a. Pipe used solely for fire protection.

b. Chromium plated pipe to plumbing fixtures. However, fixtures for use by the physically handicapped shall have the hot water supply and drain, including the trap, insulated where exposed.

c. Sanitary drain lines.

d. Air chambers.

3.2.1.2 Pipes Passing Through Walls, Roofs, and Floors

a. Pipe insulation shall be continuous through the sleeve.

b. An aluminum jacket with factory applied moisture retarder shall be provided over the insulation wherever penetrations require sealing.

c. Where penetrating interior walls, the aluminum jacket shall extend 2 inches beyond either side of the wall and shall be secured on each end with a band.

d. Where penetrating floors, the aluminum jacket shall extend from a point below the backup material to a point 10 inches above the floor with one band at the floor and one not more than 1 inch from the end of the aluminum jacket.

e. Where penetrating waterproofed floors, the aluminum jacket shall extend from below the backup material to a point 2 inchesabove the flashing with a band 1 inch from the end of the aluminum jacket.

f. Where penetrating exterior walls, the aluminum jacket required for pipe exposed to weather shall continue through the sleeve to a

point 2 inches beyond the interior surface of the wall.

g. Where penetrating roofs, pipe shall be insulated as required for interior service to a point flush with the top of the flashing and sealed with vapor retarder coating. The insulation for exterior application shall butt tightly to the top of flashing and interior insulation. The exterior aluminum jacket shall extend 2 inches down beyond the end of the insulation to form a counter flashing. The flashing and counter flashing shall be sealed underneath with caulking.

h. For hot water pipes supplying lavatories or other similar heated service which requires insulation, the insulation shall be terminated on the backside of the finished wall. The insulation termination shall be protected with two coats of vapor barrier coating with a minimum total thickness of 1/16 inch applied with glass tape embedded between coats (if applicable). The coating shall extend out onto the insulation 2 inches and shall seal the end of the insulation. Glass tape seams shall overlap 1 inch. Caulk the annular space between the pipe and wall penetration with approved fire stop material. Cover the pipe and wall penetration with a properly sized (well fitting) escutcheon plate. The escutcheon plate shall overlap the wall penetration at least 3/8 inch.

i. For domestic cold water pipes supplying lavatories or other similar cooling service which requires insulation, the insulation shall be terminated on the finished side of the wall (i.e., insulation must cover the pipe throughout the wall penetration). The insulation shall be protected with two coats of vapor barrier coating with a minimum total thickness of 1/16 inch. The coating shall extend out onto the insulation 2 inches and shall seal the end of the insulation. Caulk the annular space between the outer surface of the pipe insulation and the wall penetration with an approved fire stop material having vapor retarder properties. Cover the pipe and wall penetration with a properly sized (well fitting) escutcheon plate. The escutcheon plate shall overlap the wall penetration by at least 3/8 inch.

3.2.1.3 Pipes Passing Through Hangers

a. Insulation, whether hot or cold application, shall be continuous through hangers. All horizontal pipes 2 inches and smaller shall be supported on hangers with the addition of a Type 40 protection shield to protect the insulation in accordance with MSS SP-69. Whenever insulation shows signs of being compressed, or when the insulation or jacket shows visible signs of distortion at or near the support shield, insulation inserts as specified below for piping larger than 2 inches shall be installed.

b. Horizontal pipes larger than 2 inches at 60 degrees F and above shall be supported on hangers in accordance with MSS SP-69, and Section 15400 PLUMBING, GENERAL PURPOSE.

c. Horizontal pipes larger than 2 inches and below 60 degrees F shall be supported on hangers with the addition of a Type 40 protection shield in accordance with MSS SP-69. An insulation insert of cellular glass or calcium silicate or perlite (above 80 F) shall be installed above each shield. The insert shall cover not less

than the bottom 180 degree arc of the pipe. Inserts shall be the same thickness as the insulation, and shall extend 2 inches on each end beyond the protection shield. When insulation inserts are required per the above, and the insulation thickness is less than 1 inch, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the weight of the pipe from crushing the insulation, as an option to installing insulation inserts. The insulation jacket shall be continuous over the wooden dowel, wooden block, or insulation insert.

d. Vertical pipes shall be supported with either Type 8 or Type 42 riser clamps with the addition of two Type 40 protection shields in accordance with MSS SP-69 covering the 360 degree arc of the insulation. An insulation insert of cellular glass or calcium silicate shall be installed between each shield and the pipe. The insert shall cover the 360 degree arc of the pipe. Inserts shall be the same thickness as the insulation, and shall extend 2 inches on each end beyond the protection shield. When insulation inserts are required per the above, and the insulation thickness is less than 1 inch, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the hanger from crushing the insulation, as an option instead of installing insulation inserts. The insulation jacket shall be continuous over the wooden dowel, wooden block, or insulation insert. The vertical weight of the pipe shall be supported with hangers located in a horizontal section of the pipe. When the pipe riser is longer than 30 feet, the weight of the pipe shall be additionally supported with hangers in the vertical run of the pipe which are directly clamped to the pipe, penetrating the pipe insulation. These hangers shall be insulated and the insulation jacket sealed as indicated herein for anchors in a similar service.

e. Inserts shall be covered with a jacket material of the same appearance and quality as the adjoining pipe insulation jacket, shall overlap the adjoining pipe jacket 1-1/2 inches, and shall be sealed as required for the pipe jacket. The jacket material used to cover inserts in flexible cellular insulation shall conform to ASTM C 1136, Type I, and is allowed to be of a different material than the adjoining insulation material.

3.2.1.4 Flexible Cellular Pipe Insulation

Flexible cellular pipe insulation shall be tubular form for pipe sizes 6 inches and less. Type II sheet insulation used on pipes larger than 6 inches shall not be stretched around the pipe. On pipes larger than 12 inches, adhere insulation directly to the pipe on the lower 1/3 of the pipe. Seams shall be staggered when applying multiple layers of insulation. Sweat fittings shall be insulated with miter-cut pieces the same size as on adjacent piping. Screwed fittings shall be insulated with sleeved fitting covers fabricated from miter-cut pieces and shall be overlapped and sealed to the adjacent pipe insulation.

3.2.1.5 Pipes in High Abuse Areas

Not used.

3.2.2 Aboveground Cold Pipelines

The following cold pipelines shall be insulated per Table I minus 30

degrees to plus 60 degrees F:

a. Domestic cold water.

b. Make-up water.

c. Alum transfer and recirculation piping.

d. Air conditioner condensate drains.

3.2.2.1 Insulation Thickness

Insulation thickness for cold pipelines shall be determined using Table I.

LEGEND:

PF - Phenolic Foam
CG - Cellular Glass
MF - Mineral Fiber
FC - Flexible Cellular
PC - Polyisocyanurate Foam

Table I - Cold Piping Insulation Thickness
Pipe Size (inches)

Type of Service	Material	Runouts up to 2 in*	1 in & less	1.25 - 2 in	2.5 - 4 in	5 - 6 in	8 in & larger
Brine System Cryogenics (-30 to 0 deg F)	CG		2.5	2.5	3.0	3.0	3.5
	FC		1.5	1.5	1.5	1.75	1.75
	PF		1.0	1.0	1.5	1.5	1.5
	PC		1.0	1.0	1.0	1.0	1.0
Brine System Cryogenics 0 to 34 deg F)	CG		2.0	2.0	2.0	2.5	3.0
	FC		1.0	1.0	1.25	1.25	1.5
	PF		1.0	1.0	1.0	1.0	1.5
	PC		1.0	1.0	1.0	1.0	1.0
Refrigerant suction piping	CG		1.5	1.5	1.5	1.5	1.5
	FC		1.0	1.0	1.0	1.0	1.0
	PF		1.0	1.0	1.0	1.0	1.0
	PC		1.0	1.0	1.0	1.0	1.0
Chilled water supply & return & dual temp piping	CG	1.5	1.5	1.5	2.0	2.0	2.0
	FC	0.5	1.0	1.0	1.0	1.0	1.0
	PF	1.0	1.0	1.0	1.0	1.0	1.0
	PC	1.0	1.0	1.0	1.0	1.0	1.0
Cold domestic water, above and below ceilings & makeup water	CG	1.5	1.5	1.5	1.5	1.5	1.5
	FC	3/8	3/8	3/8	3/8	3/8	3/8
	PF	1.0	1.0	1.0	1.0	1.0	1.0
	PC	1.0	1.0	1.0	1.0	1.0	1.0
Exposed lavatory drains exposed	FC	0.5	0.5	0.5	0.5	3/4	3/4
	MF	0.5	1.0	1.0	1.5	1.5	1.5

Table I - Cold Piping Insulation Thickness
Pipe Size (inches)

Type of Service	Material	Runouts up to 2 in*	1 in & less	1.25 - 2 in	2.5 - 4 in	5 - 6 in	8 in & larger
domestic water piping & drains to areas for handicap personnel							
Horizontal & vertical roof drain leaders (including underside of roof drain fitting)	FC		0.5	0.5	0.5	0.5	0.5
	PF		1.0	1.0	1.0	1.0	1.0
	CG		1.5	1.5	1.5	1.5	1.5
	PC		1.0	1.0	1.0	1.0	1.0
Air conditioning condensate drain located inside building	FC		3/8	0.5	0.5	N/A	N/A
	PF		1.0	1.0	1.0	N/A	N/A
	PC		1.0	1.0	1.0	N/A	N/A

*When runouts to terminal units exceed 12 feet, the entire length of runout shall be insulated like main feed pipe.

3.2.2.2 Jacket for Mineral Fiber, Cellular Glass, Phenolic Foam, and Polyisocyanurate Foam Insulated Pipe

Insulation shall be covered with a factory applied vapor retarder jacket or field applied seal welded PVC jacket. Insulation inside the building shown to be protected with an aluminum jacket shall have the insulation and vapor retarder jacket installed as specified herein. The aluminum jacket shall be installed as specified for piping exposed to weather, except sealing of the laps of the aluminum jacket is not required.

3.2.2.3 Insulation for Straight Runs (Mineral Fiber, Cellular Glass, Phenolic Foam and Polyisocyanurate Foam)

a. Insulation shall be applied to the pipe with joints tightly butted. All butted joints and ends shall be sealed with a vapor retarder coating.

b. Longitudinal laps of the jacket material shall overlap not less than 1-1/2 inches. Butt strips 3 inches wide shall be provided for circumferential joints.

c. Laps and butt strips shall be secured with adhesive and stapled on 4 inch centers if not factory self-sealing. If staples are used, they shall be sealed per paragraph 3.2.2.3 e.

d. Factory self-sealing lap systems may be used when the ambient temperature is between 40 degrees and 120 degrees F during

installation. The lap system shall be installed in accordance with manufacturer's recommendations. Stapler shall be used only if specifically recommended by the manufacturer. Where gaps occur, the section shall be replaced or the gap repaired by applying adhesive under the lap and then stapling.

e. All staples, including those used to repair factory self-seal lap systems, shall be coated with a vapor retarder coating. All seams, except those on factory self-seal systems shall be coated with vapor retarder coating.

f. Breaks and punctures in the jacket material shall be patched by wrapping a strip of jacket material around the pipe and securing it with adhesive, stapling, and coating with vapor retarder coating. The patch shall extend not less than 1-1/2 inches past the break.

g. At penetrations such as thermometers, the voids in the insulation shall be filled and sealed with vapor retarder coating.

3.2.2.4 Insulation for Fittings and Accessories

a. Pipe insulation shall be tightly butted to the insulation of the fittings and accessories. The butted joints and ends shall be coated with vapor retarder coating.

b. Precut or preformed insulation shall be placed around all fittings and accessories and shall conform to MICA plates except as modified herein: 5 for anchors; 10, 11, and 13 for fittings; 14 for valves; and 17 for flanges and unions. Insulation shall be the same insulation as the pipe insulation, including same density, thickness, and thermal conductivity. Where precut/preformed is unavailable, rigid preformed pipe insulation sections may be segmented into the shape required. Insulation of the same thickness and conductivity as the adjoining pipe insulation shall be used. If nesting size insulation is used, the insulation shall be overlapped 2 inches or one pipe diameter. Elbows insulated using segments shall conform to MICA Tables 12.20 "Mitered Insulation Elbow".

c. Upon completion of insulation installation on flanges, unions, valves, anchors, fittings and accessories, terminations, seams, joints and insulation not protected by factory vapor retarder jackets or PVC fitting covers shall be protected with two coats of vapor retarder coating with a minimum total thickness of 1/16 inch, applied with glass tape embedded between coats. Tape seams shall overlap 1 inch. The coating shall extend out onto the adjoining pipe insulation 2 inches. Fabricated insulation with a factory vapor retarder jacket shall be protected with two coats of vapor retarder coating with a minimum thickness of 1/16 inch and with a 2 inch wide glass tape embedded between coats. Where fitting insulation butts to pipe insulation, the joints shall be sealed with a vapor retarder coating and a 4 inch wide ASJ tape which matches the jacket of the pipe insulation.

d. Anchors attached directly to the pipe shall be insulated for a sufficient distance to prevent condensation but not less than 6 inches from the insulation surface.

e. Insulation shall be marked showing the location of unions, strainers, and check valves.

3.2.2.5 Optional PVC Fitting Covers

At the option of the Contractor, premolded, one or two piece PVC fitting covers may be used in lieu of the vapor retarder and embedded glass tape. Factory precut or premolded insulation segments shall be used under the fitting covers for elbows. Insulation segments shall be the same insulation as the pipe insulation including same density, thickness, and thermal conductivity. The covers shall be secured by PVC vapor retarder tape, adhesive, seal-welding or with tacks made for securing PVC covers. Seams in the cover, and tacks and laps to adjoining pipe insulation jacket, shall be sealed with vapor retarder tape to ensure that the assembly has a continuous vapor seal.

3.2.3 Aboveground Hot Pipelines

The following hot pipelines above 60 degrees F shall be insulated per Table II:

a. Domestic hot water supply.

b. Hot water heating.

3.2.3.1 Insulation Thickness

Insulation thickness for hot pipelines shall be determined using Table II.

LEGEND:

PF - Phenolic Foam
CG - Cellular Glass
CS - Calcium Silicate
MF - Mineral Fiber
FC - Flexible Cellular
PL - Perlite
PC - Polyisocyanurate Foam

Table II - Hot Piping Insulation Thickness
Pipe Size (inches)

Type of Service (degrees F)	Material	Runouts up to 2 in *	1 in & less	1.25 - 2 in	2.5 - 4 in	5 - 6 in	8 in & larger
Hot domestic	CG	1.5	1.5	1.5	1.5	1.5	1.5
water supply &	FC	0.5	0.5	1.0	1.0	1.5	1.5
recirculating	PF	0.5	0.5	1.0	1.0	1.0	1.0
system, & water	MF	0.5	1.5	1.5	1.5	1.5	1.5
defrost lines	PC	1.0	1.0	1.0	1.0	1.0	1.0
(200 F max)**							
Compressed Air	CG		1.5	2.0	2.0	2.0	3.5
discharge	PF		1.0	1.0	1.0	1.0	1.5
steam	MF		1.5	1.5	2.0	2.0	2.5
& condensate	CS/PL		1.5	2.0	2.5	2.5	3.5
return (201-	PC		1.0	1.0	1.0	1.0	1.0

Table II - Hot Piping Insulation Thickness
Pipe Size (inches)

Type of Service (degrees F)	Material	Runouts up to 2 in *	1 in & less	1.25 - 2 in	2.5 - 4 in	5 - 6 in	8 in & larger
250 F)							
Heating hot	CG	1.5	1.5	2.0	2.0	2.5	3.0
water, supply	PF	0.5	1.0	1.0	1.0	1.0	1.5
& return, &	MF	0.5	1.5	1.5	2.0	2.5	3.0
Heating oil	CS	1.0	1.5	2.0	2.5	2.5	3.0
(250 F max)	PC	1.0	1.0	1.0	1.0	1.0	1.0
Medium Temp	CG	1.5	2.5	3.0	3.5	3.5	4.0
Hot water &	MF	1.5	2.0	2.5	2.5	3.0	3.5
stream, &	CS/PL	1.5	2.5	2.5	3.5	3.5	4.5
heated oil (251 - 350F)							
High Temp Hot	CG	2.0	3.5	4.0	4.5	5.0	5.5
water & steam	MF	1.5	3.0	3.5	4.0	4.0	4.5
(351 - 500 F)	CS/PL	2.0	3.5	4.0	4.5	5.0	5.5

* When runouts to terminal units exceed 12 feet, the entire length of runout shall be insulated like the main feed pipe.

** Applies to recirculating sections of service or domestic hot water systems and first 8 feet from storage tank for non-recirculating systems.

3.2.3.2 Jacket for Insulated Hot Pipe, Except Pipe Insulated with Flexible Cellular

Insulation shall be covered, in accordance with manufacturer's recommendations, with a factory applied Type II jacket or field applied aluminum where required or seal welded PVC.

3.2.3.3 Insulation for Straight Runs

a. Insulation shall be applied to the pipe with joints tightly butted.

b. Longitudinal laps of the jacket material shall overlap not less than 1-1/2 inches, and butt strips 3 inches wide shall be provided for circumferential joints.

c. Laps and butt strips shall be secured with adhesive and stapled on 4 inch centers if not factory self-sealing. Adhesive may be omitted where pipe is concealed.

d. Factory self-sealing lap systems may be used when the ambient temperature is between 40 degrees and 120 degrees F and shall be installed in accordance with manufacturer's instructions. Laps and butt strips shall be stapled whenever there is nonadhesion of the system. Where gaps occur, the section shall be replaced or the gap repaired by applying adhesive under the lap and then stapling.

e. Breaks and punctures in the jacket material shall be patched by either wrapping a strip of jacket material around the pipe and securing with adhesive and staple on 4 inch centers (if not factory self-sealing), or patching with tape and sealing with a brush coat of vapor retarder coating. Adhesive may be omitted where pipe is concealed. Patch shall extend not less than 1-1/2 inches past the break.

f. Flexible cellular pipe insulation shall be installed by slitting tubular sections and applying onto piping or tubing. Alternately, whenever possible, slide unslit sections over the open ends of piping or tubing. All seams and butt joints shall be secured and sealed with adhesive. When using self seal products only the butt joints shall be secured with adhesive. Insulation shall be pushed on the pipe, never pulled. Stretching of insulation may result in open seams and joints. All edges shall be clean cut. Rough or jagged edges of the insulation shall not be permitted. Proper tools such as sharp knives shall be used. Type II sheet insulation when used on pipe larger than 6 inches shall not be stretched around the pipe. On pipes larger than 12 inches, adhere sheet insulation directly to the pipe on the lower 1/3 of the pipe.

3.2.3.4 Insulation for Fittings and Accessories

a. Pipe insulation shall be tightly butted to the insulation of the fittings and accessories.

b. Precut or preformed insulation shall be placed around all fittings and accessories and shall conform to MICA plates, except as modified herein: 5 for anchors; 10, 11, 12,and 13 for fittings; 14, 15 and 16 for valves; 17 for flanges and unions; and 18 for couplings. Insulation shall be the same as the pipe insulation, including same density, thickness, and thermal conductivity. Where precut/preformed is unavailable, rigid preformed pipe insulation sections may be segmented into the shape required. Insulation of the same thickness and conductivity as the adjoining pipe insulation shall be used. If nesting size insulation is used, the insulation shall be overlapped 2 inches or one pipe diameter. Elbows insulated using segments shall conform to MICA Tables 12.20 "Mitered Insulation Elbow".

c. Upon completion of installation of insulation on flanges, unions, valves, anchors, fittings and accessories, terminations and insulation not protected by factory vapor retarder jackets or PVC fitting covers shall be protected with two coats of adhesive applied with glass tape embedded between coats. Tape seams shall overlap 1 inch. Adhesive shall extend onto the adjoining insulation not less than 2 inches. The total dry film thickness shall be not less than 1/16 inch.

d. Insulation terminations shall be tapered to unions at a 45-degree angle.

e. At the option of the Contractor, factory premolded one- or two-piece PVC fitting covers may be used in lieu of the adhesive and embedded glass tape. Factory premolded segments or factory or field cut blanket insert insulation segments shall be used under the cover and shall be the same thickness as adjoining pipe

insulation. The covers shall be secured by PVC vapor retarder tape, adhesive, seal-welding or with tacks made for securing PVC covers.

3.2.4 Piping Exposed to Weather

Piping exposed to weather shall be insulated and jacketed as specified for the applicable service inside the building. After this procedure, an aluminum jacket or PVC jacket shall be applied. PVC jacketing requires no factory applied jacket beneath it, however an all service jacket shall be applied if factory applied jacketing is not furnished. Flexible cellular insulation exposed to weather shall be treated in accordance with paragraph INSTALLATION OF FLEXIBLE CELLULAR INSULATION.

3.2.4.1 Aluminum Jacket

The jacket for hot piping may be factory applied. The jacket shall overlap not less than 2 inches at longitudinal and circumferential joints and shall be secured with bands at not more than 12 inch centers. Longitudinal joints shall be overlapped down to shed water and located at 4 or 8 o'clock positions. Joints on piping 60 degrees F and below shall be sealed with caulking while overlapping to prevent moisture penetration. Where jacketing on piping 60 degrees F and below abuts an uninsulated surface, joints shall be caulked to prevent moisture penetration. Joints on piping above 60 degrees F shall be sealed with a moisture retarder.

3.2.4.2 Insulation for Fittings

Flanges, unions, valves, fittings, and accessories shall be insulated and finished as specified for the applicable service. Two coats of breather emulsion type weatherproof mastic (impermeable to water, permeable to air) recommended by the insulation manufacturer shall be applied with glass tape embedded between coats. Tape overlaps shall be not less than 1 inch and the adjoining aluminum jacket not less than 2 inches. Factory preformed aluminum jackets may be used in lieu of the above. Molded PVC fitting covers shall be provided when PVC jackets are used for straight runs of pipe. PVC fitting covers shall have adhesive welded joints and shall be weatherproof.

3.2.4.3 PVC Jacket

PVC jacket shall be ultraviolet resistant and adhesive welded weather tight with manufacturer's recommended adhesive. Installation shall include provision for thermal expansion.

3.2.5 Below Ground Pipe Insulation

Not used.

3.3 DUCT INSULATION INSTALLATION

Not used.

3.4 EQUIPMENT INSULATION INSTALLATION

3.4.1 General

Removable insulation sections shall be provided to cover parts of equipment which must be opened periodically for maintenance including vessel covers,

fasteners, flanges and accessories. Equipment insulation shall be omitted on the following:

a. Handholes.

b. Boiler manholes.

c. Cleanouts.

d. ASME stamps.

e. Manufacturer's nameplates.

3.4.2 Insulation for Cold Equipment

Cold equipment below 60 degrees F: Insulation shall be furnished on equipment handling media below 60 degrees F including the following:

a. Pumps.

b. Refrigeration equipment parts that are not factory insulated.

c. Drip pans under chilled equipment.

d. Cold water storage tanks.

e. Water softeners.

f. Cold and chilled water pumps.

g. Pneumatic water tanks.

h. Roof drain bodies.

i. Air handling equipment parts that are not factory insulated.

j. Expansion and air separation tanks.

3.4.2.1 Insulation Type

Insulation shall be suitable for the temperature encountered. Thicknesses shall be as follows:

a. Equipment handling media between 35 and 60 degrees F: 1.5 inch thick cellular glass, 1 inch thick flexible cellular, 1 inch thick phenolic foam, or 1 inch thick polyisocyanurate foam.

b. Equipment handling media between 0 degree F and 34 degrees F: 3 inch thick cellular glass, 1 1/2 inch flexible cellular, 1 1/2 inch thick phenolic foam, or 1 1/2 inch thick polyisocyanurate foam.

c. Equipment handling media between minus 30 degrees F and 1 degree F: 3 1/2 inch thick cellular glass 1 3/4 inch thick flexible cellular, 1 1/2 inch thick phenolic foam, or 1 1/2 inch thick polyisocyanurate foam.

3.4.2.2 Pump Insulation

a. Pumps shall be insulated by forming a box around the pump housing. The box shall be constructed by forming the bottom and sides using joints which do not leave raw ends of insulation exposed. Joints between sides and between sides and bottom shall be joined by adhesive with lap strips for rigid mineral fiber and contact adhesive for flexible cellular insulation. The box shall conform to the requirements of MICA Insulation Stds plate No. 49 when using flexible cellular insulation. Joints between top cover and sides shall fit tightly forming a female shiplap joint on the side pieces and a male joint on the top cover, thus making the top cover removable.

b. Exposed insulation corners shall be protected with corner angles.

c. Upon completion of installation of the insulation, including removable sections, two coats of vapor retarder coating shall be applied with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 1/16 inch. A parting line shall be provided between the box and the removable sections allowing the removable sections to be removed without disturbing the insulation coating. Caulking shall be applied to parting line, between equipment and removable section insulation, and at all penetrations.

3.4.2.3 Other Equipment

a. Insulation shall be formed or fabricated to fit the equipment. To ensure a tight fit on round equipment, edges shall be beveled and joints shall be tightly butted and staggered.

b. Insulation shall be secured in place with bands or wires at intervals as recommended by the manufacturer but not more than 12 inch centers except flexible cellular which shall be adhered. Insulation corners shall be protected under wires and bands with suitable corner angles.

c. Cellular glass and phenolic foam insulation shall be set in a coating of bedding compound, and joints shall be sealed with bedding compound as recommended by the manufacturer.

d. Insulation on heads of heat exchangers shall be removable. Removable section joints shall be fabricated using a male-female shiplap type joint. The entire surface of the removable section shall be finished by applying two coats of vapor retarder coating with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 1/16 inch.

e. Exposed insulation corners shall be protected with corner angles.

f. Insulation on equipment with ribs shall be applied over 6 x 6 inches by 12 gauge welded wire fabric which has been cinched in place, or if approved by the Contracting Officer, spot welded to the equipment over the ribs. Insulation shall be secured to the fabric with J-hooks and 2 x 2 inches washers or shall be securely banded or wired in place on 12 inch centers.

3.4.2.4 Vapor Retarder

Upon completion of installation of insulation, penetrations shall be

caulked. Two coats of vapor retarder coating shall be applied over insulation, including removable sections, with a layer of open mesh synthetic fabric embedded between the coats. The total dry thickness of the finish shall be 1/16 inch. Caulking shall be applied to parting line between equipment and removable section insulation.

3.4.3 Insulation for Hot Equipment

Insulation shall be furnished on equipment handling media above 60 degrees F including the following:

a. Converters.

b. Heat exchangers.

c. Hot water generators.

d. Water heaters.

e. Pumps handling media above 130 degrees F.

f. Fuel oil heaters.

g. Hot water storage tanks.

h. Air separation tanks.

i. Surge tanks.

j. Flash tanks.

k. Feedwater heaters.

l. Unjacketed boilers or parts of boilers.

m. Boiler flue gas connection from boiler to stack (if inside).

n. Induced draft fans.

o. Fly ash and soot collectors.

p. Condensate receivers.

3.4.3.1 Insulation

Insulation shall be suitable for the temperature encountered. Shell and tube-type heat exchangers shall be insulated for the temperature of the shell medium.

Insulation thickness for hot equipment shall be determined using Table IV:

Legend

RMF: Rigid Mineral Fiber
FMF: Flexible Mineral Fiber
CS: Calcium Silicate
PL: Perlite
CG: Cellular Glass
FC: Flexible Cellular

PF: Phenolic Foam
PC: Polyisocyanurate Foam

TABLE IV
Insulation Thickness for Hot Equipment (Inches)

Equipment handling steam or media to indicated pressure or temperature limit:	Material	Thickness
15 psig	RMF	2.0 inches
or	FMF	2.0 inches
250F	CS/PL	4.0 inches
	CG	3.0 inches
	PF	1.5 inches
	FC (<200F)	1.0 inches
	PC	1.0 inches
200 psig	RMF	3.0 inches
or	FMF	3.0 inches
400 F	CS/PL	4.0 inches
	CG	4.0 inches
600 F	RMF	5.0 inches
	FMF	6.0 inches
	CS/PL	6.0 inches
	CG	6.0 inches

>600 F: Thickness necessary to limit the external temperature of the insulation to 120F, except that diesel engine exhaust piping and mufflers shall be covered with 6.0 inch thick material suitable for 1200 degrees F service. Heat transfer calculations shall be submitted to substantiate insulation and thickness selection.

3.4.3.2 Insulation of Pumps

Pumps shall be insulated by forming a box around the pump housing. The box shall be constructed by forming the bottom and sides using joints which do not leave raw ends of insulation exposed. Bottom and sides shall be banded to form a rigid housing which does not rest on the pump. Joints between top cover and sides shall fit tightly. The top cover shall have a joint forming a female shiplap joint on the side pieces and a male joint on the top cover, making the top cover removable. Two coats of Class I adhesive shall be applied over insulation, including removable sections, with a layer of glass cloth embedded between the coats. A parting line shall be provided between the box and the removable sections allowing the removable sections to be removed without disturbing the insulation coating. The total dry thickness of the finish shall be 1/16 inch. Caulking shall be applied to parting line of the removable sections and penetrations.

3.4.3.3 Other Equipment

a. Insulation shall be formed or fabricated to fit the equipment. To ensure a tight fit on round equipment, edges shall be beveled and joints shall be tightly butted and staggered.

b. Insulation shall be secured in place with bands or wires at

intervals as recommended by the manufacturer but not greater than 12 inch centers except flexible cellular which shall be adhered. Insulation corners shall be protected under wires and bands with suitable corner angles.

c. On high vibration equipment, cellular glass insulation shall be set in a coating of bedding compound as recommended by the manufacturer, and joints shall be sealed with bedding compound. Mineral fiber joints shall be filled with finishing cement.

d. Insulation on heads of heat exchangers shall be removable. The removable section joint shall be fabricated using a male-female shiplap type joint. Entire surface of the removable section shall be finished as specified.

e. Exposed insulation corners shall be protected with corner angles.

f. On equipment with ribs, such as boiler flue gas connection, draft fans, and fly ash or soot collectors, insulation shall be applied over 6 x 6 inch by 12 gauge welded wire fabric which has been cinched in place, or if approved by the Contracting Officer, spot welded to the equipment over the ribs. Insulation shall be secured to the fabric with J-hooks and 2 x 2 inch washers or shall be securely banded or wired in place on 12 inch (maximum) centers.

g. On equipment handling media above 600 degrees F, insulation shall be applied in two or more layers with joints staggered.

h. Upon completion of installation of insulation, penetrations shall be caulked. Two coats of adhesive shall be applied over insulation, including removable sections, with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 1/16 inch. Caulking shall be applied to parting line between equipment and removable section insulation.

3.4.4 Equipment Handling Dual Temperature Media

Below and above 60 degrees F: equipment handling dual temperature media shall be insulated as specified for cold equipment.

3.4.5 Equipment Exposed to Weather (Not Used)

-- End of Section --

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SECTION 15190

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SECTION 15190

GAS PIPING SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN GAS ASSOCIATION (AGA)

AGA Manual	(1994; Addenda/Correction Jan 1996) A.G.A. Plastic Pipe Manual for Gas Service

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.45	(1995) Flexible Connectors of Other Than All-Metal Construction for Gas Appliances
ANSI Z21.69	(1992; Z21.69a) Connectors for Movable Gas Appliances

AMERICAN PETROLEUM INSTITUTE (API)

API Spec 6D	(1994; Supple 1 Jun 1996; Supple 2 Dec 1997) Pipeline Valves (Gate, Plug, Ball, and Check Valves)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 88	(1999) Seamless Copper Water Tube
ASTM B 280	(1999) Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
ASTM D 2513	(1999a) Thermoplastic Gas Pressure Pipe, Tubing, and Fittings

ASME INTERNATIONAL (ASME)

ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch)
ASME B16.3	(1998) Malleable Iron Threaded Fittings
ASME B16.5	(1996; B16.5a) Pipe Flanges and Flanged Fittings NPS 1/2 thru NPS 24
ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings
ASME B16.11	(1996) Forged Fittings, Socket-Welding and

	Threaded
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.33	(1990) Manually Operated Metallic Gas Valves for Use in Gas Piping Systems Up to 125 psig (Sizes 1/2 through 2)
ASME B31.1	(1998) Power Piping
ASME B31.2	(1968) Fuel Gas Piping
ASME B36.10M	(1996) Welded and Seamless Wrought Steel Pipe
ASME BPV IX	(1998) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(1998) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(1999) National Fuel Gas Code
NFPA 70	(2002) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL Gas&Oil Dir	(1999)Gas and Oil Equipment Directory

1.2 GENERAL REQUIREMENTS

1.2.1 Welding

Piping shall be welded in accordance with qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPV IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified at least 24 hours in advance of tests and the tests shall be performed at the work site if practicable. The Contracting Officer shall be furnished with a copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record.

1.2.2 Jointing Thermoplastic and Fiberglass Piping

Piping shall be jointed by performance qualified joiners using qualified procedures in accordance with AGA Manual. Plastic Pipe Manual for Gas Service. The Contracting Officer shall be furnished with a copy of qualified procedures and list of and identification symbols of qualified joiners.

1.2.3 Standard Products

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Asbestos or products containing asbestos shall not be used. Manufacturer's descriptive data and installation instructions shall be submitted for approval for compression-type mechanical joints used in joining dissimilar materials and for insulating joints. Valves, flanges and fittings shall be marked in accordance with MSS SP-25.

1.2.4 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Gas Piping System; GA.

Drawings showing location, size and all branches of pipeline; location of all required shutoff valves; and instructions necessary for the installation of connectors and supports.

SD-03 Product Data

Qualifications; GA.

Qualified procedures and a list of names and identification symbols of qualified welders and welding operators.

SD-06 Test Reports

Testing; GA.
Pressure Tests; GA.

Test With Gas; GA.

Test reports in booklet form tabulating test and measurements performed. The reports shall be dated after award of this contract, shall state the contractor's name and address, shall name the project and location, and shall list the specific requirements which are being certified.

PART 2 PRODUCTS

2.1 MATERIALS

Construction/fabrication and other materials brought onto the job site shall contain no hazardous materials. Asbestos, lead, cadmium, mercury, PCBs and other hazardous material shall not be used.

Suspect/Counterfeit Items (S/CIs) shall not be used.

Provide Material Safety Data Sheets (MSDSs) where applicable.

2.2 PIPE AND FITTINGS

2.2.1 Steel Pipe, Joints, and Fittings

Steel pipe shall conform to ASME B36.10M. Malleable-iron threaded fittings shall conform to ASME B16.3. Steel pipe flanges and flanged fittings including bolts, nuts, and bolt pattern shall be in accordance with ASME B16.5. Wrought steel buttwelding fittings shall conform to ASME B16.9. Socket welding and threaded forged steel fittings shall conform to ASME B16.11.

2.2.2 Copper Tubing, Joints and Fittings

Copper tubing shall conform to ASTM B 88, Type K or L, or ASTM B 280. Tubing joints shall be made up with tubing fittings recommended by the tubing manufacturer.

2.2.3 Thermoplastic Pipe, Tubing, Joints, and Fittings

Thermoplastic pipe, tubing, joints and fittings shall conform to ASTM D 2513.

2.2.4 Sealants for Steel Pipe Threaded Joints

Joint sealing compound shall be listed in UL Gas&Oil Dir, Class 20 or less. Tetrafluoroethylene tape shall conform to UL Gas&Oil Dir.

2.2.5 Identification

Pipe flow markings and metal tags shall be provided as required.

2.2.6 Flange Gaskets

Gaskets shall be nonasbestos compressed material in accordance with ASME B16.21, 1/16 inch thickness, full face or self-centering flat ring type. The gaskets shall contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR) suitable for a maximum 600 degree F service. NBR binder shall be used for hydrocarbon service.

2.2.7 Pipe Threads

Pipe threads shall conform to ASME B1.20.1.

2.2.8 Escutcheons

Escutcheons shall be chromium-plated steel or chromium-plated brass, either one piece or split pattern, held in place by internal spring tension or set screw.

2.2.9 Gas Transition Fittings

Gas transition fittings shall be manufactured steel fittings approved for jointing metallic and thermoplastic or fiberglass pipe. Approved transition fittings are those that conform to AGA Manual requirements for transitions fittings.

2.2.10 Insulating Pipe Joints

2.2.10.1 Insulating Joint Material

Insulating joint material shall be provided between flanged or threaded metallic pipe systems where shown to control galvanic or electrical action.

2.2.10.2 Threaded Pipe Joints

Joints for threaded pipe shall be steel body nut type dielectric unions with insulating gaskets.

2.2.10.3 Flanged Pipe Joints

Joints for flanged pipe shall consist of full face sandwich-type flange insulating gasket of the dielectric type, insulating sleeves for flange bolts, and insulating washers for flange nuts.

2.2.11 Flexible Connectors

Flexible connectors for connecting gas utilization equipment to building gas piping shall conform to ANSI Z21.45. Flexible connectors for movable food service equipment shall conform to ANSI Z21.69.

2.3 VALVES

Valves shall be suitable for shutoff or isolation service and shall conform to the following:

2.3.1 Valves 2 Inches and Smaller

Valves 2 inches and smaller shall conform to ASME B16.33 and shall be of materials and manufacture compatible with system materials used.

2.3.2 Valves 2-1/2 Inches and Larger

Valves 2-1/2 inches and larger shall be carbon steel conforming to API Spec 6D, Class 150.

2.4 PIPE HANGERS AND SUPPORTS

Pipe hangers and supports shall conform to MSS SP-58 and MSS SP-69.

2.5 METERS, REGULATORS AND SHUTOFF VALVES

Meters, regulators and shutoff valves shall be as specified in Section 02556 GAS DISTRIBUTION SYSTEM.

PART 3 EXECUTION

3.1 EXCAVATION AND BACKFILLING

Earthwork shall be as specified in Section 02316 EXCAVATION, TRENCHING AND BACKFILLING FOR UTILITIES SYSTEMS.

3.2 GAS PIPING SYSTEM

Gas piping system shall be from the point of delivery, defined as the outlet of the meter set assembly specified in Section 02556 GAS DISTRIBUTION SYSTEM, to the connections to each gas utilization device.

3.2.1 Protection of Materials and Components

Pipe and tube openings shall be closed with caps or plugs during installation. Equipment shall be protected from dirt, water, and chemical or mechanical damage. At the completion of all work, the entire system shall be thoroughly cleaned.

3.2.2 Workmanship and Defects

Piping, tubing and fittings shall be clear and free of cutting burrs and defects in structure or threading and shall be thoroughly brushed and chip-and scale-blown. Defects in piping, tubing or fittings shall not be repaired. When defective piping, tubing, or fittings are located in a system, the defective material shall be replaced.

3.3 PROTECTIVE COVERING

3.3.1 Underground Metallic Pipe

Buried metallic piping shall be protected from corrosion with protective coatings as specified in Section 02556 GAS DISTRIBUTION SYSTEM. When dissimilar metals are joined underground, gastight insulating fittings shall be used.

3.3.2 Aboveground Metallic Piping Systems

3.3.2.1 Ferrous Surfaces

Shop primed surfaces shall be touched up with ferrous metal primer. Surfaces that have not been shop primed shall be solvent cleaned. Surfaces that contain loose rust, loose mill scale and other foreign substances shall be mechanically cleaned by power wire brushing and primed with ferrous metal primer. Primed surface shall be finished with two coats of exterior oil paint.

3.4 INSTALLATION

Installation of the gas system shall be in conformance with the manufacturer's recommendations and applicable provisions of NFPA 54, AGA Manual, and as indicated. Pipe cutting shall be done without damage to the pipe. Unless otherwise authorized, cutting shall be done by an approved type of mechanical cutter. Wheel cutters shall be used where practicable. On steel pipe 6 inches and larger, an approved gas cutting and beveling machine may be used. Cutting of thermoplastic and fiberglass pipe shall be in accordance with AGA Manual.

3.4.1 Metallic Piping Installation

Underground piping shall be buried a minimum of 18 inches below grade.

Changes in direction of piping shall be made with fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connection may be made with either tees or forged branch outlet fittings. Branch outlet fittings shall be forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Aluminum alloy pipe shall not be used.

3.4.2 Piping Buried Under Buildings

Underground piping installed beneath buildings shall be run in a steel pipe casing protected from corrosion with protective coatings as specified in Section 02556 GAS DISTRIBUTION SYSTEM. The casing shall extend at least 4 inches outside the building. The pipe shall have spacers and end bushings to seal at both ends to prevent the entrance of water and escape of gas. A vent line from the annular space shall extend above grade outside to a point where gas will not be a hazard and shall terminate in a rain- and insect-resistant fitting.

3.4.3 Concealed Piping in Buildings

When installing piping which is to be concealed, unions, tubing fittings, running threads, right- and left-hand couplings, bushings, and swing joints made by combinations of fittings shall not be used.

3.4.3.1 Piping in Partitions

Concealed piping shall be located in hollow rather than solid partitions. Tubing passing through walls or partitions shall be protected against physical damage.

3.4.4 Aboveground Piping

Aboveground piping shall be run as straight as practicable along the alignment indicated and with a minimum of joints. Piping shall be separately supported.

3.4.5 Final Gas Connections

Unless otherwise specified, final connections shall be made with rigid metallic pipe and fittings. Provide accessible gas shutoff valve and coupling for each gas equipment item.

3.5 PIPE JOINTS

Pipe joints shall be designed and installed to effectively sustain the longitudinal pull-out forces caused by contraction of the piping or superimposed loads.

3.5.1 Threaded Metallic Joints

Threaded joints in metallic pipe shall have tapered threads evenly cut and shall be made with UL approved graphite joint sealing compound for gas service or tetrafluoroethylene tape applied to the male threads only. Threaded joints up to 1-1/2 inches in diameter may be made with approved tetrafluoroethylene tape. Threaded joints up to 2 inches in diameter may be made with approved joint sealing compound. After cutting and before threading, pipe shall be reamed and burrs shall be removed. Caulking of threaded joints to stop or prevent leaks shall not be permitted.

3.5.2 Welded Metallic Joints

Beveling, alignment, heat treatment, and inspection of welds shall conform to ASME B31.2. Weld defects shall be removed and repairs made to the weld, or the weld joints shall be entirely removed and rewelded. After filler metal has been removed from its original package, it shall be protected or stored so that its characteristics or welding properties are not affected adversely. Electrodes that have been wetted or have lost any of their coating shall not be used.

3.6 PIPE SLEEVES

Pipes passing through concrete or masonry walls or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves shall not be installed in structural members except where indicated or approved. All rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective wall, floor or roof, and shall be cut flush with each surface, except in mechanical room floors not located on grade where clamping flanges or riser pipe clamps are used. Sleeves in mechanical room floors above grade shall extend at least 4 inches above finish floor. Unless otherwise indicated, sleeves shall be large enough to provide a minimum clearance of 1/4 inch all around the pipe. Sleeves in bearing walls, waterproofing membrane floors, and wet areas shall be steel pipe. Sleeves in nonbearing walls, floors, or ceilings may be steel pipe, galvanized sheet metal with lock-type longitudinal seam, or moisture-resistant fiber or plastic. For penetrations of fire walls, fire partitions and floors which are not on grade, the annular space between the pipe and sleeve shall be sealed with firestopping material and sealant that meet the requirement of Section 07840 FIRESTOPPING.

3.7 PIPES PENETRATING WATERPROOFING MEMBRANES

Pipes penetrating waterproofing membranes shall be installed as specified in Section 15400 PLUMBING, GENERAL PURPOSE.

3.8 FIRE SEAL

Penetrations of fire rated partitions, walls and floors shall be in accordance with Section 07840 FIRESTOPPING.

3.9 ESCUTCHEONS

Escutcheons shall be provided for all finished surfaces where gas piping passes through floors, walls, or ceilings except in boiler, utility, or equipment rooms.

3.10 SPECIAL REQUIREMENTS

Drips, grading of the lines, freeze protection, and branch outlet locations shall be as shown and shall conform to the requirements of NFPA 54.

3.11 BUILDING STRUCTURE

Building structure shall not be weakened by the installation of any gas piping. Beams or joists shall not be cut or notched.

3.12 PIPING SYSTEM SUPPORTS

Gas piping systems in buildings shall be supported with pipe hooks, metal pipe straps, bands or hangers suitable for the size of piping or tubing. Gas piping system shall not be supported by other piping. Spacing of supports in gas piping and tubing installations shall conform to the requirements of NFPA 54. The selection and application of supports in gas piping and tubing installations shall conform to the requirements of MSS SP-69. In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for any of the individual pipes in the multiple pipe run. The clips or clamps shall be rigidly connected to the common base member. A clearance of 1/8 inch shall be provided between the pipe and clip or clamp for all piping which may be subjected to thermal expansion.

3.13 ELECTRICAL BONDING AND GROUNDING

The gas piping system within the building shall be electrically continuous and bonded to a grounding electrode as required by NFPA 70. Conventional flange joints shall allow sufficient current flow to satisfy this requirement.

3.14 SHUTOFF VALVE

Main gas shutoff valve controlling the gas piping system shall be easily accessible for operation and shall be installed as indicated, protected from physical damage, and marked with a metal tag to clearly identify the piping system controlled.

3.15 TESTING

Before any section of a gas piping system is put into service, it shall be carefully tested to assure that it is gastight. Prior to testing, the system shall be blown out, cleaned and cleared of all foreign material. Each joint shall be tested by means of an approved gas detector, soap and water, or an equivalent nonflammable solution. Testing shall be completed before any work is covered, enclosed, or concealed. All testing of piping systems shall be done with due regard for the safety of employees and the public during the test. Bulkheads, anchorage and bracing suitably designed to resist test pressures shall be installed as necessary. Oxygen shall not be used as a testing medium.

3.15.1 Pressure Tests

Before equipment is connected, piping systems shall be filled with air or an inert gas and shall withstand a minimum pressure of 3 pounds gauge for a period of not less than 10 minutes as specified in NFPA 54 without showing any drop in pressure. Oxygen shall not be used. Pressure shall be measured with a mercury manometer, slope gauge, or an equivalent device so calibrated as to be read in increments of not greater than 0.1 pound. The source of pressure shall be isolated before the pressure tests are made.

3.15.2 Test With Gas

Before turning gas under pressure into any piping, all openings from which gas can escape shall be closed. Immediately after turning on the gas, the piping system shall be checked for leakage by using a laboratory-certified gas meter, an appliance orifice, a manometer, or equivalent device. All testing shall conform to the requirements of NFPA 54. If leakage is

recorded, the gas supply shall be shut off, the leak shall be repaired, and the tests repeated until all leaks have been stopped.

3.15.3 Purging

After testing is completed, and before connecting any equipment, all gas piping shall be fully purged. Piping shall not be purged into the combustion chamber of equipment. The open end of piping systems being purged shall not discharge into confined spaces or areas where there are ignition sources unless the safety precautions recommended in NFPA 54 are followed.

3.15.4 Labor, Materials and Equipment

All labor, materials and equipment necessary for conducting the testing and purging shall be furnished by the Contractor.

3.16 PIPE COLOR CODE MARKING

Color code marking of piping shall be as specified in Section 09900 PAINTING, GENERAL.

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SECTION 15200

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SECTION 15200

PIPELINES, LIQUID PROCESS PIPING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36/A 36M	(1997a) Carbon Structural Steel
ASTM A 47	(1990; R 1995) Ferritic Malleable Iron Castings
ASTM A 53	(1998) Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded, and Seamless
ASTM A 193/A 193M	(1998) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A 194/A 194M	(1998) Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service
ASTM A 576	(1990b; R 1995) Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM A 780	(1993a) Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM B 124	(1996) Copper and Copper Alloy Forging Rod, Bar, and Shapes
ASTM D 1784	(1999) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 1785	(1996b) Poly(Vinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2447	(1995) Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter
ASTM D 2467	(1996a) Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2564	(1996a) Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems

ASTM D 2609	(1997) Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe
ASTM D 2657	(1997) Heat Fusion Joining Polyolefin Pipe and Fittings
ASTM D 2683	(1998) Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
ASTM D 2737	(1996a) Polyethylene (PE) Plastic Tubing
ASTM D 2774	(1994) Underground Installation of Thermoplastic Pressure Piping
ASTM D 2855	(1996) Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D 3261	(1997) Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D 3308	(1997) PTFE Resin Skived Tape
ASTM D 3350	(1996) Polyethylene Plastics Pipe and Fittings Materials
ASTM D 3839	(1994a) Underground Installation of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D 3892	(1993) Packaging/Packing of Plastics
ASTM E 814	(1997) Fire Tests of Through-Penetration Fire Stops
ASTM F 402	(1993) Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings
ASTM F 656	(1996a) Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings
ASTM F 1055	(1998) Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing
ASTM F 1056	(1997) Socket Fusion Tools for Use in Socket Fusion Joining Polyethylene Pipe or Tubing and Fittings
ASTM F 1290	(1998) Electrofusion Joining Polyolefin Pipe and Fittings

ASME INTERNATIONAL (ASME)

ASME B1.1	(1989) Unified Inch Screw Threads (UN and UNR Thread Form)
ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch)
ASME B16.5	(1996; B16a) Pipe Flanges and Flanged Fittings NPS 1/2 thru NPS 24
ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings
ASME B16.11	(1996) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.34	(1997) Valves - Flanged, Threaded, and Welding End
ASME B31.1	(1998) Power Piping
ASME B31.3	(1999) Process Piping
ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C510	(1997) Double Check Valve Backflow-Prevention Assembly

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	(1998) Structural Welding Code - Steel

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1910	Occupational Safety and Health Standards

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(1998) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application
MSS SP-89	(1998) Pipe Hangers and Supports - Fabrication and Installation Practices

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1991) Enclosures for Electrical Equipment

(1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 49	(1994) Hazardous Chemical Data
NFPA 325-1	(1994) Fire Hazard Properties of Flammable Liquids, Gases and Volatile Solids
NFPA 704	(1996) Identification of the Fire Hazards of Materials for Emergency Response

1.2 SYSTEM DESCRIPTION

This specification covers the requirements for above and below grade liquid process pipe, pipe supports, fittings, equipment and accessories located both inside and outside of treatment plants.

1.2.1 Design Requirements

Support systems shall be selected and designed within the specified spans and component requirements. The absence of pipe supports and details on the contract drawings does not relieve the Contractor of responsibility for sizing and providing supports throughout facility.

1.2.2 Performance Requirements

The pressure ratings and materials specified represent minimum acceptable standards for piping systems. The piping systems shall be suitable for the services specified and intended. Each piping system shall be coordinated to function as a unit. Flanges, valves, fittings and appurtenances shall have a pressure rating no less than that required for the system in which they are installed.

1.2.2.1 Buried Piping Systems

Piping systems shall be suitable for design conditions, considering the piping both with and without internal pressure. Consideration shall be given to all operating and service conditions both internal and external to the piping systems.

1.2.2.2 Above Grade Piping Systems

Piping systems shall be suitable for design conditions, considering the piping both with and without internal pressure, and installation factors such as insulation, support spans, and ambient temperatures. Consideration shall be given to all operating and service conditions both internal and external to the piping systems.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Pipe and Equipment; GA

Equipment shop drawings and support system detail drawings showing piping systems and appurtenances, such as mechanical joints, valves, local indicators and hangers, including a complete list of equipment and materials. As-built drawings showing pipe anchors and guides, and layout of piping systems relative to other parts of the work including clearances for maintenance and operation. As-built piping and instrumentation diagrams (P&IDs) identifying and labeling equipment, instrumentation, valves, vents, drains, and all other inline devices; if the contract drawings contained P&IDs, the P&IDs found in the contract drawings shall be revised to reflect the constructed process system, as directed by the Contracting Officer.

SD-03 Product Data

Qualifications; GA

A statement certifying that the Contractor has the specified experience.

Welders; GA

The names of all qualified welders, their identifying symbols, and the qualifying procedures for each welder including support data such as test procedures used, standards tested to, etc.

Assistance and Training; GA

A signed statement certifying that the installation is satisfactory and in accordance with the contract drawings and specifications and the manufacturer's prescribed procedures and techniques, upon completion of the project and before final acceptance.

Delivery, Storage and Handling; GA

Material safety data sheets.

Materials and Equipment; FIO

Manufacturer's descriptive and technical literature for each piping system, including design recommendations; pressure and temperature ratings; dimensions, type, grade and strength of pipe and fittings; and thermal characteristics (coefficient of expansion and thermal conductivity); unless the chemicals are provided to the GC.

Installation; FIO

The manufacturer's installation recommendations or instructions for each material or procedure to be utilized, including materials preparation.

Pipe Schedule; GA

A list of piping systems, pressure ratings and source of supply for each piping system broken out by material, size and application as indicated on the contract drawings. A list of any

special tools necessary for each piping system and appurtenances furnished for adjustment, operation, maintenance and disassembly of the system.

Valve Schedule; GA
Operator Schedule; GA

A list of valve materials, pressure ratings, valve operator's materials, electrical service, location, source of supply, and reference identification as indicated in the contract drawings. A list of any special tools necessary for each valve type and appurtenances furnished for adjustment, operation, maintenance and disassembly.

SD-06 Test Reports

Pipe Leakage Tests; GA
Hydrostatic Tests; GA
Pneumatic Tests; GA
Valve Testing; GA

Copies of all field test reports within 24 hours of the completion of the test.

SD-07 Certificates

Plastic Piping System; GA

Documentation certifying that the manufacturer of each thermoplastic piping system is listed with the Plastic Pipe Institute as meeting the recipe and mixing requirements of the resin manufacturer for the resin used to manufacture each of the respective thermoplastic pipe systems.

Contractor's Installation; GA

A statement signed by the reinforced thermosetting resin pipe and plastic pipe manufacturer's representative certifying that the Contractor's personnel are capable of properly installing the piping system on the project.

SD-10 Operation and Maintenance Data

Piping and Appurtenances; FIO

Six (6) copies each of operation and maintenance manuals in indexed booklet form. Operation manuals shall detail the step-by-step procedures required for specialized startup, operation and shutdown of piping systems, and shall include the manufacturer's name, model number, parts list and brief description of piping equipment such as valves and other appurtenances and their basic operating features. Maintenance manuals shall list routine maintenance procedures and troubleshooting guides for the equipment, and shall include piping layout and valve locations.

1.4 QUALIFICATIONS

1.4.1 Contractor

Contractor shall have successfully completed at least 3 projects of the same scope and size or larger within the last 6 years. Contractor shall demonstrate specific experience in regard to the system installation to be performed.

1.4.2 Welders

The welding of pressure piping systems shall be in accordance with qualifying procedures using performance qualified welders and operators.

1.5 GENERAL JOB REQUIREMENTS

Piping materials and appurtenances shall be as specified and as shown on the drawings, and shall be suitable for the service intended. Piping materials, appurtenances and equipment supplied as part of this contract shall be new and unused except for testing equipment. Components that serve the same function and are the same size shall be identical products of the same manufacturer. The general materials to be used for the piping systems are indicated by service in the Pipe Schedule.

1.5.1 Components

Piping equipment and appurtenances shall be new products of equal material and ratings as the connecting pipe.

1.5.2 Standard Products

Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacturing of the products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

1.5.3 Identification

Each piece of pipe shall bear the ASTM designation and all other markings required for that designation. Valves shall bear a securely attached tag with the manufacturer's name, valve model number, and valve identification permanently displayed and be marked in accordance with MSS SP-25.

1.6 DELIVERY, STORAGE AND HANDLING

Materials delivered and placed in storage shall be stored with protection from the weather, excessive humidity variation, excessive temperature variation, dirt, dust and/or other contaminants. Proper protection and care of material before, during and after installation is the Contractor's responsibility. Any material found to be damaged shall be replaced at the Contractor's expense. During installation, piping shall be capped to keep out dirt and other foreign matter. A material safety data sheet in conformance with 29 CFR 1910 Section 1200(g) shall accompany each chemical delivered for use in pipe installation. At a minimum, this includes all solvents, solvent cements, glues and other materials that may contain hazardous compounds. Handling shall be in accordance with ASTM F 402. Storage facilities shall be classified and marked in accordance with NFPA 704, with classification as indicated in NFPA 49 and NFPA 325-1. Materials shall be stored with protection from puncture, dirt, grease, moisture, mechanical abrasions, excessive heat, ultraviolet (UV) radiation damage, or other damage. Pipe and fittings shall be handled and stored in accordance with the manufacturer's recommendation. Plastic pipe shall be packed,

packaged and marked in accordance with ASTM D 3892.

1.7 PROJECT/SITE CONDITIONS

1.7.1 Environmental Requirements

Buried piping at the site may be subject to corrosion from the surrounding soil. Piping system design, supply and installation shall address the external corrosion conditions so indicated.

1.7.2 Existing Conditions

The Contractor shall be responsible for the verification of existing piping and penetrations. Prior to ordering materials, the Contractor shall expose all existing pipes which are to be connected to new pipelines. The Contractor shall verify the size, material, joint types, elevation, horizontal location, and pipe service of existing pipes, and inspect size and location of structure penetrations to verify adequacy of wall sleeves, and other openings before installing connecting pipes.

1.7.3 Verification of Dimensions

After becoming familiar with all details of the work, the Contractor shall verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

1.8 SEQUENCING AND SCHEDULING

For slab, floor, wall, and roof penetrations, the Contractor shall have onsite pertinent wall pipes and sleeves before they are required for placement in concrete forms. The Contractor shall verify and coordinate the size and location of building and structure pipe penetrations before forming and placing concrete.

1.9 MAINTENANCE

1.9.1 Service

Services for automatic valve systems shall be provided by a manufacturer's representative who is experienced in the installation, adjustment and operation of the equipment specified. The representative shall inspect the installation, and supervise the adjustment and testing of the equipment.

1.9.2 Extra Materials

Concurrent with delivery and installation of the specified piping systems and appurtenances, spare parts for each different item of material and equipment specified that is recommended by the manufacturer to be replaced any time up to 3 years of service shall be furnished. For each type and size of valve, the following extra materials shall be provided: lubricator, lubricant (with appropriate temperature rating), lubricator/isolating valve. Extra materials shall include 2 of the following spare parts for each type and size of valve: gaskets; O-ring seals; diaphragms (molded); all elastomer parts; stem packing; seat rings and seat ring pulling tool.

PART 2 PRODUCTS

2.1 CARBON STEEL PIPING SYSTEM

2.1.1 Carbon Steel Pipe

2.1.1.1 General Service

Carbon steel pipe shall meet the requirements of ASTM A 53 seamless, Schedule 40.

2.1.2 Carbon Steel Joints

Carbon steel piping shall be joined by threaded couplings or welding fittings. Dielectric fittings or isolation joints shall be provided between all dissimilar metals.

2.1.3 Carbon Steel Fittings

Fittings shall be carbon steel.

2.1.3.1 Threaded Fittings

Threaded fittings shall be Class 150, and threaded in accordance with ASME B1.20.1. Polytetrafluoroethylene (PTFE) pipe-thread tape conforming to ASTM D 3308 shall be used for lubricant/sealant.

2.2 PLASTIC PIPING SYSTEM

2.2.1 Polyvinyl Chloride (PVC)

2.2.1.1 PVC Pipe

PVC, ASTM D 1784, minimum cell classification 12454B, pipe shall be Type I Grade 1 Schedule 80 conforming to ASTM D 1785.

2.2.1.2 [Enter Appropriate Subpart Title Here]

2.2.1.3 PVC Joints

The piping system shall be joined by socket-weld or flanged connections except where connecting to unions, valves, and equipment with threaded connections that may require future disassembly. Connections at those points shall be threaded and back-welded. Tubing connections shall use compression fittings.

2.2.1.4 PVC Fittings

The schedule rating for the fittings shall not be less than that for the associated pipe. Fittings shall be ASTM D 1784, minimum cell classification 12454B, PVC conforming to the requirements of ASTM D 2467, socket type.

a. Flanged Fittings. Flanges and flanged fittings shall be Class 150, DI backing flanges with ASME B16.5 drilling. Flanges shall be complete with one-piece, molded PVC stub ends. Flanged connections shall have the same pressure rating as the pipe or greater. Bolting shall be stainless steel, ASTM A 193/A 193M, Grade B8 hex head bolts and ASTM A 194/A 194M, Grade 8 hex head nuts. Bolts shall be provided with washers of the same material as the bolts. Gaskets shall be full-faced, maximum 1/8 inch thick, fabricated from polytetrafluoroethylene (PTFE) or Viton in accordance with ASME B16.21. When the mating flange or has a raised face, a flat ring gasket shall be used and a filler gasket shall be provided between outer diameter of the raised face and

the flange outer diameter to protect the PVC flange from bolting moment.

b. Tubing Fittings. Fittings shall be compression type comprised of forged brass alloy C37700, conforming to ASTM B 124, nuts, ferrules and bodies rated to a minimum 125 psig with straight threads conforming to ASME B1.1.

2.2.1.5 PVC Solvent Cement

Socket connections shall be joined with PVC solvent cement conforming to ASTM D 2564. Manufacture and viscosity shall be as recommended by the pipe and fitting manufacturer to assure compatibility. Joints shall be prepared with primers conforming to ASTM F 656 prior to cementing and assembly.

2.2.2 Polyethylene (PE)

2.2.2.1 PE Pipe

The pipe shall be extruded from PE, ASTM D 3350 with a minimum cell classification of 324433-C. The PE pipe shall be Schedule 80 conforming to ASTM D 2447.

2.2.2.2 PE Tubing

Tubing shall be flexible low-density PE conforming to ASTM D 3350, and dimensioned in accordance with ASTM D 2737 with nominal size in accordance with Pipe Schedule.

2.2.2.3 PE Joints

PE pipe shall be joined by thermal butt-fusion, except where connecting to valves and equipment that may require future disassembly, then joints shall be flanged.

2.2.2.4 PE Fittings

PE fittings shall have the same or higher pressure rating as the pipe when installed in accordance with the latest technical specifications. PE fittings shall be molded. Butt-fusion fittings shall conform to ASTM D 3261. Socket-fusion fittings shall conform to ASTM D 2683 with tools meeting the requirements of ASTM F 1056. Insert fittings shall conform to ASTM D 2609.

a. Couplings. Couplings and saddle joints shall be joined by electrofusion in accordance with ASTM F 1055.

b. Flanged Fittings. Flanges and flanged fittings shall be Class 150, DI backing flanges with ASME B16.5 drilling. Flanges shall be complete with one-piece, molded PE stub ends. Flanged connections shall have the same pressure rating as the pipe or greater. Bolting shall be stainless steel, ASTM A 193/A 193M, Grade B8 hex head bolts and ASTM A 194/A 194M, Grade 8 hex head nuts. Bolts shall be provided with washers of the same material as the bolts. Gaskets shall be full-faced, maximum 1/8 inch thick, fabricated from polytetrafluoroethylene (PTFE) or Viton in accordance with ASME B16.21.

c. Tubing Fittings. Fittings shall be compression type comprised of polypropylene nuts and bodies, with elastomeric O-ring seals rated

to a minimum 150 psig with straight threads conforming to ASME B1.1.

2.3 ISOLATION JOINTS AND COUPLINGS

2.3.1 Dielectric Fittings

Dielectric fittings shall be provided between threaded ferrous and nonferrous metallic pipe, fittings and valves. Dielectric fittings shall prevent metal-to-metal contact of dissimilar metallic piping elements and shall be suitable for the required working pressure, temperature and corrosive application.

2.3.2 Isolation Joints

Isolation joints shall be provided between nonthreaded ferrous and nonferrous metallic pipe fittings and valves. Isolation joints shall consist of an isolation gasket of the dielectric type, isolation washers and isolation sleeves for flange bolts. Isolation gaskets shall be full faced with an outside diameter equal to the flange outside diameter. Bolt isolation sleeves shall be full length. Units shall be of a shape to prevent metal-to-metal contact of dissimilar metallic piping elements.

2.3.3 Couplings for Nonmetallic Piping

2.3.3.1 Bellows Coupling

A bellows coupling shall have a minimum of two polytetrafluoroethylene (PTFE) convolutions unless otherwise shown, with ductile iron flanged, faced and drilled to ASME B16.5 Class 150 end connections, and metal reinforcing bands. The maximum allowable working pressure shall be 140 psig at 120 degrees F. Bolting shall be limited to restrain the force developed by 1.5 times the specified maximum allowable operating pressure. The coupling shall be sized to match the associated piping.

2.4 VALVES

2.4.1 General Requirements For Valves

Valves shall include operator, actuator, handwheel, chain wheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and all other accessories required for a complete operation. The valves shall be suitable for the intended service. Renewable parts are not to be of a lower quality than those specified. Valve ends shall be compatible with adjacent piping system. An operator shall be sized to operate the associated valve for the full range of pressures and velocities. Valves will open by turning counterclockwise. Operators, actuators, and accessories shall be factory mounted.

2.4.2 Factory Finishing

Exposed valves shall be finished in accordance with Section 09900 PAINTING, GENERAL.

2.4.3 Check Valves

2.4.3.1 Thermoplastic Check Valve

Thermoplastic check valves, 3/4 inch through 8 inches, shall be a horizontal swing check design, manufactured of polyvinyl chloride (PVC)

with flanged end connections. External nuts, bolts, and washers shall be made of 304SS. Internal nuts, bolts, and washers shall be made of PVC. Valves shall be rated for 150 psig service. Valves shall have Teflon seals and seats. The valves shall have a swing disc with lever and spring to balance the disc. Flow direction arrows shall be provided.

2.4.4 Ball Valves

2.4.4.1 General Purpose Ball Valves

General purpose ball valves shall conform to the following:

a. Ball valves, 8 inches and larger, shall be end entry type with cast iron bodies and ASME B16.5 flanged ends. Valves shall have polytetrafluoroethylene (PTFE) packing and seats, a stainless steel ball, full bore ports, and hand wheel operators. Valves shall be rated for 200 psig service at 150 degrees F and shall conform to ASME B16.34.

2.4.4.2 Thermoplastic Ball Valve

Thermoplastic ball valves, 6 inches and smaller, shall be rated for 150 psig service at 450 degrees F and maximum 200 psig service at 250 degrees F., polyvinyl chloride (PVC) bodies, balls, and stems. Valves shall be end entry, double union design, with flanged ends connections, a Teflon backed with EPDM seat, and ethylene propylene diene monomer (EPDM) O-ring stem seals. Valves shall have hand lever operators.

2.4.5 Gate Valves

2.4.5.1 Thermoplastic Gate Valve

Thermoplastic gate valves, 0.5 inches and larger, shall have ASTM D 1784 polyvinyl chloride (PVC), minimum cell classification 12454B bodies, bolted bonnets, single polypropylene wedge discs, non-rising stems, and flanged end connections. Valves shall be rated for service at 120 degrees F. Valves shall be equipped with handwheel operators. Chain wheel operators shall be used for all gate valves over 1 inch in size installed over 6 feet above the finished floor.

2.4.6 Plug Valves

2.4.6.1 Three-way Valve

Three-way valves, 12 inches and smaller, shall be rated for 175 psig service at 140 degrees F. Valves shall have drip-tight shutoff with pressure from either direction, and cast iron bodies in accordance with ASME B16.5 flanged end connections, chloroprene plug with rectangular ports, nickel seats, self-lubricating stainless steel stem bearings, and O-ring seals. Valves shall be equipped with electrically actuated operators.

2.4.6.2 Lined Eccentric Valve

Nonlubricated type eccentric valves, 3 inches through 14 inches, shall be rated for 175 psig service at 140 degrees F. Valves shall have drip-tight shutoff with pressure from either direction, and cast iron bodies in accordance with ASME B16.5 flanged end connections. Plugs shall be cast iron with round or rectangular ports of no less than 100 percent of the

connecting pipe area and coated with chloroprene. Valves shall have nickel seats, self-lubricating stainless steel stem bearings, and multiple O-rings stem seals nitrile rubber grit seals on the stems. Valves shall be equipped with handwheel operators. Valves 8 inches and larger shall have a totally enclosed, geared, manual operator with handwheel, 2-inch nut, or chain wheel.

2.4.7 Butterfly Valves

2.4.7.1 Thermoplastic Butterfly Valves

Thermoplastic butterfly valves, 1.5 inch and larger, shall have wafer style bodies constructed of polyvinyl chloride (PVC). Valves shall have polyvinyl chloride (PVC) discs, ethylene propylene diene monomer (EPDM) seats, ethylene propylene diene monomer (EPDM) Teflon seals, and lever operators. Valves 8 inches and larger to be provided with gear actuators. Valves shall be rated for service at 120 degrees F.

2.4.8 Operators

2.4.8.1 Manual Operator

The force in a manual operator shall not exceed 39.3 pound under any operating condition, including initial breakaway. The operator shall be equipped with gear reduction when force exceeds 39.3 pound. The manual operator shall be a self-locking type or shall be equipped with a self-locking device. A position indicator shall be supplied on quarter-turn valves. Worm and gear operators shall be a one-piece design with worm-gears of gear bronze material. Worm shall be hardened alloy steel with the thread ground and polished. Traveling nut type operators shall have threader steel reach rods with an internally threaded bronze or ductile iron nut.

a. Exposed Operators. Exposed operators shall have galvanized and painted handwheels. Lever operators are allowed on quarter-turn valves 8 inches and smaller. Cranks shall be supplied on gear type operators. If located more than 6 feet above the operator floor, chain wheel operator with tiebacks, extension stem, floor stands, and other accessories shall be provided to permit operation from normal operation level. Valve handles shall be capable of padlocking, and wheels shall be lockable with a chain and padlock.

2.4.8.2 Electric Operator

Electric operators shall be provided complete with actuators, speed controls and accessories. The actuators shall operate on 120 VAC, 60 Hz with a 75 percent duty cycle and shall be equipped with an AC thermal overload protector with automatic rest, reversing (bi-directional) operation for use with quarter-turn valves, or rotating equipment to full rotation. Gearing shall be a two-stage planetary, permanently lubricated self-locking gear train with self-lubricating bearings; connections via male output staff. The start-up torque shall be 120 foot-pound. The stall torque shall be 150 foot-pound. Two travel stop limit switches with cams, internal, independent, adjustable, and actuated by cams shall be mounted on the drive shaft. A side mounted hand turn wheel shall be provided for a manual override. The actuators shall have a NEMA 250 Type 4 enclosure with a corrosion resistant, baked epoxy finish as standard. The actuator shall operate in a temperature range of -40 to 150 degrees F. Actuators shall

fail in last position unless otherwise indicated. Limit switches shall be provided on all actuators.

a. Limit Switches. Limit switches shall be single-pole, double-throw (SPDT) type, rated 10 amps at 120 volts ac, housed in a NEMA 250 Type 4 enclosure, and adjustable for open and closed valve positions.

b. Positioners. The positioners for modulating actuators shall control valve positions as a function of the input signals. The positioner shall operate on 120 VAC, 60 Hz. voltage. The mode of operation shall be direct acting. Modulating valve positioners shall operate on a 4 to 20 mA input signal unless otherwise indicated. Corrosion-resistant enclosures for positioners shall be splash-and moisture-proof with gasketed covers.

2.4.9 Valve Accessories

2.4.9.1 Tagging

Identification tags made of engraved laminated plastic indicating service and valve number shown on the Valve Schedule shall be installed on valves using plastic straps designed for that purpose. Tags shall be 1.375 inches.

2.4.9.2 Extension Bonnet for Valve Operator

All extension bonnets shall be provided as necessary, complete with stem and accessories applicable to the specific valve and operator.

2.4.9.3 Chain Wheel and Guide

A chain wheel and guide shall be the handwheel direct-mount type, complete with galvanized or cadmium-plated chain.

2.5 DRAINS

Valved drains may not be shown on the detailed drawings for individual pipelines; their absence will not relieve the Contractor of the responsibility for providing and installing them as indicated in the piping and instrumentation diagrams to complete the piping system for the use intended.

2.5.1 Locations

All pipeline low points shall be drained.

2.5.2 Sizes

For pipelines 2.5 inches and larger, drains shall be 0.75 inch and equipped with ball valves. For pipelines 2 inches and smaller, drains shall be 0.5 inch and equipped with ball valves.

2.6 SAMPLE PORTS

Sample ports shall be provided as indicated in the piping and instrument diagrams to complete the piping systems for the use intended. The sample ports shall be located in easily accessible locations, and shall avoid potential stagnant points and/or areas where material could collect.

Sampling ports shall be comprised of pipe fittings, pipe, and ball valves which comply with material, temperature, and pressure requirements of the associated piping system as specified elsewhere in this Section.

2.7 MISCELLANEOUS PIPING COMPONENTS

2.7.1 Backflow Preventer

The backflow preventer shall be identical in size to pipe. Total head loss through the complete backflow assembly shall not exceed 10.1 psi at rated flow.

2.7.1.1 Double Check Valve Assembly

The backflow preventer shall consist of two check valves rated for 175 psig service at 140 degrees F, with one isolation gate valve, one differential relief valve, and testing cocks. Port size shall be 1 inch and be ASME B1.20.1 threaded, female or male. The check valve assembly shall be rated for 150 psig working pressure at 150 degrees F. The assembly shall meet the requirements of AWWA C510.

2.7.2 Indicating Devices

2.7.2.1 Pressure Gauges

Pressure gauges shall be stem mounted, with stainless steel or acrylonitrile-butadiene-styrene (ABS) cases and dry dials. The gauge sensors shall be Bourdon tube actuated and constructed of phosphor bronze or stainless steel. The gauges shall be equipped with brass or TP316L stainless steel threaded 0.25 or 0.5 inch male connections. The dials of the gauges shall be 4.5 inches in diameter with scale readings in psig ranging from zero to approximately twice the anticipated process operating or equipment pressure. A slotted adjustable pointer shall be provided with accuracy to conform to ASME B40.1, Grade A. The gauges shall be isolated from the process fluids using remote corrosion resistant diaphragm seals. The housing of the corrosion resistant seals shall be constructed of stainless steel. Seals shall be composed of stainless steel.

2.7.3 Static Mixer

The static mixer shall be designed to disperse the design flow, 0.15 to 0.44 gpm of added chemicals in a process flow stream with flows ranging from 700 to 2000 gpm. The diameter of the mixer housing shall be sized identical to the process piping. The length shall be in accordance with the number of mixing elements required. Housing materials shall be TP316 stainless steel, providing chemical resistance to both the chemical additives and process stream. End configurations shall be flanged faced and drilled to ASME B16.5 Class 150 and shall compatible with the piping system. Each housing shall be supplied with a name plate which at a minimum provides the manufacturer's name and address, part model number, and direction of flow. Mixing elements shall be constructed of TP316 stainless steel providing resistance to both the chemical additives and process stream. Elements shall be installed consecutively, with the number required designed to provide mixing with a homogeneity of the final mix of less than or equal to 0.05 by the end of the static mixer.

2.7.4 Pressure Relief Devices

Pressure relief devices shall conform to the requirements of ASME B31.3.

2.8 PIPE SUPPORTS AND PENETRATIONS

Auxiliary steel shall be provided by the Contractor where the support of piping systems and equipment is required between building structural elements. Light gauge and structural steel shapes shall conform to the requirements of ASTM A 36/A 36M. The Contractor shall have the option to use pre-engineered support systems of electrogalvanized steel products. However, a mixture of support system manufacturers products is not permitted.

2.8.1 Pipe Supports

Pipe supports shall conform to the requirements of MSS SP-58, MSS SP-69, and MSS SP-89. Where pipe supports contact bare piping or in-line devices, provide supports of compatible material so that neither shall have a deteriorating action on the other.

2.8.1.1 Beam Clamps

For upper attachments on structural steel, the Contractor shall provide beam clamps of ASTM A 36/A 36M carbon steel and MSS SP-58 Types 19 through 23, 25 or 27 through 30. Holes drilled in structural steel for hanger support rods will not be permitted. Clamps shall be provided with hardened steel cup-point set screws and lock-nuts for anchoring in place. Clamp size selection shall only be based on the support of the required load.

2.8.1.2 Riser Clamps

Vertical runs of piping shall be supported at each floor, or closer where required, with ASTM A 36/A 36M carbon steel clamps bolted around pipes and attached to the building construction.

2.8.1.3 Brackets

Where piping is run adjacent to walls or steel columns, the Contractor shall provide welded ASTM A 36/A 36M steel brackets, pre-punched with a minimum of two fastener holes.

2.8.1.4 Offset Pipe Clamp

Where pipes are indicated as offset from wall surfaces, a double-leg design two-piece pipe clamp shall be supplied by the Contractor.

2.8.1.5 Racks

Multiple pipe racks or trapeze hangers shall be fabricated from ASTM A 36/A 36M steel, and designed to suit the conditions at the points of installation. Pipes shall be kept in their relative positions to each other by the use of clamps or clips. Pipelines subject to thermal expansion must be free to slide or roll.

2.8.1.6 Hangers

Hangers shall be fabricated of malleable iron, ASTM A 47 or ASTM A 36/A 36M carbon steel. All hangers shall be of a uniform type and material for a given pipe run and application. Coated or plated hangers shall be used to isolate steel hangers from dissimilar metal tube or pipe. Hangers for pipe sizes 2.5 inches or larger shall incorporate a means of vertical adjustment

after erection while supporting the load.

2.8.1.7 Hanger Rods

Hanger rods shall be carbon steel conforming to ASTM A 576. The diameter of the rods for piping system support shall conform to ASME B31.1.

2.8.2 Pipe Guides

2.8.2.1 Intermediate Guides

For piping 6 inches and smaller, a pipe clamp with an oversize pipe sleeve shall be provided for a minimum 0.16 inch clearance. For piping 8 inches and larger, U-bolts with double nuts that are manufactured for the purpose shall be used to provide a minimum 0.28 inch clearance around pipe. The stock sizes for the U-bolts are as follows: for an 8 inch pipe use a 0.625 inch U-bolt; for a 10 inch pipe, use a 0.75 inch U-bolt; and for a 12 inch to 16 inch pipe, use a 0.875 inch U-bolt.

2.8.2.2 Alignment Guides

For piping, 8 inch and smaller, alignment guides shall be galvanized steel, spider or sleeve type. For piping, 10 inch and larger, alignment guides shall be galvanized steel, roller type guides.

2.8.3 Flashing Sleeves

Galvanized steel flashing sleeves shall be installed wherever piping passes through concrete roof structures. Where piping penetrates roofs, 4 lb. lead flashing shall be provided. The flashing shall extend 8 inches from the pipe in all directions, extend up the pipe, and shall be fitted with double-threaded flashing for pipes 3 inches and smaller. Flashing shall turn down inside the pipe for 4 inches and larger pipes.

2.8.4 Wall Penetrations

2.8.4.1 Above Grade Wall Penetrations

Piping which passes through fire-rated or smoke-rated walls, floors, or ceilings shall be provided with insulated and encased pipe sleeves. Penetrations through an existing fire or fire barrier wall shall be sealed with a fire stop system that has an "F" rating not less than the required fire resistance rating of the penetrated wall. The fire stopping sealant for metal piping systems shall be a water based, vibration resistant, polysiloxane (also known as silicone) based, nonslumping, premixed sealant with intumescent properties, that is rated for 3 hours pursuant to ASTM E 814 and UL requirements. The fire stopping sealant for plastic and insulated piping systems shall be a polysiloxane (also known as silicone) based, nonslumping, premixed sealant with intumescent properties, that is vibration and moisture resistant, and is rated for 3 hours pursuant to ASTM E 814 and UL requirements with metal collars. Vented plastic pipe penetrations shall be fitted with galvanized steel collars that have intumescent inlays.

2.8.4.2 Below Grade Wall Penetrations

Below-grade wall penetrations shall be provided with hydrostatic seals designed to seal opening between pipe or conduit and a through-structure opening. The seals shall be modular mechanical type consisting of

interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening.

2.8.4.3 Galvanizing

Galvanizing shall be hot-dip applied and meet the requirements of ASTM A 153/A 153M or zinc or cadmium plating. Stainless steel components may be substituted where galvanizing is specified.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Protection

Pipe and equipment openings shall be closed with caps or plugs during installation. Equipment shall be protected from dirt, water, and chemical or mechanical damage.

3.1.2 System Preparation

3.1.2.1 Pipe and Fittings

Pipe and fittings shall be inspected before exposed piping is installed or buried piping is lowered into the trench. The Contractor shall clean the ends of pipes thoroughly, remove foreign matter and dirt from inside of pipes, and keep piping clean during and after laying.

3.1.2.2 Damaged Coatings

The Contractor shall repair damaged coating areas in the field with material equal to the original coating, except for damaged glass-lined pipe which shall be promptly removed from the site. The Contractor shall not install damaged piping materials. Field repair of damaged and uncoated areas of galvanized piping shall conform to ASTM A 780.

3.1.2.3 Field Fabrication

The Contractor shall notify the Contracting Officer at least 2 weeks prior to the field fabrication of pipe or fittings and at least 3 days prior to the start of any surface preparation or coating application work. Welding electrodes shall be provided in accordance with Table 4.1 of AWS D1.1 as required for the applicable base metals and welding process. Fabrication of fittings shall be performed in accordance with the manufacturer's instructions.

3.2 EXPOSED PIPING INSTALLATION

Exposed piping shall be run as straight as practical along the alignment shown on the contract drawings and with a minimum of joints. Piping and appurtenances shall be installed in conformance with reviewed shop drawings, manufacturer's instructions and ASME B31.3. Piping shall be installed without springing or forcing the pipe.

3.2.1 Anchors and Fasteners

Impact expansion (hammer and explosive charge drive-type) anchors and fastener systems are not acceptable. Lead shields, plastic or fiber inserts, and drilled-in plastic sleeve/nail drive systems are also not

acceptable.

3.2.1.1 Drilled-In Expansion Anchors and Fasteners

The anchor/fastener assembly shall be UL listed with a one-piece stud (bolt) that has integral expansion wedges, nuts and washers. The anchor length, diameter, and embedment depth shall meet the manufacturer's requirements for the maximum allowable working load of the application.

3.2.1.2 Drilled-In Adhesive Anchors

Drilled-in adhesive anchors shall not be used for overhead applications. The anchors shall be composed of an anchor rod assembly and an anchor rod adhesive cartridge. The anchor rod assembly shall be a chamfered and threaded stud rod of zinc plated ASTM A 36/A 36M steel with a nut and washer of ASTM A 194/A 194M alloy-steel. The anchor length, diameter, and embedment depth shall meet the manufacturer's requirements for the maximum allowable working load of the application. The adhesive cartridge shall be a sealed capsule containing premeasured amounts of resin, quartz sand aggregate, and a hardener contained in a separate vial within the capsule. The capsule ingredients shall be activated by the insertion procedure of the anchor rod assembly.

3.2.2 Piping Expansion Provisions

The piping shall be installed to allow for thermal expansion resulting from the difference between installation and operating temperatures. Anchors shall be installed as shown in the contract drawings to withstand expansion thrust loads and to direct and control thermal expansion. An intermediate pipe guide shall be installed for every pipe at each metal channel framing support not carrying an anchor or alignment guide. Where pipe expansion joints are required, pipe alignment guides shall be installed adjacent to the expansion device and within four pipe diameters. Expansion devices shall be installed in accordance with the manufacturer's instructions.

3.2.3 Piping Flexibility Provisions

Thrust protection shall be provided as required. Flexible couplings and expansion joints shall be installed at connections to equipment, and where shown on the contract drawings. Additional pipe anchors and flexible couplings beyond those shown on the contract drawings, shall be provided to facilitate piping installation, in accordance with reviewed shop drawings.

3.2.4 Couplings, Adapters and Service Saddles

Pipes shall be thoroughly cleaned of oil, scale, rust, and dirt in order to provide a clean seat for gaskets. Gaskets shall be wiped clean prior to installation. Flexible couplings and flanged coupling adapter gaskets shall be lubricated with the manufacturer's standard lubricant before installation on the pipe ends. Couplings, service saddles, and anchor studs shall be installed in accordance with manufacturer's instructions. Bolts shall be tightened progressively, drawing up bolts on opposite sides a little at a time until all bolts have a uniform tightness. Torque-limiting wrenches shall be used to tighten bolts.

3.2.5 Piping Equipment/Component Installation

Piping components and indicators shall be installed in accordance with manufacturer's instructions. Required upstream and downstream clearances,

isolation valves, and miscellaneous devices shall be provided for an operable installation. The upstream and downstream lengths of undisturbed piping shall be in accordance with flow indicator manufacturer's recommendations.

3.2.5.1 Backflow Preventers

Backflow preventers shall be installed with nameplate and test cocks accessible from front of unit, and with a minimum clearance of 12.2 inches between the port and grade. The assemblies shall be installed in accordance with local codes and shall discharge to an open drain with an air gap; vertical installation is prohibited.

3.2.5.2 Local Indicators

All direct-reading indicator devices and pressure gauges shall be installed so that they can be easily read from floor level, and are readily accessible for maintenance and service. Pressure gauges and thermometers shall be installed where indicated in the contract drawings. Field calibration of all indicators shall be performed at time of installation to ensure measuring and reading accuracy. Differential pressure gauges shall be installed across the process equipment indicated in the contract drawings, in accordance with the manufacturer's recommendations, and arranged for easy observation.

3.2.6 Pipe Flanges

Pipe flanges shall be set level, plumb, and aligned. Flanged fittings shall be installed true and perpendicular to the axis of the pipe. The bolt holes shall be concentric to the centerline of the pipe.

3.2.7 Valve Locations

Valves shall be located in accordance with the contract drawings where actuators are shown. Where actuators are not shown, valves shall be located and oriented to permit easy access to the valve operator, and to avoid interferences.

3.2.8 Pipe Tap Connections

Taps to pipe barrels are unacceptable. Taps to steel piping shall be made only with a welded threadolet connection.

3.2.9 Plastic Pipe Installation

All plastic pipe shall be cut, made up, and installed in accordance with the pipe manufacturer's recommendations. Heat joining shall be performed in accordance with ASTM D 2657. Electrofusion joining shall be performed in accordance with ASTM F 1290. Schedule 40 pipe shall not be threaded. Schedule 80 threaded nipples shall be used where necessary to connect to threaded valves or fittings. Strap wrenches shall be used for tightening threaded plastic joints, and care shall be taken not to over tighten these fittings. Pipe shall not be laid when the temperature is below 40.1 degrees F, nor above 90 degrees F when exposed to direct sunlight. Any plastic pipe installed above grade and outdoors shall be ultraviolet (UV) protected or UV resistant. The pipe ends that are to be joined shall be shielded from direct sunlight prior to and during the laying operation. Adequate ventilation shall be provided when working with pipe joint solvent cement and the handling of solvent cements, primers and cleaners shall be

in accordance with ASTM F 402. The Contractor shall provide and install supports and hangers in accordance with the manufacturer's recommendations. Where plastic pipe is subjected to severe temperature fluctuations, provisions for expansion and contraction must be provided. This shall be accomplished with the use of expansion joints and offset piping arrangements. All lines shall be hydrostatically tested at the maximum operating pressures.

3.2.9.1 PVC Piping

Solvent-cemented joints shall be constructed in accordance with ASTM D 2855.

3.3 BURIED PIPE PLACEMENT

Thermoplastic piping systems shall be installed underground in accordance with ASTM D 2774. Thermosetting resin and reinforced plastic mortar piping systems shall be installed underground in accordance with ASTM D 3839.

3.3.1 Excavation and Backfilling

Earthwork shall be performed as specified in Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS. Backfilling shall be accomplished after inspection by the Contracting Officer. The Contractor shall exercise care when lowering pipe into the trench to prevent damage or twisting of the pipe.

3.3.2 Fittings

At valves and connections, the trench bottom shall be dug out with sufficient length, width, and depth to ensure clearance between the undisturbed trench bottom and the valves and such connections.

3.3.3 Thrust Restraint

Thrust restraint devices are generally not shown in the contract drawings; their absence will not relieve Contractor of the responsibility for providing them as required to provide complete systems for the use intended. The Contractor shall provide thrust blocks and ties where required, whether or not shown on the contract drawings. At a minimum, thrust restraint shall be provided at pipeline tees, plugs, caps, bends, and other locations where unbalanced forces exist.

3.3.3.1 Thrust Blocks

Thrust blocking shall be concrete of a mix not leaner than 1 cement, 2.5 sand and 5 gravel, and have a compressive strength of not less than 2000 psi after 28 days. Blocking shall be placed between solid ground and the fitting to be anchored. Unless otherwise indicated or directed, the base and thrust bearing sides of the thrust blocks shall be poured against undisturbed earth. The sides of thrust blocks not subject to thrusts may be poured against forms. The area of bearing shall be as shown or directed. Blocking shall be placed so that fitting joints shall be accessible for repair. Steel rods and clamps, protected by galvanizing or a coating of bituminous paint shall be used to anchor vertical down bends into gravity thrust blocks.

3.3.4 Marking Tape

Pipe marking tape shall be provided and installed in accordance with the

requirements of Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.

3.3.5 Plastic Pipe Installation

Plastic pipe shall be cut, fabricated, and installed in strict conformance with the pipe manufacturer's recommendations. Offset loops from the trench centerline shall be as recommended by the manufacturer for the maximum temperature variation between the pipe temperature at the time of solvent welding and operating temperature. Flexible plastic pipe connected to heavy fittings, manholes, and rigid structures shall be supported in such a manner that no subsequent relative movement between the plastic pipe at the flanged joint and the rigid structures is possible. Thrust blocking shall not be used for flexible plastic piping. The piping shall be designed and installed to withstand the compression and expansion forces imposed by the trench conditions.

3.4 CONNECTING DISSIMILAR PIPE

Flexible transition couplings, dielectric fittings and isolation joints shall be installed in accordance with the manufacturer's instructions.

3.5 EXTERNAL CORROSION PROTECTION

Protect all pipe and piping accessories from corrosion and adverse environmental conditions.

3.5.1 Above Grade Metallic Piping

Nonferrous and stainless steel piping shall not be painted except for aluminum alloy piping. Where dissimilar metals are joined, isolation joints shall be used.

3.5.1.1 Ferrous Piping

Shop primed surfaces shall be touched up with ferrous metal primer. Surfaces that have not been shop primed shall be solvent cleaned. Surfaces that contain loose rust, mill scale or other foreign substances shall be mechanically cleaned by power wire brushing and primed with a ferrous metal primer. Primed surfaces shall be finished with two coats of exterior paint in accordance with Section 09900 PAINTING, GENERAL.

3.6 FLEXIBLE JOINTS AT CONCRETE STRUCTURES

Flexible joints shall be provided at the face of all structures, whether or not shown on the contract drawings. Rubber ring joints, mechanical joints, flexible couplings, and proprietary restrained ductile iron pipe joints shall be considered flexible joints; welded pipe joints shall not. Joints may be flush with the structure face or may be located up to 1 pipe diameter away from face , but not further than 17.7 inches away from face.

3.7 CLOSURES

Closure pieces shall be installed as necessary to end pipe runs and shall conform to ASME B16.9 or ASME B16.11. Elastomer sleeves bonded to pipe ends are not acceptable. Pressure piping shall have closures of blind flanges unless otherwise shown on contract drawings or approved by the Contracting Officer. Pipes with restrained joints shall have pipe closures installed with thrust tie-rod assemblies.

3.8 PENETRATIONS

Steel pipe sleeves shall be hot-dipped galvanized after fabrication for above grade applications in nonsubmerged areas. For below grade, or in submerged and damp environments, steel pipe sleeves shall be lined and coated as specified in Section 09900 PAINTING, GENERAL. Embedded metallic piping shall be isolated from concrete reinforcement using coated pipe penetrations. Coatings shall be as specified in Section 09900 PAINTING, GENERAL. Wall pipes shall be securely supported by form work to prevent contact with reinforcing steel and tie-wires. Joints shall be sealed with a wall penetration seal. For existing concrete walls, rotary drilled holes may be provided in lieu of sleeves.

3.9 VALVE INSTALLATION

Flanged valve bolt holes shall be installed so as to straddle the vertical centerline of pipe. Flanged faces shall be cleaned prior to inserting the gasket and bolts, and then the nuts shall be tightened progressively and uniformly. Threaded ends shall have the threads cleaned by wire brushing or swabbing prior to installation.

3.9.1 Valve Orientation

The operating stem of a manual valve shall be installed in a vertical position when the valve is installed in horizontal runs of pipe having centerline elevations 4.5 feet above finished floor, unless otherwise shown on contract drawings. The operating stem of a manual valve shall be installed in a horizontal position in horizontal runs of pipe having centerline elevations between 4.5 feet and 6.75 feet above finish floor, unless otherwise shown on contract drawings. Automatic valves shall be installed in accordance with the manufacturer's instructions and approved drawings.

3.9.1.1 Butterfly Valves

Orientation of butterfly valves shall take into account changes in pipe direction. Valve shafts shall be oriented so that unbalanced flows caused by pipe direction changes or other disturbances are equally divided to each half of the disc.

3.9.1.2 Plug Valves

If a plug valve seat position is not shown in the contract drawings, locate the seat position as follows: for horizontal flow, the flow shall produce an "unseating" pressure, and the plug shall open into the top half of valve; and for vertical flow, the seat shall be installed in the highest portion of the valve.

3.9.2 Line Size Ball Valves

A line size ball valve and union shall be installed upstream of each solenoid valve, in-line flow switch, or other in-line electrical device, excluding magnetic flowmeters, for isolation during maintenance.

3.9.3 Chain Wheel and Guide

Chain wheel and guide assemblies or chain lever assemblies shall be installed on manually operated valves located over 6.73 feet above finished

floor elevation. Where chains hang in normally traveled areas, appropriate "L" type tie-back anchors shall be used.

3.10 AIR RELEASE, DRAINS AND SAMPLE PORTS

Sample ports shall be provided where indicated on the contract drawings. The Contractor shall install specified vents at piping high points for entrapped air release and install drains in the low points of pipelines regardless of whether shown on contract drawings.

3.11 PIPING SUPPORT SYSTEMS INSTALLATION

The absence of pipe supports and details on the contract drawings shall not relieve the Contractor of responsibility for sizing and providing supports throughout plant.

3.11.1 General Support Requirements

Pipe support systems shall meet the requirements of MSS SP-58. Contractor-designed and selected support systems shall be installed in accordance with MSS SP-69, and as specified herein. Piping connections to equipment shall be supported by pipe supports and not off the equipment. Large or heavy valves, fittings, and/or equipment shall be supported independently of associated piping. Pipes shall not be supported off other pipes. Supports shall be provided at piping changes in direction or in elevation, adjacent to flexible joints and couplings, and where otherwise shown on the contract drawings. Pipe supports and hangers shall not be installed in equipment access areas or bridge crane runs. Hanging pipes shall be braced against horizontal movement by both longitudinal and lateral sway bracing. At each channel type support, every pipe shall be provided with an intermediate pipe guide, except where pipe anchors are required. Existing support systems may be used to support additional new piping only if the Contractor can demonstrate that the existing support systems are adequate for the additional loads, or if the existing systems are strengthened to support the additional loads. Pedestal type pipe supports shall be provided under base flanges adjacent to rotating equipment and where required to isolate vibration.

3.11.2 Support of Insulated Piping

The Contractor shall install oversized supports to fit the insulation inserts. Supports shall be provided with galvanized or stainless steel protection shields and oversized rollers.

3.11.3 Dielectric Barriers

Dielectric barriers shall be installed between supports and copper or stainless steel piping, and between stainless steel supports and non-stainless steel ferrous piping.

3.11.4 Support Spacing

3.11.4.1 Acceptable Limits for Metallic Piping

Steal, Schedule 40, diameter 4 inch shall have a maximum span of 12 feet and a minimum rod size for single rod hangers of 5/8 inch.

3.11.4.2 Acceptable Limits for Thermoplastic Piping

PVC Schedule 80, diameter 12 inches, shall have a maximum span of 12 feet and a minimum rod size for single rod hangers of 7/8 inch. PVC Schedule 80, diameter 8 inches, shall have a maximum span of 10 feet and a minimum rod size for single rod hangers of 7/8 inch.

3.11.5 Support Methods

Piping support shall be provided as specified and as shown in the contract drawings. Single horizontal suspended piping shall be supported by adjustable swivel-ring, split-ring, or clevis hangers. Multiple horizontal suspended piping shall be supported by trapeze hangers with channel type supports. Horizontal pedestal mounted piping shall have saddle type supports. Horizontal wall mounted piping shall have wall brackets. Vertical piping shall be supported by wall brackets, base elbows, or riser clamps on floor penetrations.

3.12 PIPE IDENTIFICATION, PAINTING AND COLOR CODING

Color, coating, and lettering requirements for exposed piping shall be in accordance with Section 09900 PAINTING, GENERAL. A single individual band, of plastic adhesive tape or paint, designating pipe contents shall be provided with sufficient length to permit the stenciling of pipe contents in letters. Identification shall be provided at branch connections, inlets and outlets of equipment, every 19.7 feet of straight run, upstream of valves, and within 3.3 feet of entrance to or exit from wall curtains, or other similar type barrier.

3.13 FIELD QUALITY CONTROL

3.13.1 Hydrostatic Tests

Where any section of a pipeline is provided with concrete thrust blocking for fitting, the hydrostatic tests shall not be made until at least 5 days after the installation of the concrete thrust blocking, unless otherwise approved by the Contracting Officer.

3.13.1.1 Buried Piping

After the pipe is laid, the joints completed and the trench partially backfilled leaving the joints exposed for examination, the newly laid piping or any valved section of piping shall, unless otherwise specified, be subjected for 2 hours to a hydrostatic test pressure of 150 psig. Each valve shall be opened and closed several times during the test. Exposed pipe, joints, fittings, and valves shall be carefully examined during the partially open trench test. Joints showing visible leakage shall be replaced as necessary. Defective pipe, joints, fittings, and valves found during the pressure test shall be removed and replaced with new material, and the test repeated until the test results are satisfactory. The requirement for the joints to remain exposed for the hydrostatic tests may be waived by the Contracting Officer when one or more of the following conditions are encountered: (1) wet or unstable soil conditions in the trench; (2) compliance would require maintaining barricades and walkways around and across an open trench in a heavily used area that would require continuous surveillance to assure safe conditions; or (3) maintaining the trench in an open condition would delay completion of the Contract. The Contractor may request a waiver, setting forth in writing the reasons for the request and stating the alternative procedure proposed to comply with the hydrostatic tests. Backfill placed prior to the tests shall be placed in accordance with the requirements of Section 02316 EXCAVATION, TRENCHING,

AND BACKFILLING FOR UTILITIES SYSTEMS.

3.13.1.2 Exposed Piping

Hydrostatic testing shall be conducted in accordance with ASME B31.3. Piping systems shall be tested under normal service conditions to demonstrate compliance. The test pressure shall not be less than 1.5 times the design pressure. Water shall be used as the hydrostatic test fluid. The Contractor shall provide clean test water of such quality to prevent corrosion of the piping system materials. Air release vents shall be opened at all high points of the piping system in order to purge air pockets while the piping system is filling.

a. For rigid piping hydrostatic testing, the maximum test pressure shall be calculated according to ASME B31.3, but shall not exceed the yield strength of the piping system. The maximum velocity during filling shall be in accordance with the manufacturer's instructions. Venting during filling may also be provided by loosening flanges with a minimum of four bolts or by the use of equipment vents. The Contractor shall test all parts of the piping system. The hydrostatic test pressure shall be maintained continuously for 30 minutes minimum and for such additional time as necessary to conduct examinations for leakage. All joints and connections shall be examined by the Contractor for leakage. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leaking. The Contractor shall correct visible leakage and retest. Unless otherwise directed by the Contracting Officer, the piping system shall be left full of water after leaks are repaired.

b. For non-rigid, non-metallic piping and metallic piping with a non-metallic liner hydrostatic testing, the maximum test pressure shall be calculated according to ASME B31.3, but shall not exceed 1.5 times the maximum pressure rating of the lowest rated component in the piping system. The maximum velocity during filling shall be in accordance with the manufacturer's instructions. The system shall be initially pressurized to 50 percent of the normal service conditions and inspected. Any leaks shall be repaired by the Contractor. The system shall then be pressurized to the test pressure. Small amounts of water shall be added as required on a hourly basis for a maximum of 3 hours in order to maintain the test pressure. After 4 hours, the test pressure shall be lowered by 10.2 psi. If the hydrostatic pressure remains steady for 1 hour, then no leakage is indicated. The Contractor shall inspect for leaks, repair and retest if necessary. The piping system shall be allowed to relax for 8 hours before retesting.

3.13.1.3 Time for Making Test

Except for joint material setting or where concrete thrust blocks necessitate a delay, underground piping jointed with rubber gaskets, mechanical or push-on joints, or couplings may be subjected to hydrostatic pressure, inspected, and tested for leakage at any time after partial completion of backfill. Tests for above ground pressure piping shall be conducted after the piping has been completely installed, including all supports, hangers, and anchors, and inspected for proper installation but prior to installation of insulation.

3.13.2 Pipe Leakage Tests

Unless approved by the Contracting Officer, leakage testing shall be conducted after the pressure tests have been satisfactorily completed. The duration of each leakage test shall be at least 2 hours, and during the test the piping shall be subjected to not less than 200 psig pressure. Leakage is defined as the quantity of the test liquid, water, that is supplied to the piping system, or any valved or approved section thereof, in order to maintain pressure within 5 psi of the specified leakage test pressure after the piping has been filled with the test liquid and all air is expelled. No piping installation will be accepted if leakage exceeds the allowable leakage determined by the following formula:

L = Cf x N x D x P0.5
Cf = conversion factor = 0.0001351
L = allowable leakage, gallons per hour
N = number of joints in the length of piping tested
D = nominal pipe diameter, inches
P = average test pressure during the test, psig.

Should any test disclose leakage greater than that allowed, the leaks shall be located and repaired until the leakage is within the specified allowance, without additional cost.

3.13.3 Testing New to Existing Connections

New piping connected to existing pipe, existing equipment, existing treatment systems, or tanks and treatment systems furnished under other Sections shall be tested. The Contractor shall isolate the new piping with pipe caps, spectacle blinds, or blind flanges. The joint between new piping and existing piping shall be tested by methods that do not place the entire existing system under the test load. The Contractor shall then proceed with the testing of new piping systems as specified herein.

3.13.4 Valve Testing

Valves may either be tested while testing pipelines, or as a separate step. It shall be demonstrated that valves open and close smoothly with operating pressure on one side and atmospheric pressure on the other, and in both directions for two-way valve applications. The Contractor shall count and record the number of turns required to open and close each valve, and account for any discrepancies with manufacturer's data. Air and vacuum relief valves shall be examined as the associated pipe is being filled to verify venting and seating is fully functional. The Contractor shall set, verify, and record set pressures for all relief and regulating valves. Self-contained automatic valves shall be tested at both maximum and minimum operating ranges, and reset upon completion of test to the design value. Automatic valves that are not self-contained shall be tested in conjunction with control system testing.

3.14 FINAL CLEANING

3.14.1 Interim Cleaning

The Contractor shall prevent the accumulation of weld rod, weld spatter, pipe cuttings and filings, gravel, cleaning rags, and other foreign material within piping sections during fabrication. The piping shall be examined to assure removal of these and other foreign objects prior to assembly and installation.

3.14.2 Flushing

Following assembly and testing, and prior to final acceptance, piping systems shall be flushed with water to remove accumulated construction debris and other foreign matter. The piping shall be flushed until all foreign matter is removed from the pipeline. The Contractor shall provide all hoses, temporary pipes, ditches, and other items as required to properly dispose of flushing water without damage to adjacent properties. The minimum flushing velocity shall be 2.5 fps. For large diameter pipe where it is impractical to flush the pipe at the minimum flushing velocity, the pipeline shall be cleaned in-place from the inside by brushing and sweeping, then flushing the pipeline at a lower velocity. Cone strainers shall be installed in the flushing connections of attached equipment and left in place until cleaning is completed. Accumulated debris shall be removed through drains, or by removing spools or valves.

3.15 WASTE WATER DISPOSAL

The water used for testing, cleaning, and/or flushing shall be disposed of in accordance with all applicable regulations. Disposal is solely the responsibility of the Contractor. The method proposed for disposal of waste water shall be provided to, and approved by, the Contracting Officer prior to performing any testing, cleaning, and flushing activities.

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PLUMBING, GENERAL PURPOSE

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1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.10.1	(1993; Z21.10.1a; Z21.10.1b; Z21.10.1c) Gas Water Heaters Vol. I, Storage Water Heaters with Input Ratings of 75,000 Btu Per Hour or Less
ANSI Z21.10.3	(1998) Gas Water Heaters Vol. III, Storage Water Heaters with Input Ratings Above 75,000 Btu Per Hour, Circulating and Instantaneous Water Heaters
ANSI Z21.22	(1986; Z21.22a) Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53/A 53M	(1999b) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 74	(1998) Cast Iron Soil Pipe and Fittings
ASTM A 105/A 105M	(1998) Carbon Steel Forgings for Piping Applications
ASTM A 183	(1983; R 1998) Carbon Steel Track Bolts and Nuts
ASTM A 193/A 193M	(1999a) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A 515/A 515M	(1989; R 1997) Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service
ASTM A 516/A 516M	(1990; R 1996) Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A 518/A 518M	(1999) Corrosion-Resistant High-Silicon

	Iron Castings
ASTM A 733	(1999) Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM A 888	(1998el) Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
ASTM B 32	(1996) Solder Metal
ASTM B 42	(1998) Seamless Copper Pipe, Standard Sizes
ASTM B 43	(1998) Seamless Red Brass Pipe, Standard Sizes
ASTM B 88	(1999) Seamless Copper Water Tube
ASTM B 306	(1999) Copper Drainage Tube (DWV)
ASTM B 370	(1998) Copper Sheet and Strip for Building Construction
ASTM B 813	(1993) Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube
ASTM B 828	(1998) Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
ASTM C 564	(1997) Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C 920	(1998) Elastomeric Joint Sealants
ASTM D 1785	(1999) Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2000	(1999) Rubber Products in Automotive Applications
ASTM D 2235	(1996a) Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings
ASTM D 2239	(1999) Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
ASTM D 2241	(1999a) Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2447	(1999) Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter
ASTM D 2464	(1999) Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

ASTM D 2466	(1999) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2467	(1999) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2564	(1996a) Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2657	(1997) Heat Fusion Joining Polyolefin Pipe and Fittings
ASTM D 2661	(1997ael) Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D 2665	(1998) Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D 2672	(1996a) Joints for IPS PVC Pipe Using Solvent Cement
ASTM D 2683	(1998) Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
ASTM D 2737	(1999) Polyethylene (PE) Plastic Tubing
ASTM D 2822	(1991; R 1997el) Asphalt Roof Cement
ASTM D 2846/D 2846M	(1999) Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems
ASTM D 2855	(1996) Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D 2996	(1995) Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D 3035	(1995) Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM D 3122	(1995) Solvent Cements for Styrene-Rubber (SR) Plastic Pipe and Fittings
ASTM D 3138	(1995) Solvent Cements for Transition Joints Between Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Non-Pressure Piping Components
ASTM D 3139	(1998) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals

ASTM D 3212	(1996a) Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D 3261	(1997) Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D 3308	(1997) PTFE Resin Skived Tape
ASTM D 3311	(1994) Drain, Waste, and Vent (DWV) Plastic Fittings Patterns
ASTM E 1	(1998) ASTM Thermometers
ASTM F 409	(1999a) Thermoplastic Accessible and Replaceable Plastic Tube and Tubular Fittings
ASTM F 437	(1999) Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F 438	(1999) Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40
ASTM F 439	(1999) Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F 441/F 441M	(1999) Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM F 442/F 442M	(1999) Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)
ASTM F 477	(1999) Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 493	(1997) Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings
ASTM F 628	(1999el) Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe with a Cellular Core
ASTM F 891	(1998el) Coextruded Poly(Vinyl Chloride) (PVC) Plastic Pipe with a Cellular Core
ASTM F 1290	(1998a) Electrofusion Joining Polyolefin Pipe and Fittings
ASTM F 1760	(1997) Coextruded Poly(Vinyl Chloride) (PVC) Non-Pressure Plastic Pipe Having Reprocessed-Recycled Content

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1	(1989; 90.1b; 90.1c; 90.1d; 90.1e; 90.1g; 90.1i; 90.1l-1995; 90.1m-1995; 90.1n-1997) Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings

ASME INTERNATIONAL (ASME)

ASME A112.1.2	(1991; R 1998) Air Gaps in Plumbing Systems
ASME A112.6.1M	(1997) Supports for Off-the-Floor Plumbing Fixtures for Public Use
ASME A112.14.1	(1975; R 1998) Backwater Valves
ASME A112.19.2M	(1998) Vitreous China Plumbing Fixtures
ASME A112.19.3M	(1987; R 1996) Stainless Steel Plumbing Fixtures (Designed for Residential Use)
ASME A112.36.2M	(1991; R 1998) Cleanouts
ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch)
ASME B16.3	(1998) Malleable Iron Threaded Fittings
ASME B16.4	(1998) Gray Iron Threaded Fittings
ASME B16.5	(1996; B16.5a) Pipe Flanges and Flanged Fittings NPS 1/2 thru NPS 24
ASME B16.12	(1998) Cast Iron Threaded Drainage Fittings
ASME B16.15	(1985; R 1994) Cast Bronze Threaded Fittings Classes 125 and 250
ASME B16.18	(1984; R 1994) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(1995; B16.22a1998) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.23	(1992; Errata Jan 1994) Cast Copper Alloy Solder Joint Drainage Fittings - DWV
ASME B16.24	(1991; R 1998) Cast Copper Alloy Pipe Flanges, Class 150, 300, 400, 600, 900, 1500, and 2500, and Flanged Fittings, Class 150 and 300
ASME B16.29	(1994) Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV
ASME B16.34	(1997) Valves - Flanged, Threaded, and Welding End

ASME B16.39	(1998) Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300
ASME B31.1	(1998) Power Piping
ASME B31.5	(1992; B31.5a1994) Refrigeration Piping
ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element
ASME BPV VIII Div 1	(1998) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage
ASME BPV IX	(1998) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications
ASME CSD-1	(1998) Controls and Safety Devices for Automatically Fired Boilers

AMERICAN SOCIETY OF SANITARY ENGINEERING FOR PLUMBING AND SANITARY RESEARCH(ASSE)

ASSE 1001	(1990) Pipe Applied Atmospheric Type Vacuum Breakers
ASSE 1003	(1995) Water Pressure Reducing Valves for Domestic Water Supply Systems
ASSE 1005	(1986) Water Heater Drain Valves - 3/4-Inch Iron Pipe Size
ASSE 1011	(1995) Hose Connection Vacuum Breakers
ASSE 1012	(1995) Backflow Preventers with Intermediate Atmospheric Vent
ASSE 1013	(1993) Reduced Pressure Principle Backflow Preventers
ASSE 1018	(1986) Trap Seal Primer Valves Water Supply Fed
ASSE 1037	(1990; Rev thru Mar 1990) Pressurized Flushing Devices (Flushometers) for Plumbing Fixtures

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA EWW	(1999) Standard Methods for the Examination of Water and Wastewater
AWWA B300	(1999) Hypochlorites
AWWA B301	(1992; Addenda B301a - 1999) Liquid Chlorine

AWWA C104	(1995) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C105	(1993) Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C110	(1998) Ductile-Iron and Gray-Iron Fittings, 3 in. through 48 in., for Water
AWWA C111	(2000) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C151	(1996) Ductile-Iron Pipe, Centrifugally Cast, for Water
AWWA C203	(1997; addenda C203a - 1999) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C606	(1997) Grooved and Shouldered Joints
AWWA D100	(1996) Welded Steel Tanks for Water Storage
AWWA M20	(1973) Manual: Water Chlorination Principles and Practices

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8	(1992) Filler Metals for Brazing and Braze Welding
AWS B2.2	(1991) Brazing Procedure and Performance Qualification

CAST IRON SOIL PIPE INSTITUTE (CISPI)

CISPI 301	(1997) Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
CISPI 310	(1997) Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
CISPI HSN-85	(1985) Neoprene Rubber Gaskets for Hub and Spigot Cast Iron Soil Pipe and Fittings

CODE OF FEDERAL REGULATIONS (CFR)

10 CFR 430	Energy Conservation Program for Consumer Products
21 CFR 175	Indirect Food Additives: Adhesives and Components of Coatings

COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA Tube Handbook	(1995) Copper Tube Handbook

COUNCIL OF AMERICAN BUILDING OFFICIALS (CABO)

CABO A117.1	(1998) Accessible and Usable Buildings and Facilities

FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH (FCCCHR)

FCCCHR-01	(1993) Manual of Cross-Connection Control

FEDERAL SPECIFICATION (FS)

FS WW-U-516B	(1995) Unions, Brass or Bronze, Threaded Pipe Connections and Solder-Joint Tube Connections

INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANCIAL OFFICIALS (IAPMO)

IAPMO Z124.5	(1997) Plastic Toilet (Water Closets) Seats
IAPMO Z124.9	(1994) Plastic Urinal Fixtures

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(1998) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-44	(1996) Steel Pipeline Flanges
MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-67	(1995) Butterfly Valves
MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application
MSS SP-70	(1998) Cast Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(1997) Cast Iron Swing Check Valves, Flanges and Threaded Ends
MSS SP-72	(1999) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-73	(1991; R 1996) Brazing Joints for Copper and Copper Alloy Pressure Fittings
MSS SP-78	(1998) Cast Iron Plug Valves, Flanged and Threaded Ends
MSS SP-80	(1997) Bronze Gate, Globe, Angle and Check Valves

MSS SP-83	(1995) Class 3000 Steel Pipe Unions Socket-Welding and Threaded
MSS SP-85	(1994) Cast Iron Globe & Angle Valves, Flanged and Threaded Ends
MSS SP-110	(1996) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

NATIONAL ASSOCIATION OF PLUMBING-HEATING-COOLING CONTRACTORS (NAPHCC)

NAPHCC Plumbing Code	(1996) National Standard Plumbing Code

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1997) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(1999) National Fuel Gas Code
NFPA 90A	(1996) Installation of Air Conditioning and Ventilating Systems

NSF INTERNATIONAL (NSF)

NSF 14	(1999) Plastics Piping Components and Related Materials

PLASTIC PIPE AND FITTINGS ASSOCIATION (PPFA)

PPFA-01	(1998) Plastic Pipe in Fire Resistive Construction

PLUMBING AND DRAINAGE INSTITUTE (PDI)

PDI WH 201	(1992) Water Hammer Arresters

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

SAE J 1508	(1997) Hose Clamps

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 5/NACE 1	(1994) White Metal Blast Cleaning

1.2 STANDARD PRODUCTS

Specified materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such products. Specified equipment shall essentially duplicate equipment that has performed satisfactorily at least two years prior to bid opening.

1.3 PERFORMANCE REQUIREMENTS

1.3.1 Welding

Piping shall be welded in accordance with qualified procedures using performance-qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPV IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer, may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified 24 hours in advance of tests, and the tests shall be performed at the work site if practicable. Welders or welding operators shall apply their assigned symbols near each weld they make as a permanent record. Structural members shall be welded as specified.

1.4 ELECTRICAL WORK

Motors, motor controllers and motor efficiencies shall conform to the requirements of Section 16415 ELECTRICAL WORK, INTERIOR. Electrical motor-driven equipment specified herein shall be provided complete with motors. Equipment shall be rated at 60 Hz, single phase, ac unless otherwise indicated. Where a motor controller is not provided in a motor-control center on the electrical drawings, a motor controller shall be as indicated. Motor controllers shall be provided complete with properly sized thermal-overload protection in each ungrounded conductor, auxiliary contact, and other equipment, at the specified capacity, and including an allowable service factor.

1.5 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Plumbing System; GA.

Detail drawings consisting of illustrations, schedules, performance charts, instructions, brochures, diagrams, and other information to illustrate the requirements and operations of each system. Detail drawings for the complete plumbing system including piping layouts and locations of connections; dimensions for roughing-in, foundation, and support points; schematic diagrams and wiring diagrams or connection and interconnection diagrams. Detail drawings shall indicate clearances required for maintenance and operation. Where piping and equipment are to be supported other than as indicated, details shall include loadings and proposed support methods.

Electrical Schematics; GA.

Complete electrical schematic lineless or full line interconnection and connection diagram for each piece of mechanical equipment having more than one automatic or manual electrical control device.

SD-03 Product Data

Welding; GA.

A copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators.

Plumbing Fixture Schedule; GA.

Catalog cuts of specified plumbing fixtures, valves, and related piping.

Vibration-Absorbing Features; GA.

Details of vibration-absorbing features, including arrangement, foundation plan, dimensions and specifications.

SD-06 Test Reports

Tests, Flushing and Disinfection; GA.

Test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, completion and testing of the installed system. Each test report shall indicate the final position of controls.

Backflow Prevention Assembly Tests; GA.

Certification of proper operation shall be as accomplished in accordance with state regulations by an individual certified by the state to perform such tests. If no state requirement exists, the Contractor shall have the manufacturer's representative test the device, to ensure the unit is properly installed and performing as intended. The Contractor shall provide written documentation of the tests performed and signed by the individual performing the tests.

SD-07 Certificates

Materials and Equipment; FIO.

Where materials or equipment are specified to comply with requirements of AGA, or ASME, proof of such compliance. The label or listing of the specified agency will be acceptable evidence. In lieu of the label or listing, a written certificate may be submitted from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency. Where equipment is specified to conform to requirements of the ASME Boiler and Pressure Vessel Code, the design, fabrication, and installation shall conform to the code.

Bolts; FIO.

Written certification by the bolt manufacturer that the bolts furnished comply with the specified requirements. The certification shall include illustrations of product-required markings, the date of manufacture, and the number of each type of bolt to be furnished based on this certification.

SD-10 Operation and Maintenance Data

Plumbing System; FIO.

Six (6) copies of the operation manual outlining the step-by-step procedures required for system startup, operation and shutdown. The manual shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Six (6) copies of the maintenance manual listing routine maintenance procedures, possible breakdowns and repairs. The manual shall include piping and equipment layout and simplified wiring and control diagrams of the system as installed.

1.6 REGULATORY REQUIREMENTS

Plumbing work shall be in accordance with NAPHCC Plumbing Code as well as the local plumbing code.

1.7 PROJECT/SITE CONDITIONS

The Contractor shall become familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

PART 2 PRODUCTS

2.1 MATERIALS

Construction/fabrication and other materials brought onto the job site shall contain no hazardous materials. Asbestos, lead, cadmium, mercury, PCBs and other hazardous material shall not be used.

Suspect/Counterfeit Items (S/CIs) shall not be used.

Provide Material Safety Data Sheets (MSDSs) as required.

Materials for various services shall be in accordance with TABLES I and II. Pipe schedules shall be selected based on service requirements. Pipe fittings shall be compatible with the applicable pipe materials. Plastic pipe, fittings, and solvent cement shall meet NSF 14 and shall be NSF listed for the service intended. Plastic pipe, fittings, and solvent cement used for potable hot and cold water service shall bear the NSF seal "NSF-PW." Polypropylene pipe and fittings shall conform to dimensional requirements of Schedule 40, Iron Pipe size. Pipe threads (except dry seal) shall conform to ASME B1.20.1. Grooved pipe couplings and fittings shall be from the same manufacturer. Material or equipment containing lead shall not be used in any potable water system. Hubless cast-iron soil pipe shall not be installed underground or under concrete floor slabs. Plastic pipe shall not be installed in air plenums. Plastic pipe shall not be installed in a pressure piping system in buildings greater than three stories including any basement levels.

2.1.1 Pipe Joint Materials

Grooved pipe and hubless cast-iron soil pipe shall not be used under ground. Joints and gasket materials shall conform to the following:

a. Coupling for Cast-Iron Pipe: for hub and spigot type ASTM A 74, AWWA C606. For hubless type: CISPI 310

b. Coupling for Steel Pipe: AWWA C606.

c. Flange Gaskets: Gaskets shall be made of non-asbestos material in accordance with ASME B16.21. Gaskets shall be flat, 1/16 inch thick, and contain Aramid fibers bonded with Styrene Butadiene Rubber (SBR) or Nitro Butadiene Rubber (NBR). Gaskets shall be the full face or self centering flat ring type. Gaskets used for hydrocarbon service shall be bonded with NBR.

d. Neoprene Gaskets for Hub and Cast-Iron Pipe and Fittings: CISPI HSN-85.

e. Brazing Material: Brazing material shall conform to AWS A5.8, BCuP-5.

f. Brazing Flux: Flux shall be in paste or liquid form appropriate for use with brazing material. Flux shall be as follows: lead-free; have a 100 percent flushable residue; contain slightly acidic reagents; contain potassium borides; and contain fluorides. Silver brazing materials shall be in accordance with AWS A5.8.

g. Solder Material: Solder metal shall conform to ASTM B 32 95-5 tin-antimony.

h. Solder Flux: Flux shall be liquid form, non-corrosive, and conform to ASTM B 813, Standard Test 1.

i. PTFE Tape: PTFE Tape, for use with Threaded Metal or Plastic Pipe, ASTM D 3308.

j. Rubber Gaskets for Cast-Iron Soil-Pipe and Fittings (hub and spigot type and hubless type): ASTM C 564.

k. Rubber Gaskets for Grooved Pipe: ASTM D 2000, maximum temperature 230 degrees F.

l. Flexible Elastomeric Seals: ASTM D 3139, ASTM D 3212 or ASTM F 477.

m. Bolts and Nuts for Grooved Pipe Couplings: Heat-treated carbon steel, ASTM A 183.

n. Solvent Cement for Transition Joints between ABS and PVC Nonpressure Piping Components: ASTM D 3138.

o. Plastic Solvent Cement for ABS Plastic Pipe: ASTM D 2235.

p. Plastic Solvent Cement for PVC Plastic Pipe: ASTM D 2564 and ASTM D 2855.

q. Plastic Solvent Cement for CPVC Plastic Pipe: ASTM F 493.

r. Flanged fittings including flanges, bolts, nuts, bolt patterns, etc., shall be in accordance with ASME B16.5 class 150 and shall have the manufacturer's trademark affixed in accordance with MSS SP-25. Flange material shall conform to ASTM A 105/A 105M. Blind flange material shall conform to ASTM A 516/A 516M for cold service and ASTM A 515/A 515M for hot service. Bolts shall be high strength or intermediate strength with material conforming to

ASTM A 193/A 193M.

s. Plastic Solvent Cement for Styrene Rubber Plastic Pipe: ASTM D 3122.

2.1.2 Miscellaneous Materials

Miscellaneous materials shall conform to the following:

a. Water Hammer Arrester: PDI WH 201.

b. Copper, Sheet and Strip for Building Construction: ASTM B 370.

c. Asphalt Roof Cement: ASTM D 2822.

d. Hose Clamps: SAE J 1508.

e. Supports for Off-The-Floor Plumbing Fixtures: ASME A112.6.1M.

f. Metallic Cleanouts: ASME A112.36.2M.

g. Plumbing Fixture Setting Compound: A preformed flexible ring seal molded from hydrocarbon wax material. The seal material shall be nonvolatile nonasphaltic and contain germicide and provide watertight, gastight, odorproof and verminproof properties.

h. Coal-Tar Protective Coatings and Linings for Steel Water Pipelines: AWWA C203.

i. Hypochlorites: AWWA B300.

j. Liquid Chlorine: AWWA B301.

k. Polyethylene Encasement for Ductile-Iron Piping: AWWA C105.

l. Gauges - Pressure and Vacuum Indicating Dial Type - Elastic Element: ASME B40.1.

m. Thermometers: ASTM E 1.

2.1.3 Pipe Insulation Material

Insulation shall be as specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.2 PIPE HANGERS, INSERTS, AND SUPPORTS

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69.

2.3 VALVES

Valves shall be provided on supplies to equipment and fixtures. Valves 2-1/2 inches and smaller shall be bronze with threaded bodies for pipe and solder-type connections for tubing. Valves 3 inches and larger shall have flanged iron bodies and bronze trim. Pressure ratings shall be based upon the application. Grooved end valves may be provided if the manufacturer certifies that the valves meet the performance requirements of applicable MSS standard. Valves shall conform to the following standards:

Description	Standard
Butterfly Valves	MSS SP-67
Cast-Iron Gate Valves, Flanged and Threaded Ends	MSS SP-70
Cast-Iron Swing Check Valves, Flanged and Threaded Ends	MSS SP-71
Ball Valves with Flanged Butt-Welding Ends for General Service	MSS SP-72
Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends	MSS SP-110
Cast-Iron Plug Valves, Flanged and Threaded Ends	MSS SP-78
Bronze Gate, Globe, Angle, and Check Valves	MSS SP-80
Steel Valves, Socket Welding and Threaded Ends	ASME B16.34
Cast-Iron Globe and Angle Valves, Flanged and Threaded Ends	MSS SP-85
Backwater Valves	ASME A112.14.1
Vacuum Relief Valves	ASSE 1001
Water Pressure Reducing Valves	ASSE 1003
Water Heater Drain Valves	ASSE 1005
Trap Seal Primer Valves	ASSE 1018
Temperature and Pressure Relief Valves for Hot Water Supply Systems	ANSI Z21.22
Temperature and Pressure Relief Valves for Automatically Fired Hot Water Boilers	ASME CSD-1 Safety Code No., Part CW, Article 5

2.3.1 Wall Faucets

Wall faucets with vacuum-breaker backflow preventer shall be brass with 3/4 inch male inlet threads, hexagon shoulder, and 3/4 inch hose connection. Faucet handle shall be securely attached to stem.

2.3.2 Relief Valves

Water heaters and hot water storage tanks shall have a combination pressure and temperature (P&T) relief valve. The pressure relief element of a P&T relief valve shall have adequate capacity to prevent excessive pressure buildup in the system when the system is operating at the maximum rate of heat input. The temperature element of a P&T relief valve shall have a relieving capacity which is at least equal to the total input of the heaters when operating at their maximum capacity. Relief valves shall be

rated according to ANSI Z21.22. Relief valves for systems where the maximum rate of heat input is less than 200,000 Btuh shall have 3/4 inch minimum inlets, and 3/4 inch outlets. Relief valves for systems where the maximum rate of heat input is greater than 200,000 Btuh shall have 1 inch minimum inlets, and 1 inch outlets. The discharge pipe from the relief valve shall be the size of the valve outlet.

2.3.3 Thermostatic Mixing Valves

Mixing valves, thermostatic type, shall be line size and shall be constructed with rough or finish bodies either with or without plating. Each valve shall be constructed to control the mixing of hot and cold water and to deliver water at a desired temperature regardless of pressure or input temperature changes. The control element shall be of an approved type. The body shall be of heavy cast bronze, and interior parts shall be brass, bronze, or copper. The valve shall be equipped with necessary stops, check valves, unions, and sediment strainers on the inlets. Mixing valves shall maintain water temperature within 5 degrees F of any setting.

2.4 FIXTURES

Fixtures shall be water conservation type, in accordance with NAPHCC Plumbing Code. Fixtures for use by the physically handicapped shall be in accordance with CABO A117.1. Vitreous china, nonabsorbent, hard-burned, and vitrified throughout the body shall be provided. Porcelain enameled ware shall have specially selected, clear white, acid-resisting enamel coating evenly applied on surfaces. No fixture will be accepted that shows cracks, crazes, blisters, thin spots, or other flaws. Fixtures shall be equipped with appurtenances such as traps, faucets, stop valves, and drain fittings. Each fixture and piece of equipment requiring connections to the drainage system, except grease interceptors, shall be equipped with an automatic priming trap where applicable. Brass expansion or toggle bolts capped with acorn nuts shall be provided for supports, and polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view. Fixtures with the supply discharge below the rim shall be equipped with backflow preventers. Internal parts of flush and/or flushometer valves, shower mixing valves, shower head face plates, pop-up stoppers of lavatory waste drains, and pop-up stoppers and overflow tees may contain acetal resin, fluorocarbon, nylon, acrylonitrile-butadiene-styrene (ABS) or other plastic material, if the material has provided satisfactory service under actual commercial or industrial operating conditions for not less than 2 years. Plastic in contact with hot water shall be suitable for 180 degrees F water temperature. Plumbing fixtures shall be as indicated in paragraph PLUMBING FIXTURE SCHEDULE.

2.4.1 Lavatories

Vitreous china lavatories shall be provided with two integral molded lugs on the back-underside of the fixture and drilled for bolting to the wall in a manner similar to the hanger plate.

2.5 BACKFLOW PREVENTERS

Backflow preventers shall be approved and listed by the Foundation For Cross-Connection Control & Hydraulic Research. Reduced pressure principle assemblies, double check valve assemblies, atmospheric (nonpressure) type vacuum breakers, and pressure type vacuum breakers shall be tested, approved, and listed in accordance with FCCCHR-01. Backflow preventers

with intermediate atmospheric vent shall conform to ASSE 1012. Reduced pressure principle backflow preventers shall conform to ASSE 1013. Hose connection vacuum breakers shall conform to ASSE 1011. Pipe applied atmospheric type vacuum breakers shall conform to ASSE 1001. Air gaps in plumbing systems shall conform to ASME A112.1.2.

2.6 TRAPS

Traps shall be automatic self priming. Unless otherwise specified, traps shall be plastic per ASTM F 409 or copper-alloy adjustable tube type with slip joint inlet and swivel. Traps shall be without a cleanout. Tubes shall be copper alloy with walls not less than 0.032 inch thick within commercial tolerances, except on the outside of bends where the thickness may be reduced slightly in manufacture by usual commercial methods. Inlets shall have rubber washer and copper alloy nuts for slip joints above the discharge level. Swivel joints shall be below the discharge level and shall be of metal-to-metal or metal-to-plastic type as required for the application. Nuts shall have flats for wrench grip. Outlets shall have internal pipe thread, except that when required for the application, the outlets shall have sockets for solder-joint connections. The depth of the water seal shall be not less than 2 inches. The interior diameter shall be not more than 1/8 inch over or under the nominal size, and interior surfaces shall be reasonably smooth throughout. A copper alloy "P" trap assembly consisting of an adjustable "P" trap and threaded trap wall nipple with cast brass wall flange shall be provided for lavatories. The assembly shall be a standard manufactured unit and may have a rubber-gasketed swivel joint.

2.7 WATER HEATERS

Water heater types and capacities shall be as indicated. Each primary water heater shall have controls with an adjustable range that includes 90 to 120 degrees F. Each gas-fired water heater and booster water heater shall have controls with an adjustable range that includes 120 to 180 degrees F. Hot water systems utilizing recirculation systems shall be tied into building off-hour controls. The thermal efficiencies and standby heat losses shall conform to TABLE III for each type of water heater specified. The only exception is that storage water heaters and hot water storage tanks having more than 500 gallons storage capacity need not meet the standard loss requirement if the tank surface area is not insulated to R-12.5 and if a standing light is not used. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases.

2.7.1 Automatic Storage Type

Heaters shall be complete with control system, temperature gauge, and pressure gauge, and shall have ASME rated combination pressure and temperature relief valve.

2.7.1.1 Gas-Fired Type

Gas-fired water heaters shall conform to ANSI Z21.10.1 when input is 75,000 BTU per hour or less or ANSI Z21.10.3 for heaters with input greater than 75,000 BTU per hour.

2.7.2 Phenolic Resin Coatings

The phenolic resin coating shall be applied at either the coil or coating

manufacturer's factory. The coil shall be chemically cleaned to remove any scale if present and to etch the metal surface. The exposed exterior surface of the coil shall be abrasively cleaned to white metal blast in accordance with SSPC SP 5/NACE 1. The coating shall be a product specifically intended for use on the material the water heating coils are made of. Steel, copper, copper alloy, or stainless steel coatings shall be capable of withstanding temperatures up to 400 degrees F dry bulb; and meet the requirements of 21 CFR 175. The entire exterior surface and the first 5 to 8 inches inside the tubes of each coil shall be coated with three component phenolic resin coating system. The system shall consist of the following: wash primer, pigmented base coat, the clear top coat. Immediate and final cure times and temperatures shall be as recommended by the coating manufacturer.

2.7.2.1 Wash Primer

The wash primer shall be composed of a combination of polyvinyl butyral and a heat hardening phenolic resin. The weight per gallon shall be between 7.0 lbs per gallon minimum and 7.4 lbs. per gallon maximum.

2.7.2.2 Pigmented Base Coat

The pigmented baking phenolic base coat shall consist of heat hardening phenolic resins, suitable pigments of the earth type, and softening agents, and shall not contain drying oils or cellulose material. The weight per gallon shall be between 10.3 lbs per gallon minimum and 10.7 lbs per gallon maximum. The non-volatile solids content shall be between 60 percent minimum and 64 percent maximum by weight.

2.7.2.3 Clear Top Coat

The clear non-pigmented baking phenolic top coat shall have a weight per gallon of between 8.65 lbs per gallon minimum and 8.95 lbs per gallon maximum. The non-volatile solids content shall be between 48 percent minimum and 52 percent maximum by weight.

2.7.2.4 Certificate of Compliance

A certificate of compliance shall be submitted by the coating manufacturer that documents successful use of coating system under service conditions indicated on the drawings for a minimum of 2 years at three different locations, and that the coating material and application comply with the testing procedures outlined.

2.8 HOT-WATER STORAGE TANKS

Hot-water storage tanks shall be constructed by one manufacturer, ASME stamped for the working pressure, and shall have the National Board (ASME) registration. The tank shall be cement-lined or glass-lined steel type in accordance with AWWA D100. The heat loss shall conform to TABLE III as determined by the requirements of ASHRAE 90.1. Each tank shall be equipped with a thermometer, conforming to ASTM E 1, Type I, Class 3, Range C, style and form as required for the installation, and with 7 inch scale. Thermometer shall have a separable socket suitable for a 3/4 inch tapped opening. Tanks shall be equipped with a ASME rated combination pressure and temperature relief valve and pressure gauge 6 inch minimum diameter face. Insulation shall be as specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.9 COMPRESSED AIR SYSTEM

2.9.1 Air Compressors

Air compressor unit shall be a factory-packaged assembly, including 3 phase, 430 volt motor controls, switches, wiring, accessories, and motor controllers, in a NEMA 250, Type 1 enclosure. Tank-mounted air compressors shall be manufactured to comply with UL listing requirements. Air compressors shall have manufacturer's name and address, together with trade name, and catalog number on a nameplate securely attached to the equipment. Each compressor shall start and stop automatically at upper and lower pressure limits of the system. Guards shall shield exposed moving parts. Each duplex compressor system shall be provided with automatic alternation system. Each compressor motor shall be provided with an across-the-line-type magnetic controller, complete with low-voltage release. An intake air filter and silencer shall be provided with each compressor. Aftercooler and moisture separator shall be installed between compressors and air receiver to remove moisture and oil condensates before the air enters the receiver. Aftercoolers shall be air-cooled. The air shall pass through a sufficient number of tubes to affect cooling. Tubes shall be sized to give maximum heat transfer. Cooling capacity of the aftercooler shall be sized for the total capacity of the compressors. Means shall be provided for draining condensed moisture from the receiver by an automatic float type trap. Capacities of air compressors and receivers shall be as indicated.

2.9.2 Lubricated Compressors

Compressors shall be two-stage, V-belt drive, capable of operating continuously against their designed discharge pressure, and shall operate at a speed not in excess of 1800 rpm. Compressors shall have the capacity and discharge pressure indicated. Compressors shall be assembled complete on a common subbase. The compressor main bearings shall be either roller or ball. The discharge passage of the high pressure air shall be piped to the air receiver with a copper pipe or tubing. A pressure gauge calibrated to 150 psi and equipped with a gauge cock and pulsation dampener shall be furnished for installation adjacent to pressure switches.

2.9.3 Air Receivers

Receivers shall be designed for 200 psi working pressure. Receivers shall be factory air tested to 1-1/2 times the working pressure. Receivers shall be equipped with safety relief valves and accessories, including pressure gauges and automatic and manual drains. The outside of air receivers may be galvanized or supplied with commercial enamel finish. Receivers shall be designed and constructed in accordance with ASME BPV VIII Div 1 and shall have the design working pressures specified herein. A display of the ASME seal on the receiver or a certified test report from an approved independent testing laboratory indicating conformance to the ASME Code shall be provided.

2.9.4 Intake Air Supply Filter

Dry type air filter shall be provided having a collection efficiency of 99 percent of particles larger than 10 microns. Filter body and media shall withstand a maximum 125 psi, capacity as indicated.

2.9.5 Pressure Regulators

The air system shall be provided with the necessary regulator valves to maintain the desired pressure for the installed equipment. Regulators shall be designed for a maximum inlet pressure of 125 psi and a maximum temperature of 200 degrees F. Regulators shall be single-seated, pilot-operated with valve plug, bronze body and trim or equal, and threaded connections. The regulator valve shall include a pressure gauge and shall be provided with an adjustment screw for adjusting the pressure differential from 0 to 125 psi. Regulator shall be sized as indicated.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Piping located in air plenums shall conform to NFPA 90A requirements. Plastic pipe shall not be installed in air plenums. Piping located in shafts that constitute air ducts or that enclose air ducts shall be noncombustible in accordance with NFPA 90A. Installation of plastic pipe where in compliance with NFPA may be installed in accordance with PPFA-01. The plumbing system shall be installed complete with necessary fixtures, fittings, traps, valves, and accessories. Water and drainage piping shall be extended 5 feet outside the building, unless otherwise indicated. A full port ball valve and drain shall be installed on the water service line inside the building approximately 6 inches above the floor from point of entry. Piping shall be connected to the exterior service lines or capped or plugged if the exterior service is not in place. Sewer and water pipes shall be laid in separate trenches, except when otherwise shown. Exterior underground utilities shall be at least 12 inches below the average local frost depth or as indicated on the drawings. If trenches are closed or the pipes are otherwise covered before being connected to the service lines, the location of the end of each plumbing utility shall be marked with a stake or other acceptable means. Valves shall be installed with control no lower than the valve body.

3.1.1 Water Pipe, Fittings, and Connections

3.1.1.1 Utilities

The piping shall be extended to fixtures, outlets, and equipment. The hot-water and cold-water piping system shall be arranged and installed to permit draining. The supply line to each item of equipment or fixture, except faucets, flush valves, or other control valves which are supplied with integral stops, shall be equipped with a shutoff valve to enable isolation of the item for repair and maintenance without interfering with operation of other equipment or fixtures. Supply piping to fixtures, faucets, hydrants, shower heads, and flushing devices shall be anchored to prevent movement.

3.1.1.2 Cutting and Repairing

The work shall be carefully laid out in advance, and unnecessary cutting of construction shall be avoided. Damage to building, piping, wiring, or equipment as a result of cutting shall be repaired by mechanics skilled in the trade involved.

3.1.1.3 Protection of Fixtures, Materials, and Equipment

Pipe openings shall be closed with caps or plugs during installation. Fixtures and equipment shall be tightly covered and protected against dirt, water, chemicals, and mechanical injury. Upon completion of the work, the

fixtures, materials, and equipment shall be thoroughly cleaned, adjusted, and operated. Safety guards shall be provided for exposed rotating equipment.

3.1.1.4 Mains, Branches, and Runouts

Piping shall be installed as indicated. Pipe shall be accurately cut and worked into place without springing or forcing. Structural portions of the building shall not be weakened. Aboveground piping shall run parallel with the lines of the building, unless otherwise indicated. Branch pipes from service lines may be taken from top, bottom, or side of main, using crossover fittings required by structural or installation conditions. Supply pipes, valves, and fittings shall be kept a sufficient distance from other work and other services to permit not less than 1/2 inch between finished covering on the different services. Bare and insulated water lines shall not bear directly against building structural elements so as to transmit sound to the structure or to prevent flexible movement of the lines. Water pipe shall not be buried in or under floors unless specifically indicated or approved. Changes in pipe sizes shall be made with reducing fittings. Use of bushings will not be permitted except for use in situations in which standard factory fabricated components are furnished to accommodate specific excepted installation practice. Change in direction shall be made with fittings, except that bending of pipe 4 inches and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. The center-line radius of bends shall be not less than six diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be acceptable.

3.1.1.5 Pipe Drains

Pipe drains indicated shall consist of 3/4 inch hose bibb with renewable seat and ball valve ahead of hose bibb. At other low points, 3/4 inch brass plugs or caps shall be provided. Disconnection of the supply piping at the fixture is an acceptable drain; however, this type of drain shall be used only when necessary.

3.1.1.6 Expansion and Contraction of Piping

Allowance shall be made throughout for expansion and contraction of water pipe. Each hot-water and hot-water circulation riser shall have expansion loops or other provisions such as offsets, changes in direction, etc., where indicated and/or required. Risers shall be securely anchored as required or where indicated to force expansion to loops. Branch connections from risers shall be made with ample swing or offset to avoid undue strain on fittings or short pipe lengths. Horizontal runs of pipe over 50 feet in length shall be anchored to the wall or the supporting construction about midway on the run to force expansion, evenly divided, toward the ends. Sufficient flexibility shall be provided on branch runouts from mains and risers to provide for expansion and contraction of piping. Flexibility shall be provided by installing one or more turns in the line so that piping will spring enough to allow for expansion without straining. If mechanical grooved pipe coupling systems are provided, the deviation from design requirements for expansion and contraction may be allowed pending approval of Contracting Officer.

3.1.1.7 Commercial-Type Water Hammer Arresters

Commercial-type water hammer arresters shall be provided on hot- and cold-water supplies and shall be located as generally indicated, with

precise location and sizing to be in accordance with PDI WH 201. Water hammer arresters, where concealed, shall be accessible by means of access doors or removable panels. Commercial-type water hammer arresters shall conform to PDI WH 201. Vertical capped pipe columns will not be permitted.

3.1.2 Compressed Air Piping (Non-Oil Free)

Compressed air piping shall be installed as specified for water piping and suitable for 125 psig working pressure. Compressed air piping shall have supply lines and discharge terminals legibly and permanently marked at both ends with the name of the system and the direction of flow.

3.1.3 Joints

Installation of pipe and fittings shall be made in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Joints shall be made up with fittings of compatible material and made for the specific purpose intended.

3.1.3.1 Threaded

Threaded joints shall have American Standard taper pipe threads conforming to ASME B1.20.1. Only male pipe threads shall be coated with graphite or with an approved graphite compound, or with an inert filler and oil, or shall have a polytetrafluoroethylene tape applied.

3.1.3.2 Unions and Flanges

Unions, flanges and mechanical couplings shall not be concealed in walls, ceilings, or partitions. Unions shall be used on pipe sizes 2-1/2 inches and smaller; flanges shall be used on pipe sizes 3 inches and larger.

3.1.3.3 Cast Iron Soil, Waste and Vent Pipe

Bell and spigot compression and hubless gasketed clamp joints for soil, waste and vent piping shall be installed per the manufacturer's recommendations.

3.1.3.4 Copper Tube and Pipe

The tube or fittings shall not be annealed when making connections. Connections shall be made with a multiflame torch.

a. Brazed. Brazed joints shall be made in conformance with AWS B2.2, MSS SP-73, and CDA Tube Handbook with flux and are acceptable for all pipe sizes. Copper to copper joints shall include the use of copper-phosphorus or copper-phosphorus-silver brazing metal without flux. Brazing of dissimilar metals (copper to bronze or brass) shall include the use of flux with either a copper-phosphorus, copper-phosphorus-silver or a silver brazing filler metal.

b. Soldered. Soldered joints shall be made with flux and are only acceptable for piping 2 inches and smaller. Soldered joints shall conform to ASME B31.5 and CDA Tube Handbook.

c. Copper Tube Extracted Joint. An extracted mechanical joint may be made in copper tube. Joint shall be produced with an appropriate

tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, dimpled depth stops shall be provided. Branch tube shall be notched for proper penetration into fitting to ensure a free flow joint. Extracted joints shall be brazed in accordance with NAPHCC Plumbing Code using B-Cup series filler metal in accordance with MSS SP-73. Soldered extracted joints will not be permitted.

3.1.3.5 Plastic Pipe

Acrylonitrile-Butadiene-Styrene (ABS) pipe shall have joints made with solvent cement. PVC and CPVC pipe shall have joints made with solvent cement elastomeric, threading, (threading of Schedule 80 Pipe is allowed only where required for disconnection and inspection; threading of Schedule 40 Pipe is not allowed), or mated flanged.

3.1.3.6 Corrosive Waste Plastic Pipe

Joints for polyolefin pipe and fittings shall be made by mechanical joint or electrical fusion coil method in accordance with ASTM D 2657 and ASTM F 1290. Joints for filament-wound reinforced thermosetting resin pipe shall be made in accordance with manufacturer's instructions. Unions or flanges shall be used where required for disconnection and inspection.

3.1.3.7 Other Joint Methods

3.1.4 Dissimilar Pipe Materials

Connections between ferrous and non-ferrous copper water pipe shall be made with dielectric unions or flange waterways. Connecting joints between plastic and metallic pipe shall be made with transition fitting for the specific purpose.

3.1.5 Corrosion Protection for Buried Pipe and Fittings

3.1.5.1 Steel

Steel pipe, joints, and fittings shall be cleaned, coated with primer, and wrapped with tape. Pipe shall be cleaned, coated, and wrapped prior to pipe tightness testing. Joints and fittings shall be cleaned, coated, and wrapped after pipe tightness testing. Tape shall conform to AWWA C203 and shall be applied with a 50 percent overlap. Primer shall be as recommended by the tape manufacturer.

3.1.6 Pipe Sleeves and Flashing

Pipe sleeves shall be furnished and set in their proper and permanent location.

3.1.6.1 Sleeve Requirements

Pipes passing through concrete or masonry walls or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves are not required for cast-iron soil pipe passing through concrete slab on grade, except where penetrating a membrane waterproof floor. A modular mechanical type sealing assembly may be installed in lieu of a waterproofing clamping flange and caulking and

sealing of annular space between pipe and sleeve. The seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and sleeve with corrosion-protected carbon steel bolts, nuts, and pressure plates. The links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe and sleeve involved. Sleeves shall not be installed in structural members, except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective floor, or roof, and shall be cut flush with each surface, except for special circumstances. Pipe sleeves passing through floors in wet areas such as mechanical equipment rooms, lavatories, and other plumbing fixture areas shall extend a minimum of 4 inches above the finished floor. Unless otherwise indicated, sleeves shall be of a size to provide a minimum of 1/4 inch clearance between bare pipe and inside of sleeve or between jacket over insulation and sleeves. Sleeves in bearing walls shall be steel pipe or cast-iron pipe. Sleeves for membrane waterproof floors shall be steel pipe, cast-iron pipe, or plastic pipe. Membrane clamping devices shall be provided on pipe sleeves for waterproof floors. Sleeves in nonbearing walls or ceilings may be steel pipe, cast-iron pipe, galvanized sheet metal with lock-type longitudinal seam, or moisture-resistant fiber or plastic. Plastic sleeves shall not be used in nonbearing fire walls, roofs, or floor/ceilings. Except as otherwise specified, the annular space between pipe and sleeve, or between jacket over insulation and sleeve, shall be sealed as indicated with sealants conforming to ASTM C 920 and with a primer, backstop material and surface preparation as specified in Section 07900 JOINT SEALING. Pipes passing through sleeves in concrete floors over crawl spaces shall be sealed as specified above. The annular space between pipe and sleeve or between jacket over insulation and sleeve shall not be sealed for interior walls which are not designated as fire rated. Sleeves through below-grade walls in contact with earth shall be recessed 1/2 inch from wall surfaces on both sides. Annular space between pipe and sleeve shall be filled with backing material and sealants in the joint between the pipe and wall as specified above. Sealant selected for the earth side of the wall shall be compatible with dampproofing/waterproofing materials that are to be applied over the joint sealant.

3.1.6.2 Flashing Requirements

Pipes passing through pitched roofs shall be flashed, using lead or copper flashing, with an adjustable integral flange of adequate size to extend not less than 8 inches from the pipe in all directions and lapped into the roofing to provide a watertight seal. The annular space between the flashing and the bare pipe or between the flashing and the metal-jacket-covered insulation shall be sealed as indicated. Flashing for dry vents shall be turned down into the pipe to form a waterproof joint.

3.1.7 Fire Seal

Where pipes pass through fire walls, fire-partitions, fire-rated pipe chase walls or floors above grade, a fire seal shall be provided as specified in Section 07840 FIRESTOPPING.

3.1.8 Supports

3.1.8.1 General

Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Piping subjected to vertical movement when operating temperatures exceed ambient temperatures shall be supported by variable spring hangers and supports or by constant support hangers. In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run. Threaded sections of rods shall not be formed or bent.

3.1.8.2 Pipe Hangers, Inserts, and Supports

Installation of pipe hangers, inserts and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein.

a. Types 5, 12, and 26 shall not be used.

b. Type 3 shall not be used on insulated pipe.

c. Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for Type 18 inserts.

d. Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and shall have both locknuts and retaining devices furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

e. Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

f. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

g. Type 39 saddles shall be used on insulated pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher. Type 39 saddles shall be welded to the pipe.

h. Type 40 shields shall:

(1) Be used on insulated pipe less than 4 inches.

(2) Be used on insulated pipe 4 inches and larger when the temperature of the medium is 60 degrees F or less.

(3) Have a high density insert for pipe 2 inches and larger and for smaller pipe sizes when the insulation is suspected of being visibly compressed, or distorted at or near the shield/insulation interface. High density inserts shall have a density of 8 pcf or greater.

i. Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe

supports shall be spaced not over 5 feet apart at valves. Operating temperatures in determining hanger spacing for PVC or CPVC pipe shall be 120 degrees F for PVC and 180 degrees F for CPVC. Horizontal pipe runs shall include allowances for expansion and contraction.

j. Vertical pipe shall be supported at each floor, except at slab-on-grade, at intervals of not more than 15 feet nor more than 8 feet from end of risers, and at vent terminations. Vertical pipe risers shall include allowances for expansion and contraction.

k. Type 40 shields used on insulated pipe shall have high density inserts with a density of 8 pcf or greater.

l. Type 35 guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided to allow longitudinal pipe movement. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered. Lateral restraints shall be provided as needed. Where steel slides do not require provisions for lateral restraint the following may be used:

(1) On pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher, a Type 39 saddle, welded to the pipe, may freely rest on a steel plate.

(2) On pipe less than 4 inches a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.

(3) On pipe 4 inches and larger carrying medium less that 60 degrees F a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.

m. Pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation. The insulation shall be continuous through the hanger on all pipe sizes and applications.

n. Where there are high system temperatures and welding to piping is not desirable, the Type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 4 inches or by an amount adequate for the insulation, whichever is greater.

o. Hangers and supports for plastic pipe shall not compress, distort, cut or abrade the piping, and shall allow free movement of pipe except where otherwise required in the control of expansion/contraction.

3.1.9 Welded Installation

Plumbing pipe weldments shall be as indicated. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connection may be made with either welding tees or forged branch outlet fittings. Branch outlet fittings shall be forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.1. Weld defects shall be

removed and repairs made to the weld, or the weld joints shall be entirely removed and rewelded. After filler metal has been removed from its original package, it shall be protected or stored so that its characteristics or welding properties are not affected. Electrodes that have been wetted or that have lost any of their coating shall not be used.

3.1.10 Pipe Cleanouts

Pipe cleanouts shall be the same size as the pipe except that cleanout plugs larger than 4 inches will not be required. A cleanout installed in connection with cast-iron soil pipe shall consist of a long-sweep 1/4 bend or one or two 1/8 bends extended to the place shown. An extra-heavy cast-brass or cast-iron ferrule with countersunk cast-brass head screw plug shall be caulked into the hub of the fitting and shall be flush with the floor. Cleanouts in connection with other pipe, where indicated, shall be T-pattern, 90-degree branch drainage fittings with cast-brass screw plugs, except plastic plugs shall be installed in plastic pipe. Plugs shall be the same size as the pipe up to and including 4 inches. Cleanout tee branches with screw plug shall be installed at the foot of soil and waste stacks, at the foot of interior downspouts, on each connection to building storm drain where interior downspouts are indicated, and on each building drain outside the building. Cleanout tee branches may be omitted on stacks in single story buildings with slab-on-grade construction or where less than 18 inches of crawl space is provided under the floor. Cleanouts on pipe concealed in partitions shall be provided with chromium plated bronze, nickel bronze, nickel brass or stainless steel flush type access cover plates. Round access covers shall be provided and secured to plugs with securing screw. Square access covers may be provided with matching frames, anchoring lugs and cover screws. Cleanouts in finished walls shall have access covers and frames installed flush with the finished wall. Cleanouts installed in finished floors subject to foot traffic shall be provided with a chrome-plated cast brass, nickel brass, or nickel bronze cover secured to the plug or cover frame and set flush with the finished floor. Heads of fastening screws shall not project above the cover surface. Where cleanouts are provided with adjustable heads, the heads shall be plastic.

3.2 WATER HEATERS AND HOT WATER STORAGE TANKS

3.2.1 Relief Valves

No valves shall be installed between a relief valve and its water heater or storage tank. The P&T relief valve shall be installed where the valve actuator comes in contact with the hottest water in the heater. Whenever possible, the relief valve shall be installed directly in a tapping in the tank or heater; otherwise, the P&T valve shall be installed in the hot-water outlet piping. A vacuum relief valve shall be provided on the cold water supply line to the hot-water storage tank or water heater and mounted above and within 6 inches above the top of the tank or water heater.

3.2.2 Installation of Gas-Fired Water Heater

Installation shall conform to NFPA 54. Storage water heaters that are not equipped with integral heat traps and having vertical pipe risers shall be installed with heat traps directly on both the inlet and outlet. Circulating systems need not have heat traps installed. An acceptable heat trap may be a piping arrangement such as elbows connected so that the inlet and outlet piping make vertically upward runs of not less than 24 inches just before turning downward or directly horizontal into the water heater's inlet and outlet fittings. Commercially available heat traps, specifically

designed by the manufacturer for the purpose of effectively restricting the natural tendency of hot water to rise through vertical inlet and outlet piping during standby periods may also be approved.

3.2.3 Heat Traps

Piping to and from each water heater and hot water storage tank shall be routed horizontally and downward a minimum of 2 feet before turning in an upward direction.

3.2.4 Connections to Water Heaters

Connections of metallic pipe to water heaters shall be made with dielectric unions or flanges.

3.3 FIXTURES AND FIXTURE TRIMMINGS

Angle stops, straight stops, stops integral with the faucets, or concealed type of lock-shield, and loose-key pattern stops for supplies with threaded, sweat or solvent weld inlets shall be furnished and installed with fixtures. Where connections between copper tubing and faucets are made by rubber compression fittings, a beading tool shall be used to mechanically deform the tubing above the compression fitting. Exposed traps and supply pipes for fixtures and equipment shall be connected to the rough piping systems at the wall, unless otherwise specified under the item. Floor and wall escutcheons shall be as specified. Drain lines and hot water lines of fixtures for handicapped personnel shall be insulated and do not require polished chrome finish. Plumbing fixtures and accessories shall be installed within the space shown.

3.3.1 Fixture Connections

Where space limitations prohibit standard fittings in conjunction with the cast-iron floor flange, special short-radius fittings shall be provided. Connections between earthenware fixtures and flanges on soil pipe shall be made gastight and watertight with a closet-setting compound or neoprene gasket and seal. Use of natural rubber gaskets or putty will not be permitted. Fixtures with outlet flanges shall be set the proper distance from floor or wall to make a first-class joint with the closet-setting compound or gasket and fixture used.

3.3.2 Flushometer Valves

Flushometer valves shall be secured to prevent movement by anchoring the long finished top spud connecting tube to wall adjacent to valve with approved metal bracket. Flushometer valves for water closets shall be installed 39 inches above the floor. Bumpers for water closet seats shall be installed as specified.

3.3.3 Height of Fixture Rims Above Floor

Lavatories shall be mounted with rim 31 inches above finished floor. Wall-hung drinking fountains and water coolers shall be installed with rim 42 inches above floor. Wall-hung service sinks shall be mounted with rim 28 inches above the floor. Installation of fixtures for use by the physically handicapped shall be in accordance with CABO A117.1.

3.3.4 Fixture Supports

Fixture supports for off-the-floor lavatories, urinals, water closets, and other fixtures of similar size, design, and use, shall be of the chair-carrier type. The carrier shall provide the necessary means of mounting the fixture, with a foot or feet to anchor the assembly to the floor slab. Adjustability shall be provided to locate the fixture at the desired height and in proper relation to the wall. Support plates, in lieu of chair carrier, shall be fastened to the wall structure only where it is not possible to anchor a floor-mounted chair carrier to the floor slab.

3.3.4.1 Support for Cellular-Masonry Wall Construction

Chair carrier shall be anchored to floor slab. Where a floor-anchored chair carrier cannot be used, a suitable wall plate shall be fastened to the cellular wall using through bolts and a back-up plate.

3.3.4.2 Support for Steel Stud Frame Partitions

Chair carrier shall be used. The anchor feet and tubular uprights shall be of the heavy duty design; and feet (bases) shall be steel and welded to a square or rectangular steel tube upright. Wall plates, in lieu of floor-anchored chair carriers, shall be used only if adjoining steel partition studs are suitably reinforced to support a wall plate bolted to these studs.

3.3.4.3 Support for Wood Stud Construction

Where floor is a concrete slab, a floor-anchored chair carrier shall be used. Where entire construction is wood, wood crosspieces shall be installed. Fixture hanger plates, supports, brackets, or mounting lugs shall be fastened with not less than No. 10 wood screws, 1/4 inch thick minimum steel hanger, or toggle bolts with nut. The wood crosspieces shall extend the full width of the fixture and shall be securely supported.

3.3.4.4 Wall-Mounted Water Closet Gaskets

Where wall-mounted water closets are provided, reinforced wax, treated felt, or neoprene gaskets shall be provided. The type of gasket furnished shall be as recommended by the chair-carrier manufacturer.

3.3.5 Backflow Prevention Devices

Plumbing fixtures, equipment, and pipe connections shall not cross connect or interconnect between a potable water supply and any source of nonpotable water. Backflow preventers shall be installed where indicated and in accordance with NAPHCC Plumbing Code at all other locations necessary to preclude a cross-connect or interconnect between a potable water supply and any nonpotable substance. In addition backflow preventers shall be installed at all locations where the potable water outlet is below the flood level of the equipment, or where the potable water outlet will be located below the level of the nonpotable substance. Backflow preventers shall be located so that no part of the device will be submerged. Backflow preventers shall be of sufficient size to allow unrestricted flow of water to the equipment, and preclude the backflow of any nonpotable substance into the potable water system. Bypass piping shall not be provided around backflow preventers. Access shall be provided for maintenance and testing. Each device shall be a standard commercial unit.

3.3.6 Access Panels

Access panels shall be provided for concealed valves and controls, or any item requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced, maintained, or replaced. Access panels shall be as specified in Section 05500 MISCELLANEOUS METAL.

3.3.7 Traps

Each trap shall be placed as near the fixture as possible, and no fixture shall be double-trapped. Traps installed on cast-iron soil pipe shall be cast iron. Traps installed on steel pipe or copper tubing shall be recess-drainage pattern, or brass-tube type. Traps installed on plastic pipe may be plastic conforming to ASTM D 3311. Traps for acid-resisting waste shall be of the same material as the pipe.

3.4 VIBRATION-ABSORBING FEATURES

Mechanical equipment, including compressors and pumps, shall be isolated from the building structure by approved vibration-absorbing features, unless otherwise shown. Each foundation shall include an adequate number of standard isolation units. Each unit shall consist of machine and floor or foundation fastening, together with intermediate isolation material, and shall be a standard product with printed load rating. Piping connected to mechanical equipment shall be provided with flexible connectors. Isolation unit installation shall limit vibration.

3.4.1 Tank- or Skid-Mounted Compressors

Floor attachment shall be as recommended by compressor manufacturer.

3.4.2 Foundation-Mounted Compressors

Foundation attachment shall be as recommended by the compressor manufacturer.

3.5 WATER METER REMOTE READOUT REGISTER

Where applicable, the remote readout register shall be mounted at the location indicated or as directed by the Contracting Officer.

3.6 IDENTIFICATION SYSTEMS

3.6.1 Identification Tags

Identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and valve number shall be installed on valves, except those valves installed on supplies at plumbing fixtures. Tags shall be 1-3/8 inch minimum diameter, and marking shall be stamped or engraved. Indentations shall be black, for reading clarity. Tags shall be attached to valves with No. 12 AWG, copper wire, chrome-plated beaded chain, or plastic straps designed for that purpose.

3.6.2 Pipe Color Code Marking

Color code marking of piping shall be as specified in Section 09900 PAINTING, GENERAL.

3.6.3 Color Coding Scheme for Locating Hidden Utility Components

Scheme shall be provided in buildings having suspended grid ceilings. The color coding scheme shall identify points of access for maintenance and operation of operable components which are not visible from the finished space and installed in the space directly above the suspended grid ceiling. The operable components shall include valves, dampers, switches, linkages and thermostats. The color coding scheme shall consist of a color code board and colored metal disks. Each colored metal disk shall be approximately 3/8 inch in diameter and secured to removable ceiling panels with fasteners. The fasteners shall be inserted into the ceiling panels so that the fasteners will be concealed from view. The fasteners shall be manually removable without tools and shall not separate from the ceiling panels when panels are dropped from ceiling height. Installation of colored metal disks shall follow completion of the finished surface on which the disks are to be fastened. The color code board shall have the approximate dimensions of 3 foot width, 30 inches height, and 1/2 inch thickness. The board shall be made of wood fiberboard and framed under glass or 1/16 inch transparent plastic cover. Unless otherwise directed, the color code symbols shall be approximately 3/4 inch in diameter and the related lettering in 1/2 inch high capital letters. The color code board shall be mounted and located in the mechanical or equipment room.

3.7 ESCUTCHEONS

Escutcheons shall be provided at finished surfaces where bare or insulated piping, exposed to view, passes through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Escutcheons shall be fastened securely to pipe or pipe covering and shall be satin-finish, corrosion-resisting steel, polished chromium-plated zinc alloy, or polished chromium-plated copper alloy. Escutcheons shall be either one-piece or split-pattern, held in place by internal spring tension or setscrew.

3.8 PAINTING

Painting of pipes, hangers, supports, and other iron work, either in concealed spaces or exposed spaces, is specified in Section 09900 PAINTING, GENERAL.

3.9 TESTS, FLUSHING AND DISINFECTION

3.9.1 Plumbing System

The plumbing system shall be tested in accordance with NAPHCC Plumbing Code and/or in accordance with local code authority.

3.9.1.1 Test of Backflow Prevention Assemblies

Backflow prevention assembly shall be tested using gauges specifically designed for the testing of backflow prevention assemblies. Gauges shall be tested annually for accuracy in accordance with the University of Southern California's Foundation of Cross Connection Control and Hydraulic Research or the American Water Works Association Manual of Cross Connection (Manual M-14). Report form for each assembly shall include, as a minimum, the following:

Data on Device	Data on Testing Firm
Type of Assembly	Name
Manufacturer	Address
Model Number	Certified Tester
Serial Number	Certified Tester No.

Size	Date of Test
Location	
Test Pressure Readings	Serial Number and Test Data of Gauges

If the unit fails to meet specified requirements, the unit shall be repaired and retested.

3.9.1.2 Compressed Air Piping (Non oil-Free)

Piping systems shall be filled with oil-free dry air or gaseous nitrogen to 150 psig and hold this pressure for 2 hours with no drop in pressure.

3.9.2 Defective Work

If inspection or test shows defects, such defective work or material shall be replaced or repaired as necessary and inspection and tests shall be repeated. Repairs to piping shall be made with new materials. Caulking of screwed joints or holes will not be acceptable.

3.9.3 System Flushing

Before operational tests or disinfection, potable water piping system shall be flushed with potable water. In general, sufficient water shall be used to produce a minimum water velocity of 2.5 feet per second through piping being flushed. Flushing shall be continued until entrained dirt and other foreign materials have been removed and until discharge water shows no discoloration. System shall be drained at low points. Strainer screens shall be removed, cleaned, and replaced. After flushing and cleaning, systems shall be prepared for testing by immediately filling water piping with clean, fresh potable water. Any stoppage, discoloration, or other damage to the finish, furnishings, or parts of the building due to the Contractor's failure to properly clean the piping system shall be repaired by the Contractor. When the system flushing is complete, the hot-water system shall be adjusted for uniform circulation. Flushing devices and automatic control systems shall be adjusted for proper operation.

3.9.4 Operational Test

Upon completion of flushing and prior to disinfection procedures, the Contractor shall subject the plumbing system to operating tests to demonstrate satisfactory functional and operational efficiency. Such operating tests shall cover a period of not less than 8 hours for each system and shall include the following information in a report with conclusion as to the adequacy of the system:

a. Time, date, and duration of test.

b. Water pressures at the most remote and the highest fixtures.

c. Operation of each fixture and fixture trim.

d. Operation of each valve, hydrant, and faucet.

e. Pump suction and discharge pressures.

f. Temperature of each domestic hot-water supply.

g. Operation of each floor and roof drain by flooding with water.

h. Operation of each vacuum breaker and backflow preventer.

i. Complete operation of each water pressure booster system, including pump start pressure and stop pressure.

j. Compressed air readings at each compressor and at each outlet. Each indicating instrument shall be read at 1/2 hour intervals. The report of the test shall be submitted in quadruplicate. The Contractor shall furnish instruments, equipment, and personnel required for the tests; the Government will furnish the necessary water and electricity.

3.9.5 Disinfection

After operational tests are complete, the entire domestic hot- and cold-water distribution system shall be disinfected. System shall be flushed as specified, before introducing chlorinating material. The chlorinating material shall be hypochlorites or liquid chlorine. Water chlorination procedure shall be in accordance with AWWA M20. The chlorinating material shall be fed into the water piping system at a constant rate at a concentration of at least 50 parts per million (ppm). A properly adjusted hypochlorite solution injected into the main with a hypochlorinator, or liquid chlorine injected into the main through a solution-feed chlorinator and booster pump, shall be used. The chlorine residual shall be checked at intervals to ensure that the proper level is maintained. Chlorine application shall continue until the entire main is filled. The water shall remain in the system for a minimum of 24 hours. Each valve in the system being disinfected shall be opened and closed several times during the contact period to ensure its proper disinfection. Following the 24-hour period, no less than 25 ppm chlorine residual shall remain in the system. Water tanks shall be disinfected by the addition of chlorine directly to the filling water. Following a 6 hour period, no less than 50 ppm chlorine residual shall remain in the tank. If after the 24 hour and 6 hour holding periods, the residual solution contains less than 25 ppm and 50 ppm chlorine respectively, flush the piping and tank with potable water, and repeat the above procedures until the required residual chlorine levels are satisfied. The system including the tanks shall then be flushed with clean water until the residual chlorine level is reduced to less than one part per million. During the flushing period each valve and faucet shall be opened and closed several times. Samples of water in disinfected containers shall be obtained from several locations selected by the Contracting Officer. The samples of water shall be tested for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with AWWA EWW. The testing method used shall be either the multiple-tube fermentation technique or the membrane-filter technique. Disinfection shall be repeated until tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained.

3.10 PLUMBING FIXTURE SCHEDULE

P-1 WATER CLOSET:

Siphon-jet, elongated bowl, top supply spud, ASME A112.19.2M, floor mounted. Floor flange shall be copper alloy, cast iron, or plastic.

Gasket shall be wax type.

Seat - IAPMO Z124.5, Type A, white plastic, elongated, open front.

Flushometer Valve - ASSE 1037, large diaphragm type with non-hold-open feature, backcheck angle control stop, and vacuum breaker. Minimum upper chamber inside diameter of not less than 2-5/8 inches at the point where the diaphragm is sealed between the upper and lower chambers. The maximum water use shall be 1.0 gallon per flush.

Flush Tank - An adequate quantity of water shall be provided to flush and clean the fixture served. The water supply to flush tanks equipped for manual flushing shall be controlled by a float valve or other automatic device designed to refill the tank after each discharge, and to completely shut off the water flow to the tank when the tank is filled to operational capacity. Water closets having their flush valve seat located below the flood level rim of the closet bowl shall have a ballcock installed within a sheath or in a separate and isolated compartment of the tank, both to have visible discharge onto the floor in case of failure. Provision shall be made to automatically supply water to the fixture so as to refill the trap seal after each flushing.

Flush Valve in Flush Tank - Flush valve seats in tanks for flushing water closets shall be at least 1 inch above the flood level rim of the bowl connected thereto, except in approved water closet and flush tank combinations designed so that when the tank is flushed and the fixture is clogged or partially clogged, the flush valve shall close tightly so that water will not spill continuously over the rim of the bowl or back flow from the bowl to the tank.

P-2 WATER CLOSET HANDICAPPED:

Height of top rim of bowl shall be in accordance with CABO A117.1; other features are the same as P-1.

P-3 URINAL:

Wall hanging, with integral trap and extended shields, ASME A112.19.2M. Top supply connection, back outlet.

Flushometer Valve - Similar to Flushometer Valve for P-1. The maximum water use shall be 1 gallon per flush.

Wall hanging urinal shall be in accordance with IAPMO Z124.9 and be a waterless, non-flushing type, with replaceable trap insert having circular outer rim opening for flow. The replaceable trap insert shall contain a low specific gravity immiscible barrier liquid. The liquid shall be biodegradable. The urinal shall not require chair carrier. The urinal and trap assembly shall maintain a sufficient barrier of immiscible liquid necessary to inhibit backflow of sewer gases.

P-4 LAVATORY:

Manufacturer's standard sink depth, vitreous china ASME A112.19.2M, rectangular.

Faucet - Faucets shall be center set, mixing type. Faucets shall have replaceable seats and washers. Valves and handles shall be copper alloy. Connection between valve and spout for center-set faucet shall be of rigid metal tubing. Flow shall be limited to 0.25 gallon per cycle at a flowing

water pressure of 80 psi if a metering device or fitting is used that limits the period of water discharge such as a foot switch or fixture occupancy sensor. If a metering device is not used, the flow shall be limited to 2.5 gpm at a flowing pressure of 80 psi.

Handles - Cast, formed, or drop forged copper alloy.

Drain - Strainer shall be copper alloy or stainless steel, pop-up drain shall include stopper, lift rods, jam nut, washer, and tail piece. See paragraph FIXTURES for optional plastic accessories.

P-5 WHEELCHAIR LAVATORY:

Vitreous china, ASME A112.19.2M, wheelchair lavatory with wrist or elbow controls 20 inches wide x 27 inches deep with gooseneck spout. Flow shall be limited to 0.25 gallon per cycle at a flowing water pressure of 80 psi if a metering device or fitting is used that limits the period of water discharge such as foot switch or fixture occupancy sensor. If a metering device is not used, the flow shall be limited to 2.5 gpm at a flowing water pressure of 80 psi.

Drain - Strainer shall be copper alloy or stainless steel.

P-6 SERVICE SINK:

Stainless steel ASME A112.19.3M wall mounted 24 inches wide x 20 inches deep, splashback 9 inches high, or corner or floor mounted 28 inches square, 6-3/4 inches deep.

Faucet and Spout - Cast or wrought copper alloy. Faucets shall have replaceable seat and the washer shall rotate onto the seat. Strainers shall have internal threads.

Drain Assembly - Plug, cup strainer, crossbars, jam nuts, washers, couplings, stopper, etc., shall be copper alloy or stainless steel.

Trap - Cast iron, minimum 3 inch diameter.

P-7 SHOWER:

Emergency Showers: Head for Emergency and Emergency Eye and Face Wash. Shower control shall be 1 inch or 1-1/2 inch stay-open type control valve. Unit shall be corrosion-resisting steel and shall be either wall mounted or pedestal mounted.

3.11 POSTED INSTRUCTIONS

At the direction of the Contracting Officer, provide framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, shall be posted where directed. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system shall be prepared in typed form, framed as specified above for the wiring and control diagrams and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the systems.

3.12 PERFORMANCE OF WATER HEATING EQUIPMENT

Standard rating condition terms are as follows:

EF = Energy factor, overall efficiency.

ET = Thermal efficiency with 70 degrees F delta T.

EC = Combustion efficiency.

SL = Standby loss in W/sq. ft. based on 80 degrees F delta T, or in percent per hour based on nominal 90 degrees F delta T.

HL = Heat loss of tank surface area (Btu/(hr-degrees F)).

V = Storage volume in gallons.

3.12.1 Storage Water Heaters

3.12.1.1 Gas

a. Storage capacity of 100 gallons or less, and input rating of 75,000 Btu/h or less: minimum EF shall be 0.62-0.0019V per 10 CFR 430.

b. Storage capacity of more than 100 gallons - or input rating more than 75,000 Btu/h: ET shall be 77 percent; maximum SL shall be 1.3+38/V, per ANSI Z21.10.3.

3.12.2 Unfired Hot Water Storage

Volumes and inputs: maximum HL shall be 6.5 Btu/h/sq. ft.

3.12.3 Instantaneous Water Heater

3.12.3.1 Gas

Volumes and inputs: ET shall be 80 percent per ANSI Z21.10.3.

3.13 TABLES

TABLE I
PIPE AND FITTING MATERIALS FOR
DRAINAGE, WASTE, AND VENT PIPING SYSTEMS

		SERVICE					
Item #	Pipe and Fitting Materials	A	B	C	D	E	F
1	Cast iron soil pipe and fittings, hub and spigot, ASTM A 74 with compression gaskets	X	X	X	X	X	
2	Cast iron soil pipe and fittings hubless, CISPI 301 and ASTM A 888		X	X	X		
3	Cast iron drainage fittings, threaded, ASME B16.12 for use with Item 6	X		X	X		
4	Cast iron screwed fittings (threaded) ASME B16.4 for use with Item 6				X	X	
5	Malleable-iron threaded fittings, galvanized ASME B16.3 for use with Item 6				X	X	
6	Steel pipe, seamless galvanized, ASTM A 53/A 53M, Type S, Grade B	X			X	X	
7	Seamless red brass pipe, ASTM B 43		X	X			
8	Bronzed flanged fittings, ASME B16.24 for use with Items 7 and 10				X	X	
9	Cast copper alloy solder joint pressure fittings, ASME B16.18 for use with Item 10				X	X	
10	Seamless copper pipe, ASTM B 42				X		
11	Cast bronze threaded fittings, ASME B16.15				X	X	
12	Copper drainage tube, (DWV), ASTM B 306	X*	X	X*	X	X	
13	Wrought copper and wrought alloy solder-joint drainage fittings. ASME B16.29	X	X	X	X	X	
14	Cast copper alloy solder joint drainage fittings, DWV, ASME B16.23	X	X	X	X	X	

TABLE I
PIPE AND FITTING MATERIALS FOR
DRAINAGE, WASTE, AND VENT PIPING SYSTEMS

		SERVICE					
Item #	Pipe and Fitting Materials	A	B	C	D	E	F
15	Acrylonitrile-Butadiene-Styrene (ABS) plastic drain, waste, and vent pipe and fittings ASTM D 2661, ASTM F 628	X	X	X	X	X	X
16	Polyvinyl Chloride plastic drain, waste and vent pipe and fittings, ASTM D 2665, ASTM F 891, (Sch 40) ASTM F 1760	X	X	X	X	X	X
17	High-silicon content cast iron pipe and fittings (hub and spigot, and mechanical joint), ASTM A 518/A 518M		X			X	

SERVICE:

A - Underground Building Soil, Waste and Storm Drain
B - Aboveground Soil, Waste, Drain In Buildings
C - Underground Vent
D - Aboveground Vent
E - Interior Rainwater Conductors Aboveground
F - Corrosive Waste And Vent Above And Belowground
* - Hard Temper

TABLE II
PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

		SERVICE			
Item No.	Pipe and Fitting Materials	A	B	C	D
1	Ductile iron fittings, mechanical joints AWWA C110, AWWA C104, AWWA C111		X		
2	Ductile iron pipe, AWWA C151, AWWA C104		X		
3	Seamless red brass pipe, ASTM B 43	X	X		X
4	Bronze flanged fittings, ASME B16.24 for use with Items 3 and 5	X	X		X
5	Seamless copper pipe, ASTM B 42	X	X		X
6	Seamless copper water tube, ASTM B 88	X**	X**	X**	X***
7	Cast bronze threaded fittings, ASME B16.15 for use with Items 3 and 5	X	X		X
8	Wrought copper and bronze solder-joint pressure fittings, ASME B16.22 for use with Items 3 and 5	X	X	X	X
9	Cast copper alloy solder-joint pressure fittings, ASME B16.18 for use with Items 6 and 7	X	X	X	X
10	Polyethylene (PE) plastic pipe, Schedules 40 and 80, based on outside diameter ASTM D 2447	X			X
11	Polyethylene (PE) plastic pipe (SDR-PR), based on controlled outside diameter, ASTM D 3035	X			X
12	Polyethylene (PE) plastic pipe (SIDR-PR), based on controlled inside diameter, ASTM D 2239	X			X
13	Butt fusion polyethylene (PE) plastic pipe fittings, ASTM D 3261	X			X

TABLE II
PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

		SERVICE			
Item No.	Pipe and Fitting Materials	A	B	C	D
	for use with Items 11, 12, and 13				
14	Socket-type polyethylene fittings for outside diameter-controlled polyethylene pipe, ASTM D 2683 for use with Item 12	X			X
15	Polyethylene (PE) plastic tubing, ASTM D 2737	X			X
16	Chlorinated polyvinyl chloride (CPVC) plastic hot and cold water distribution system, ASTM D 2846/D 2846M	X	X		X
17	Chlorinated polyvinyl chloride (CPVC) plastic pipe, Schedule 40 and 80, ASTM F 441/F 441M	X	X		X
18	Chlorinated polyvinyl chloride (CPVC) plastic pipe (SDR-PR) ASTM F 442/F 442M	X	X		X
19	Threaded chlorinated polyvinyl chloride (chloride CPVC) plastic pipe fittings, Schedule 80, ASTM F 437, for use with Items 17, and 18	X	X		X
20	Socket-type chlorinated polyvinyl chloride (CPVC) plastic pipe fittings, Schedule 40, ASTM F 438 for use with Items 17, 18, and 19	X	X		X
21	Socket-type chlorinated polyvinyl chloride (CPVC) plastic pipe fittings Schedule 80, ASTM F 439 for use with Items 17, 18, and 19	X	X		X
22	Polyvinyl chloride (PVC) plastic pipe, Schedules 40, 80, and 120, ASTM D 1785	X			X
23	Polyvinyl chloride (PVC) pressure-rated pipe (SDR Series), ASTM D 2241	X			X
24	Polyvinyl chloride (PVC) plastic pipe fittings, Schedule 40, ASTM D 2466	X			X

TABLE II
PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

		SERVICE			
Item No.	Pipe and Fitting Materials	A	B	C	D
25	Socket-type polyvinyl chloride (PVC) plastic pipe fittings, schedule 80, ASTM D 2467 for use with Items 23 and 24	X			X
26	Threaded polyvinyl chloride (PVC) plastic pipe fittings, schedule 80, ASTM D 2464	X			X
27	Joints for IPS PVC pipe using solvent cement, ASTM D 2672	X			X
28	Filament-wound reinforced thermosetting resin (RTRP) pipe, ASTM D 2996	X	X		
29	Steel pipeline flanges, MSS SP-44	X	X		
30	Unions, Fittings: brass or bronze; FS WW-U-516B, ASME B16.15, ASME B16.18, and ASTM B 828		X	X	
31	Carbon steel pipe unions, socket-welding and threaded, MSS SP-83	X	X	X	
32	Malleable-iron threaded pipe unions ASME B16.39	X	X		
33	Nipples, pipe threaded ASTM A 733	X	X	X	

A - Cold Water Aboveground
B - Hot Water 180 degrees F Maximum Aboveground
C - Compressed Air Lubricated
D - Cold Water Service Belowground
Indicated types are minimum wall thicknesses.
** - Type L - Hard
*** - Type K - Hard temper with brazed joints only or type K-soft temper without joints in or under floors
**** - In or under slab floors only brazed joints

TABLE III
STANDARD RATING CONDITIONS AND MINIMUM PERFORMANCE RATINGS FOR WATER HEATING EQUIPMENT

A. STORAGE WATER HEATERS

FUEL	STORAGE CAPACITY GALLONS	INPUT RATING	TEST PROCEDURE	REQUIRED PERFORMANCE
Gas	100 max.	75,000 Btu/h max.	10 CFR 430	EF = 0.62-0.0019V minimum
Gas	100 min. OR	75,000 Btu/h	ANSI Z21.10.3	ET = 77 percent; SL = 1.3+38/V max.

B. Unfired Hot Water Storage and instantaneous water heater.

Volumes and inputs: maximum HL shall be 6.5 Btu/h/sq. ft.

C. Instantaneous Water Heater

Gas	All	All	ANSI Z21.10.3	ET = 80 percent

TERMS:

EF = Energy factor, overall efficiency.
ET = Thermal efficiency with 70 degrees F delta T.
SL = Standby loss in W/sq. ft. based on 80 degrees F delta T, or in percent per hour based on nominal 90 degrees F delta T.
HL = Heat loss of tank surface area
V = Storage volume in gallons

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SECTION 15565

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SECTION 15565

HEATING SYSTEM; GAS-FIRED HEATERS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.66	(1996) Automatic Vent Damper Devices for Use with Gas-Fired Appliances
ANSI Z83.6	(1990; Z83.6a; Z83.6b) Gas-Fired Infrared Heaters
ANSI Z83.8	(1996; Z83.8a) Gas Unit Heaters

INTERNATIONAL APPROVAL SERVICES (IAS)

IAS Directory	(1999) IAS Directory of AGA & CGA Certified Appliances and Accessories

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(1998) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(1999) National Fuel Gas Code
NFPA 211	(2000) Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances

UNDERWRITERS LABORATORIES (UL)

UL Gas&Oil Dir	(1999) Gas and Oil Equipment Directory

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Heating System; GA.
Installation; GA.

Detail drawings consisting of illustrations, schedules, performance charts, instructions, brochures, diagrams, and other

information to illustrate the requirements and operation of the system. Detail drawings for space heating equipment, controls, associated equipment, and for piping and wiring. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

SD-03 Product Data

Heating System; FIO.

Spare parts data for each different item of materials and equipment specified, after approval of the detail drawings, and not later than one month prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

SD-06 Test Reports

Testing, Adjusting, and Balancing; FIO.

Test reports shall be submitted in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall indicate the final position of controls.

SD-10 Operation and Maintenance Data

Instructions; FIO.

Six complete copies of operating instructions outlining the step-by-step procedures required for system startup, operation and shutdown. The instructions shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and basic operating features. Six complete copies of maintenance instructions listing routine maintenance, possible breakdowns, repairs and troubleshooting guide. The instructions shall include simplified piping, wiring, and control diagrams for the system as installed.

1.3 GENERAL REQUIREMENTS

1.3.1 Nameplates

Each major component of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the equipment.

1.3.2 Equipment Guards

Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts so located that any person may come in close proximity thereto shall be completely enclosed or guarded. High-temperature equipment and piping so located as to endanger personnel or create a fire hazard shall be guarded or covered with insulation of type specified for service.

1.3.3 Verification of Dimensions

The Contractor shall become thoroughly familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

1.4 DELIVERY AND STORAGE

All equipment delivered and placed in storage shall be stored with protection from weather, humidity and temperature variations, dirt and dust, or other contaminants.

PART 2 PRODUCTS

2.1 MATERIALS

Construction/fabrication and other materials brought onto the job site shall contain no hazardous materials. Asbestos, lead, cadmium, mercury, PCBs and other hazardous material shall not be used.

Suspect/Counterfeit Items (S/CIs) shall not be used.

Provide Material Safety Data Sheets (MSDSs) as required.

2.2 STANDARD PRODUCTS

Material and equipment shall be standard products of a manufacturer regularly engaged in manufacturing of the products. Equipment shall essentially duplicate equipment that has been in satisfactory use at least 2 years prior to bid opening.

2.3 ELECTRICAL WORK

Electrical motor driven equipment shall be provided complete with motors, motor starters, and controls. Motors shall conform to NEMA MG 1. Electrical equipment and wiring shall be in accordance with Section 16415 ELECTRICAL WORK, INTERIOR. Electrical characteristics shall be as specified or indicated. Unless otherwise indicated motors of 1 Hp and above shall be high efficiency type. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary for the motor control specified. Each motor shall be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, shall be provided.

2.4 HEATERS

Heaters shall be equipped for and adjusted to burn natural gas. Each heater shall be provided with a gas pressure regulator that will satisfactorily limit the main gas burner supply pressure. Heaters shall have an intermittent or interrupted electrically ignited pilot or a direct electric ignition system. Safety controls shall conform to the ANSI standard specified for each heater. Mounting brackets and hardware shall be furnished by the heater manufacturer and shall be factory finished to match the supported equipment.

2.4.1 Unit Heaters

Heaters shall conform to requirements of ANSI Z83.8. Heat exchangers shall be aluminized steel or stainless steel. Air discharge section shall be equipped with adjustable horizontal louvers and vertical louvers or fins. Fan shafts shall be either directly connected to the driving motor, or indirectly connected by multiple V-belt drive. Fans in one unit shall be of the same size. Heaters shall be power-vented type, suitable for sidewall vent discharge and single-wall-thickness vent piping. Heaters shall have automatic ignition. Heaters shall employ metered combustion air with enclosed draft diverter (no open flue collar). Heaters shall have minimum steady state thermal efficiencies of 80 percent at maximum rated capacity and 75 percent at minimum rated capacity that is provided and allowed by the controls. Heaters shall be provided with a space thermostat which controls both unit's fan and burner.

2.4.2 Infrared Heaters

Heaters shall conform to the requirements of ANSI Z83.6 and shall be unvented type. Heater style shall be surface combustion type. Reflector shape shall be standard. Heaters shall be provided with space thermostats which control the unit's burner. Thermostats located in the direct radiation pattern shall be covered with a metal shield.

2.5 THERMOSTATS

Thermostats shall be the adjustable electric or electronic type. Control wiring required to complete the space temperature control system shall be included. Thermostats shall have a 3 degree F differential and a set point range of 0 to 100 degrees F. Thermostats shall be the two stage type.

2.6 VENT PIPING

Vent piping shall conform to the requirements of NFPA 54. Plastic material polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases.

2.7 INSULATION

Insulation for piping and equipment and application shall be in accordance with Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.8 FACTORY FINISHES

Equipment and component items, when fabricated from ferrous metal, shall be factory finished with the manufacturer's standard finish.

PART 3 EXECUTION

3.1 INSTALLATION

Equipment shall be installed as indicated and in accordance with the recommendations of the equipment manufacturer and the listing agency, except as otherwise specified.

3.1.1 Heating Equipment

Heaters shall be installed with clearance to combustibles complying with minimum distances as determined by IAS Directory, UL Gas & Oil Directory and as indicated on each heater approval and listing plate. Heaters shall be independently supported from the building structure as indicated and

shall not rely on support from suspended ceiling systems.

3.1.2 Vents

Vent dampers, piping and structural penetrations shall be located as indicated. Vent damper installation shall conform to ANSI Z21.66. Vent pipes, where not connected to a masonry chimney conforming to NFPA 211, shall extend through the roof or an outside wall and shall terminate, in compliance with NFPA 54. Vents passing through waterproof membranes shall be provided with the necessary flashings to obtain waterproof installations.

3.1.3 Gas Piping

Gas piping shall be connected as indicated and shall comply with the applicable requirements at Section 15190 GAS PIPING SYSTEMS.

3.2 TESTING, ADJUSTING, AND BALANCING

Testing, adjusting, and balancing shall be as specified in Section 15990 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

3.3 Training

The Contractor shall conduct a training course for the maintenance and operating staff. The training period of 8 hours normal working time shall start after the system is functionally complete but before the final acceptance tests. The training shall include all of the items contained in the approved operation and maintenance instructions as well as demonstrations of routine maintenance operations. The Contracting Officer shall be given at least two weeks advance notice of such training.

-- End of Section --

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SECTION 15700

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SECTION 15700

UNITARY HEATING AND COOLING EQUIPMENT

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI 210/240	(1994) Unitary Air-Conditioning and Air-Source Heat Pump Equipment
ARI 270	(1995) Sound Rating of Outdoor Unitary Equipment
ARI 310/380	(1993) Packaged Terminal Air-Conditioners and Heat Pumps
ARI 340/360	(1993) Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment
ARI 350	(1986) Sound Rating of Non-Ducted Indoor Air-Conditioning Equipment
ARI 370	(1986) Sound Rating of Large Outdoor Refrigerating and Air-Conditioning Equipment
ARI 700	(1999) Specifications for Fluorocarbon and Other Refrigerants

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 307	(2000) Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM B 117	(1997) Operating Salt Spray (Fog) Apparatus
ASTM C 1071	(1998) Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material)
ASTM D 520	(2000) Zinc Dust Pigment
ASTM E 437	(1992; R 1997) Industrial Wire Cloth and Screens (Square Opening Series)
ASTM E 84	(2000a) Surface Burning Characteristics of Building Materials
ASTM F 104	(1995) Nonmetallic Gasket Materials

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 15	(1994) Safety Code for Mechanical Refrigeration
ASHRAE 34	(1997) Number Designation and Safety Classification of Refrigerants
ASHRAE 52.1	(1992) Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter

AMERICAN WELDING SOCIETY (AWS)

AWS Z49.1	(1999) Safety in Welding and Cutting

ASME INTERNATIONAL (ASME)

ASME BPVC SEC IX	(1998) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications
ASME BPVC SEC VIII D1	(1998) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage

ASSOCIATION OF HOME APPLIANCE MANUFACTURERS (AHAM)

AHAM Directory	(1997) Directory of Certified Room Air Conditioners

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(1998) Motors and Generators
NEMA MG 2	(1989) Safety Standard for Construction and Guide for Selection, Installation, and Use of Electric Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(1999) National Fuel Gas Code
NFPA 90A	(1999) Installation of Air Conditioning and Ventilating Systems

UNDERWRITERS LABORATORIES (UL)

UL 1995	(1995; Rev thru Aug 1999) Heating and Cooling Equipment
UL 207	(1993; Rev thru Oct 1997) Refrigerant-Containing Components and Accessories, Nonelectrical
UL 484	(1993; Rev thru Feb 1999) Room Air Conditioners

UL 900 (1994; Rev thru Nov 1999) Test Performance of Air Filter Units

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Drawings; GA

Drawings provided in adequate detail to demonstrate compliance with contract requirements. Drawings shall consist of:

a. Equipment layouts which identify assembly and installation details.

b. Plans and elevations which identify clearances required for maintenance and operation.

c. Wiring diagrams which identify each component individually and interconnected or interlocked relationships between components.

d. Foundation drawings, bolt-setting information, and foundation bolts prior to concrete foundation construction for equipment indicated or required to have concrete foundations.

e. Details, if piping and equipment are to be supported other than as indicated, which include loadings and type of frames, brackets, stanchions, or other supports.

f. Automatic temperature control diagrams and control sequences.

g. Installation details which includes the amount of factory set superheat and corresponding refrigerant pressure/temperature.

SD-03 Product Data

Unitary Equipment; GA

Manufacturer's standard catalog data, at least 5 weeks prior to the purchase or installation of a particular component, highlighted to show material, size, options, performance charts and curves, etc. in adequate detail to demonstrate compliance with contract requirements. Data shall include manufacturer's recommended installation instructions and procedures. If vibration isolation is specified for a unit, vibration isolator literature shall be included containing catalog cuts and certification that the isolation characteristics of the isolators provided meet the manufacturer's recommendations. Data shall be submitted for each specified component.

Spare Parts Data; GA

Spare parts data for each different item of equipment specified,

after approval of detail drawings and not later than 1 month prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, a recommended spare parts list for 1 year of operation, and a list of the parts recommended by the manufacturer to be replaced on a routine basis.

Posted Instructions; GA

Posted instructions, at least 2 weeks prior to construction completion, including equipment layout, wiring and control diagrams, piping, valves and control sequences, and typed condensed operation instructions. The condensed operation instructions shall include preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system. The posted instructions shall be framed under glass or laminated plastic and be posted where indicated by the Contracting Officer.

Verification of Dimensions; GA

A letter, at least 2 weeks prior to beginning construction, including the date the site was visited, conformation of existing conditions, and any discrepancies found.

SD-07 Certificates

Unitary Equipment; GA

Where the system, components, or equipment are specified to comply with requirements of ARI, ASHRAE, ASME, or UL, proof of such compliance shall be provided. The label or listing of the specified agency shall be acceptable evidence. In lieu of the label or listing, a written certificate from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency may be submitted. When performance requirements of this project's drawings and specifications vary from standard ARI rating conditions, computer printouts, catalog, or other application data certified by ARI or a nationally recognized laboratory as described above shall be included. If ARI does not have a current certification program that encompasses such application data, the manufacturer may self certify that his application data complies with project performance requirements in accordance with the specified test standards.

Service Organization; GA

A certified list of qualified permanent service organizations, which includes their addresses and qualifications, for support of the equipment. The service organizations shall be reasonably convenient to the equipment installation and be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

SD-10 Operation and Maintenance Data

Operation Manuals; GA

Six complete copies of an operation manual in bound 8 1/2 x 11 inch booklets listing step-by-step procedures required for system startup, operation, abnormal shutdown, emergency shutdown, and normal shutdown at least 4 weeks prior to equipment delivery. The booklets shall include the manufacturer's name, model number, and parts list. The manuals shall include the manufacturer's name, model number, service manual, and a brief description of all equipment and their basic operating features.

Maintenance Manuals; GA

Six complete copies of maintenance manual in bound 8-1/2 x 11 inch booklets listing routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide. The manuals shall include piping and equipment layouts and simplified wiring and control diagrams of the system as installed.

1.3 SAFETY REQUIREMENTS

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices shall be installed so that proper operation of equipment is not impaired. Welding and cutting safety requirements shall be in accordance with AWS Z49.1.

1.4 DELIVERY, STORAGE, AND HANDLING

Stored items shall be protected from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation shall be the Contractor's responsibility. Any materials found to be damaged shall be replaced at the Contractor's expense. During installation, piping and similar openings shall be capped to keep out dirt and other foreign matter.

1.5 PROJECT/SITE CONDITIONS

1.5.1 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

1.5.2 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

PART 2 PRODUCTS

2.1 STANDARD COMMERCIAL PRODUCTS

Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a

similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2 year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience shall be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a 2 year field service record shall be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. Products shall be supported by a service organization. System components shall be environmentally suitable for the indicated locations.

2.2 NAMEPLATES

Major equipment including compressors, condensers, receivers, heat exchanges, fans, and motors shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment. Plates shall be durable and legible throughout equipment life and made of anodized aluminum or stainless steel. Plates shall be fixed in prominent locations with nonferrous screws or bolts.

2.3 ELECTRICAL WORK

Electrical equipment, motors, motor efficiencies, and wiring shall be in accordance with Section 16415 ELECTRICAL WORK, INTERIOR. Electrical motor driven equipment specified shall be provided complete with motors, motor starters, and controls. Electrical characteristics shall be as shown, and unless otherwise indicated, all motors of 1 horsepower and above with open, dripproof, totally enclosed, or explosion proof fan cooled enclosures, shall be high efficiency type. Field wiring shall be in accordance with manufacturer's instructions. Each motor shall conform to NEMA MG 1 and NEMA MG 2 and be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Motors shall be continuous duty with the enclosure specified. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary for the motor control indicated. Motors shall be furnished with a magnetic across-the-line or reduced voltage type starter as required by the manufacturer. Motor duty requirements shall allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motors shall be sized for the applicable loads. Motor torque shall be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Motor bearings shall be fitted with grease supply fittings and grease relief to outside of enclosure. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, shall be provided.

2.4 UNITARY EQUIPMENT, ROOM UNIT

2.4.1 Window or Through-the-Wall Mounted Unit

Units furnished as window or through-the-wall mounted, appliance grade, factory assembled air-conditioner units shall be in accordance with AHAM Directory and UL 484. Units shall include a self-contained, precharged, slide-in and removable chassis-mounted, air-cooled refrigeration system. Cooling section shall be equipped with a filter-drier on the suction line.

Fan and condenser motors shall have dripproof enclosures.

2.4.2 Packaged Terminal Unit

Units furnished as through-the-wall mounted, heavy-duty commercial grade, factory assembled and precharged air-conditioner or heat pump units shall be in accordance with ARI 310/380 and UL 1995. Units shall be removable from inside the building for servicing without removing the outside cabinet. Unit shall have a noise rating in accordance with ARI 350. Heat pump units shall contain a reversing valve to change unit to heating cycle. An outdoor coil temperature sensor shall be provided to guard against coil freeze-up by either switching to supplemental heat only, or by cycling the compressor to defrost the coil.

2.4.3 Compressor

Compressor shall be hermetically sealed reciprocating, rotary, or scroll type. Compressor shall be fitted with permanent split capacitor motor, overload protection, and vibration isolators. Compressor shall be protected against high discharge pressure, loss of charge, low voltage, and short cycling.

2.4.4 Air-To-Refrigerant Coils

Evaporator and condenser coils shall have copper or aluminum tubes of 3/8 inch minimum diameter with copper or aluminum fins that are mechanically bonded or soldered to the tubes. Coils shall be protected with a minimum 3 mil thick phenolic or vinyl coating. Casing shall be galvanized steel or aluminum. Contact of dissimilar metals shall be avoided. Coils shall be tested in accordance with ASHRAE 15 at the factory and be suitable for the working pressure of the installed system. Each coil shall be dehydrated and sealed after testing and prior to evaluation and charging. Each unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge shall be field charged. A condensate removal system shall be provided.

2.4.5 Fans

Indoor and outdoor fans shall be the centrifugal, direct driven type. Fans shall be statically and dynamically balanced. Outdoor fan shall be designed so that condensate will evaporate without drip, splash, or spray on building exterior. Indoor fan shall be provided with a minimum two-speed motor with built-in overload protection. Fan motors shall be the inherently protected, permanent split-capacitor type.

2.4.6 Air Filters

Filters shall be of the sectional or panel cleanable type and be capable of filtering the entire air supply.

2.4.7 Primary/Supplemental Heat

Primary or supplemental heat shall be provided as specified in paragraph "Unitary Equipment Components".

2.4.8 Cabinet Construction

Cabinet shall be free of visible fasteners, sharp protuberances and edges. Enclosure sheet metal shall be a minimum of 18 gauge steel with a

protective coating. Face panels shall be removable and shall provide full access to unit appurtenances. Access to controls shall be without removal of the face panel. Conditioned air shall discharge through adjustable louvers. Cabinet shall be thermally and acoustically insulated with materials which conform to NFPA 90A. Units shall be furnished with a prewired subbase. Subbase shall have leveling screws. Subbase shall be of 18 gauge galvanized steel construction with a protective coating to match that of the room cabinet. Paint and finishes shall comply with the requirements specified in paragraph FACTORY COATING.

2.4.9 Wall Sleeve

Louver shall be stormproof type, constructed of anodized, stamped or extruded aluminum. Sleeve shall be a water and airtight completely insulated assembly, with weather-resistant protective coating.

2.4.10 Duct Package (Not Used)

2.4.11 Unit Controls

Controls shall include an on-off switch, high and low selector switch for both the heating and cooling mode, multiple speed fan cooling and heating mode, room air fan switch, outside air damper control, and an adjustable cooling and heating thermostat. Function and temperature controls shall be integral to unit.

2.5 UNITARY EQUIPMENT, PACKAGE SYSTEM

Unit shall be an air-cooled factory assembled, weatherproof packaged unit as indicated. Unit shall be the air-conditioning type conforming to applicable Underwriters Laboratories (UL) standards including UL 1995. Unit shall be rated in accordance with ARI 210/240 or ARI 340/360. Unit shall be provided with equipment as specified in paragraph "Unitary Equipment Components". Evaporator or supply fans shall be double-width, double inlet, forward curved, backward inclined, or airfoil blade, centrifugal scroll type. Motors shall have open dripproof enclosures. Condenser fans shall be manufacturer's standard for the unit specified and may be either propeller or centrifugal scroll type. Unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge shall be field charged with refrigerant and oil in accordance with manufacturer's recommendations. Outdoor unit shall produce a maximum ARI sound rating of 8.8 bels in accordance with ARI 270 or ARI 370.

2.5.1 Air-to-Refrigerant Coils

Air-to-refrigerant coils shall have copper or aluminum tubes of 3/8 inch minimum diameter with copper or aluminum fins that are mechanically bonded or soldered to the tubes. Coils shall be protected with a minimum 3 mil thick phenolic or vinyl coating. Casing shall be galvanized steel or aluminum. Contact of dissimilar metals shall be avoided. Coils shall be tested in accordance with ASHRAE 15 at the factory and be suitable for the working pressure of the installed system. Each coil shall be dehydrated and sealed after testing and prior to evaluation and charging. Each unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge shall be field charged. Separate expansion devices shall be provided for each compressor circuit.

2.5.2 Water-to-Refrigerant Coils (Not Used)

2.5.3 Evaporatively-Cooled Section (Not Used)

2.5.4 Compressor

Compressor shall be direct drive, semi-hermetic or hermetic reciprocating, or scroll type capable of operating at partial load conditions. Compressor shall be capable of continuous operation down to the lowest step of unloading as specified. Compressors of 10 tons and larger shall be provided with capacity reduction devices to produce automatic capacity reduction of at least 50 percent. If standard with the manufacturer, two or more compressors may be used in lieu of a single compressor with unloading capabilities, in which case the compressors shall operate in sequence, and each compressor shall have an independent refrigeration circuit through the condenser and evaporator. Compressors shall start in the unloaded position. Each compressor shall be provided with vibration isolators, crankcase heater, thermal overloads, lubrication pump, high and low pressure safety cutoffs and protection against short cycling.

2.5.5 Refrigeration Circuit

Refrigerant containing components shall comply with ASHRAE 15 and be factory tested, cleaned, dehydrated, charged, and sealed. Refrigerant charging valves and connections, and pumpdown valves shall be provided for each circuit. Filter-drier shall be provided in each liquid line and be reversible-flow type. Refrigerant flow control devices shall be an adjustable superheat thermostatic expansion valve with external equalizer matched to coil, capillary or thermostatic control, and a pilot solenoid controlled, leak-tight, four-way refrigerant flow reversing valve.

2.5.6 Unit Controls

Unit shall be internally prewired with a 24 volt control circuit powered by an internal transformer. Terminal blocks shall be provided for power wiring and external control wiring. Unit shall have cutoffs for high and low pressure, and low oil pressure for compressors with positive displacement oil pumps, supply fan failure and safety interlocks on all service panels. Head pressure controls shall sustain unit operation with ambient temperature of 110 degrees F. Adjustable-cycle timers shall prevent short-cycling. Multiple compressors shall be staged by means of a time delay. Unit shall be internally protected by fuses or a circuit breaker in accordance with UL 1995. Low cost cooling shall be made possible by means of a control circuit which will modulate dampers to provide 100 percent outside air while locking out compressors.

2.6 UNITARY EQUIPMENT, SPLIT SYSTEM (Not Used)

2.7 REMOTE CONDENSER OR CONDENSING UNIT (Not Used)

2.8 AIR-CONDITIONERS FOR ELECTRONIC DATA PROCESSING (EDP) SPACES (Not Used)

2.9 EQUIPMENT EFFICIENCY

Unit shall have a minimum cooling efficiency of 10.0 EER.

2.10 UNITARY EQUIPMENT COMPONENTS

2.10.1 Refrigerant and Oil

Refrigerant shall be one of the HCFC or fluorocarbon gases. Refrigerants shall have number designations and safety classifications in accordance with ASHRAE 34. Refrigerants shall meet the requirements of ARI 700 as a minimum. Refrigerants shall have an Ozone Depletion Potential (ODP) of less than or equal to 0.05. Contractor shall provide and install a complete charge of refrigerant for the installed system as recommended by the manufacturer except for factory sealed units. Lubricating oil shall be of a type and grade recommended by the manufacturer for each compressor. Where color leak indicator dye is incorporated, charge shall be in accordance with manufacturer's recommendation.

2.10.2 Fans

Fan wheel shafts shall be supported by either maintenance-accessible lubricated antifriction block-type bearings, or permanently lubricated ball bearings. Unit fans shall be selected to produce the cfm required at the fan total pressure. Motor starters shall be magnetic across-the-line type with a open dripproof enclosure. Thermal overload protection shall be of the manual or automatic-reset type. Fan wheels or propellers shall be constructed of aluminum or galvanized steel. Centrifugal fan wheel housings shall be of galvanized steel, and both centrifugal and propeller fan casings shall be constructed of aluminum or galvanized steel. Steel elements of fans, except fan shafts, shall be hot-dipped galvanized after fabrication or fabricated of mill galvanized steel. Mill-galvanized steel surfaces and edges damaged or cut during fabrication by forming, punching, drilling, welding, or cutting shall be recoated with an approved zinc-rich compound. Fan wheels or propellers shall be statically and dynamically balanced. Direct-drive fan motors shall be of the multiple-speed variety. Belt-driven fans shall have adjustable sheaves to provide not less than +/- 10 percent fan-speed adjustment. The sheave size shall be selected so that the fan speed at the approximate midpoint of the sheave adjustment will produce the specified air quantity. Centrifugal scroll-type fans shall be provided with streamlined orifice inlet and V-belt drive. Each drive will be independent of any other drive. Propeller fans shall be either direct-drive or V-belt drive type with fixed pitch blades. V-belt driven fans shall be mounted on a corrosion protected drive shaft supported by either maintenance-accessible lubricated antifriction block-type bearings, or permanently lubricated ball bearings. Each drive will be independent of any other drive. Drive bearings shall be protected with water slingers or shields. V-belt drives shall be fitted with guards where exposed to contact by personnel and adjustable pitch sheaves.

2.10.3 Primary/Supplemental Heating

2.10.3.1 Water Coil (Not Used)

2.10.3.2 Steam Coil (Not Used)

2.10.3.3 Electric Heating Coil (Not Used)

2.10.3.4 Gas-Fired Heating Section

Gas-fired heat exchanger shall be constructed of aluminized steel, ceramic coated cold-rolled steel or stainless steel suitable for natural gas fuel supply. Burner shall have direct spark or hot surface ignition. Valve shall include a pressure regulator. Combustion air shall be supplied with a centrifugal combustion air blower. Safety controls shall include a flame sensor and air pressure switch. Heater section shall be mounted to

eliminate noise from expansion and contraction and shall be completely accessible for service. Gas equipment shall bear the AGA label for the type of service involved. Burner shall be in accordance with NFPA 54.

2.10.4 Air Filters

Air filters shall be Class 1 listed in accordance with requirements of UL 900.

2.10.4.1 Extended Surface Pleated Panel Filters (Not Used)

2.10.4.2 Replaceable Media Filters

Replaceable media filters shall be the dry-media type, of the size required to suit the application. Filtering media shall be not less than 2 inches thick fibrous glass media pad supported by a structural wire grid or woven wire mesh. Pad shall be enclosed in a holding frame of not less than 16 gauge galvanized steel, and equipped with quick-opening mechanism for changing filter media. The air flow capacity of the filter shall be based on net filter face velocity not 500 feet per minute, with maximum initial resistance of 0.5 inches water gauge. Average efficiency shall be not less than 85 percent when tested in accordance with ASHRAE 52.1.

2.10.4.3 Sectional Cleanable Filters (Not Used)

2.10.5 Coil Frost Protection

Each circuit shall be provided with a coil frost protection system which is a manufacturer's standard. The coil frost protection system shall use a temperature sensor in the suction line of the compressor to shut the compressor off when coil frosting occurs. Timers shall be used to prevent the compressor from rapid cycling.

2.10.6 Pressure Vessels

Pressure vessels shall conform to ASME BPVC SEC VIII D1 or UL 207, as applicable for maximum and minimum pressure or temperature encountered. Where referenced publications do not apply, pressure components shall be tested at 1-1/2 times design working pressure. Refrigerant wetted carbon steel surfaces shall be pickled or abrasive blasted free of mill scale, cleaned, dried, charged, and sealed.

2.10.6.1 Hot Gas Muffler

Unit shall be selected by the manufacturer for maximum noise attenuation. Units rated for 30 tons capacity and under may be field tunable type.

2.10.6.2 Liquid Receiver (Not Used)

2.10.6.3 Oil Separator

Separator shall be the high efficiency type and be provided with removable flanged head for ease in removing float assembly and removable screen cartridge assembly. Pressure drop through a separator shall not exceed 10 psi during the removal of hot gas entrained oil. Connections to compressor shall be as recommended by the compressor manufacturer. Separator shall be provided with an oil float valve assembly or needle valve and orifice assembly, drain line shutoff valve, sight glass, filter for removal of all particulate sized 10 microns and larger, and strainer.

2.10.6.4 Oil Reservoir

Reservoir capacity shall equal one charge of all connected compressors. Reservoir shall be provided with an external liquid gauge glass, plugged drain, and isolation valves. Vent piping between the reservoir and the suction header shall be provided with a 5 psi pressure differential relief valve. Reservoir shall be provided with the manufacturer's standard filter on the oil return line to the oil level regulators.

2.10.7 Internal Dampers

Dampers shall be opposed blade type with renewable frame and blade seals and be integral to the unitary unit. Dampers shall be provided for the outside air intake and mixing box. Dampers shall have manual modulation and operate as specified.

2.10.8 Mixing Boxes

Mixing boxes shall match the base unit in physical size and shall include equally-sized openings, each capable of full air flow. Arrangement shall be as indicated.

2.10.9 Cabinet Construction

Casings for the specified unitary equipment shall be constructed of galvanized steel or aluminum sheet metal and galvanized or aluminum structural members. Minimum thickness of single wall exterior surfaces shall be 18 gauge galvanized steel or 0.071 inch thick aluminum on units with a capacity above 20 tons and 20 gauge galvanized steel or 0.064 inch thick aluminum on units with a capacity less than 20 tons. Casing shall be fitted with lifting provisions, access panels or doors, fan vibration isolators, electrical control panel, corrosion-resistant components, structural support members, insulated condensate drip pan and drain, and internal insulation in the cold section of the casing. Where double-wall insulated construction is proposed, minimum exterior galvanized sheet metal thickness shall be 20 gauge. Provisions to permit replacement of major unit components shall be incorporated. Penetrations of cabinet surfaces, including the floor, shall be sealed. Unit shall be fitted with a drain pan which extends under all areas where water may accumulate. Drain pan shall be fabricated from Type 300 stainless steel, galvanized steel with protective coating as required, or an approved plastic material. Pan insulation shall be water impervious. Extent and effectiveness of the insulation of unit air containment surfaces shall prevent, within limits of the specified insulation, heat transfer between the unit exterior and ambient air, heat transfer between the two conditioned air streams, and condensation on surfaces. Insulation shall conform to ASTM C 1071. Paint and finishes shall comply with the requirements specified in paragraph FACTORY COATING.

2.10.9.1 Indoor Cabinet (Not Used)

2.10.9.2 Outdoor Cabinet

Outdoor cabinets shall be suitable for outdoor service with a weathertight, insulated and corrosion-protected structure. Cabinets constructed exclusively for indoor service which have been modified for outdoor service are not acceptable.

2.11 ACCESSORIES

2.11.1 Dry-Cooler, Glycol Solution (Not Used)

2.11.2 Humidifier (Not Used)

2.11.3 Purge System (Not Used)

2.11.4 Refrigerant Leak Detector (Not Used)

2.11.5 Refrigerant Relief Valve/Rupture Disc Assembly (Not Used)

2.11.6 Refrigerant Signs (Not Used)

2.11.6.1 Controls and Piping Identification

Refrigerant systems containing more than 110 lb of refrigerant shall be provided with refrigerant signs which designate the following as a minimum:

a. Valves or switches for controlling the refrigerant flow and the refrigerant compressor.

b. Pressure limiting device(s).

2.11.7 Heat Recovery Devices (Not Used)

2.11.8 Gaskets

Gaskets shall conform to ASTM F 104 - classification for compressed sheet with nitrile binder and acrylic fibers for maximum 700 degrees F service.

2.11.9 Bolts and Nuts

Bolts and nuts shall be in accordance with ASTM A 307. The bolt head shall be marked to identify the manufacturer and the standard with which the bolt complies in accordance with ASTM A 307.

2.11.10 Bird Screen

Screen shall be in accordance with ASTM E 437, Type 1, Class 1, 2 by 2 mesh, 0.063 inch diameter aluminum wire or 0.031 inch diameter stainless steel wire.

2.12 FABRICATION

2.12.1 Factory Coating

Unless otherwise specified, equipment and component items, when fabricated from ferrous metal, shall be factory finished with the manufacturer's standard finish, except that items located outside shall have weather resistant finishes that will withstand 500 hours exposure to the salt spray test specified in ASTM B 117 using a 5 percent sodium chloride solution. Immediately after completion of the test, the specimen shall show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 1/8 inch on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used shall be coated with a zinc-rich coating conforming to ASTM D 520, Type I.

2.12.2 Factory Applied Insulation

Refrigeration equipment shall be provided with factory installed insulation on surfaces subject to sweating including the suction line piping. Where motors are the gas-cooled type, factory installed insulation shall be provided on the cold-gas inlet connection to the motor per manufacturer's standard practice. Factory insulated items installed outdoors are not required to be fire-rated. As a minimum, factory insulated items installed indoors shall have a flame spread index no higher than 75 and a smoke developed index no higher than 150. Factory insulated items (no jacket) installed indoors and which are located in air plenums, in ceiling spaces, and in attic spaces shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Flame spread and smoke developed indexes shall be determined by ASTM E 84. Insulation shall be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket shall be tested as a composite material. Jackets, facings, and adhesives shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E 84.

2.13 SUPPLEMENTAL COMPONENTS/SERVICES

2.13.1 Condenser Water Piping and Accessories (Not Used)

2.13.2 Refrigerant Piping (Not Used)

2.13.3 Cooling Tower (Not Used)

2.13.4 Ductwork (Not Used)

2.13.5 Temperature Controls

Temperature controls shall be in accordance with Section 15950 HEATING, VENTILATING AND AIR CONDITIONING (HVAC) CONTROL SYSTEMS.

PART 3 EXECUTION

3.1 INSTALLATION

Work shall be performed in accordance with the manufacturer's published diagrams, recommendations, and equipment warranty requirements. Where equipment is specified to conform to the requirements of ASME BPVC SEC VIII D1 and ASME BPVC SEC IX, the design, fabrication, and installation of the system shall conform to ASME BPVC SEC VIII D1 and ASME BPVC SEC IX.

3.1.1 Equipment

Refrigeration equipment and the installation thereof shall conform to ASHRAE 15. Necessary supports shall be provided for all equipment, appurtenances, and pipe as required, including frames or supports for compressors, pumps, cooling towers, condensers, and similar items. Compressors shall be isolated from the building structure. If mechanical vibration isolators are not provided, vibration absorbing foundations shall be provided. Each foundation shall include isolation units consisting of machine and floor or foundation fastenings, together with intermediate isolation material. Other floor-mounted equipment shall be set on not less than a 6 inch concrete pad doweled in place. Concrete foundations for floor mounted pumps shall have a mass equivalent to three times the weight of the components, pump, base plate, and motor to be supported. In lieu of concrete pad foundation, concrete pedestal block with isolators placed

between the pedestal block and the floor may be provided. Concrete pedestal block shall be of mass not less than three times the combined pump, motor, and base weights. Isolators shall be selected and sized based on load-bearing requirements and the lowest frequency of vibration to be isolated. Isolators shall limit vibration to a maximum of 10 percent transmissibility. Lines connected to pumps mounted on pedestal blocks shall be provided with flexible connectors. Foundation drawings, bolt-setting information, and foundation bolts shall be furnished prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Concrete for foundations shall be as specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. Equipment shall be properly leveled, aligned, and secured in place in accordance with manufacturer's instructions.

3.1.2 Mechanical Room Ventilation

Mechanical ventilation systems shall be in accordance with Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

3.1.3 Field Applied Insulation

Field applied insulation shall be as specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS, except as defined differently herein.

3.1.4 Field Painting

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory are specified in Section 09900 PAINTING, GENERAL.

3.2 CLEANING AND ADJUSTING

Equipment shall be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided for all fans that are operated during construction, and new filters shall be installed after all construction dirt has been removed from the building. System shall be maintained in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions. Testing, adjusting, and balancing shall be as specified in Section 15990 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

3.3 REFRIGERANT TESTS, CHARGING, AND START-UP

Split-system refrigerant piping systems shall be tested and charged as specified. Packaged refrigerant systems which are factory charged shall be checked for refrigerant and oil capacity to verify proper refrigerant levels per manufacturer's recommendations. Following charging, packaged systems shall be tested for leaks with a halide torch or an electronic leak detector.

3.3.1 Refrigerant Leakage

If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system shall immediately be isolated from the remainder of the system and the refrigerant pumped into the system receiver

or other suitable container. Under no circumstances shall the refrigerant be discharged into the atmosphere.

3.3.2 Contractor's Responsibility

The Contractor shall, at all times during the installation and testing of the refrigeration system, take steps to prevent the release of refrigerants into the atmosphere. The steps shall include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim. At no time shall more than 3 ounces of refrigerant be released to the atmosphere in any one occurrence. Any system leaks within the first year shall be repaired in accordance with the requirements herein at no cost to the Government including material, labor, and refrigerant if the leak is the result of defective equipment, material, or installation.

3.4 SYSTEM PERFORMANCE TESTS

Before each refrigeration system is accepted, tests to demonstrate the general operating characteristics of all equipment shall be conducted by a registered professional engineer or an approved manufacturer's start-up representative experienced in system start-up and testing, at such times as directed. Tests shall cover a period of not less than 48 hours for each system and shall demonstrate that the entire system is functioning in accordance with the drawings and specifications. Corrections and adjustments shall be made as necessary and tests shall be re-conducted to demonstrate that the entire system is functioning as specified. Prior to acceptance, service valve seal caps and blanks over gauge points shall be installed and tightened. Any refrigerant lost during the system startup shall be replaced. If tests do not demonstrate satisfactory system performance, deficiencies shall be corrected and the system shall be retested. Tests shall be conducted in the presence of the Contracting Officer. Water and electricity required for the tests will be furnished by the Government. Any material, equipment, instruments, and personnel required for the test shall be provided by the Contractor. Field tests shall be coordinated with Section 15990 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

3.5 DEMONSTRATIONS

Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total 4 hours of normal working time and start after the system is functionally completed but prior to final acceptance tests. The field posted instructions shall cover all of the items contained in the approved operation and maintenance manuals as well as demonstrations of routine maintenance operations.

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SECTION 15760

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SECTION 15760

TERMINAL HEATING AND COOLING UNITS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z83.6	(1990; Addenda 1992 and 1993) Gas-Fired Infrared Heaters
ANSI Z83.8	(1996) Gas Unit Heater and Gas-Fired Duct Furnaces

AMERICAN SOCIETY OF HEATING, REFRIGERATING, AND AIR-CONDITIONING ENGINEERS, INC. (ASHRAE)

ASHRAE 33	(1978) Forced Circulation Air Cooling and Air Heating Coils

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 109	(1993) Steel, Strip, Carbon, Cold-Rolled
ASTM A 123	(1989; Rev. A) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 167	(1996) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 463/A 463M	(1996; Rev. A) Steel Sheet, Aluminum-Coated, by the Hot-Dip Process
ASTM A 569/A 569M	(1996) Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip Commercial Quality
ASTM A 653/A 653M	(1996) Steel Sheet Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B 117	(1995) Operating Salt Spray (Fog) Apparatus
ASTM B 209	(1996) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM D 1654	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(1993) Industrial Control and Systems Controllers, Contactors and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC
NEMA ICS 6	(1993) Industrial Control and Systems Enclosures
NEMA MG 1	(1993; Rev. 1-4) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(1996) National Fuel Gas Code
NFPA 70	(1996) National Electrical Code
NFPA 90A	(1996) Installation of Air Conditioning and Ventilating Systems
NFPA 90B	(1996) Installation of Warm Air Heating and Air Conditioning Systems
NFPA 91	(1995) Exhaust Systems for Air Conveying of Materials
NFPA 211	(1996) Chimneys, Fireplaces, Vents, and Solid Fuel Burning Appliances

UNDERWRITERS LABORATORIES INC. (UL)

UL 441	(1996; R 1997) Gas Vents
UL 731	(1995; R 1995) Oil-Fired Unit Heaters

1.2 RELATED REQUIREMENTS

Section 15050, "Basic Mechanical Materials and Methods," applies to this section with additions and modifications specified herein.

1.3 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

SD-03 Product Data

Unit heaters; GA

Infrared heaters; GA

SD-10 Operation and Maintenance Data

Unit heaters; GA

Infrared heaters; GA

PART 2 PRODUCTS

2.1 UNIT HEATERS

Self-contained and factory assembled, propeller or centrifugal fan with capacities expressed as Btu per hour output and cubic foot-per-minute air delivery, operating conditions, and mounting arrangements as indicated. Average fan bearing life shall be minimum 200,000 hours at operating conditions. Provide fan motor with direct or belt drive. Construct fan-guard motor mount of steel wire. Equip each heater with individually adjustable package discharge louvers with adjustment for both horizontal and vertical air patterns. Louvers may be substituted by discharge cones or diffusers. Provide thermostats indicated with manual relay kits and manual summer/winter switch. Furnish circuit breaker disconnect switch.

2.1.1 Gas-Fired Unit Heater

ANSI Z83.8 and AGA label.

2.1.1.1 Casing

Minimum 22 gage steel or aluminum. Provide removable access panels.

2.1.1.2 Heat Exchanger

Minimum 20 gage all-welded steel construction with corrosion-resistant aluminum finish.

2.1.1.3 Burners

Die-formed, slot ports, and steel construction with aluminum paint.

2.1.1.4 Draft Diverter

All-welded steel construction and an integral part of each heat exchanger section. Allows backdrafts to bypass burner assembly without affecting normal operation.

2.1.1.5 Controls

Consisting of a combination pressure regulator, two-stage gas valve in 100 percent and 50 percent of full rating, main shutoff valve, spark ignited intermittent safety pilot with timed lockout pilot cock, pilot safety switch for 100 percent shutoff, high temperature limit switch, and time-delay fan switch. Include power and control connections in an integral junction box.

2.1.1.6 Efficiency

Minimum steady state efficiencies shall be 78 percent at maximum rated capacity and 75 percent at minimum rated capacity that is provided and allowed by the controls.

2.1.1.7 Accessories

Provide automatic electric pilot recognition kit and multiple control heater.

2.1.2 Oil-Fired Unit Heater (Not Used)

UL 731 and UL labeled.

2.1.3 Steam or Hot-Water Unit Heater (Not Used)

ASHRAE 33 tested for heating coils; UL listed for motor and controls.

2.1.4 Electric Unit Heater (Not Used)

2.2 INFRARED HEATERS

Reflector-beam spread and operating conditions as indicated. Provide pre-wired control boxes, thermostats, and reflector hangers.

2.2.1 Sheet Metal

Provide materials in accordance with one of the following configurations:

a. Aluminum-Clad Steel: ASTM A 463/A 463M, nominal thickness of minimum 16 gage for radiant tubing between burners and vacuum pump or vent.

b. Aluminum: ASTM B 209, manufacturer's standard thickness.

c. Stainless Steel: ASTM A 167, nominal thickness of not less than 20 gage.

d. Ceramic-Coated or Enamel-Coated Steel: ASTM A 569/A 569M hot rolled or ASTM A 109 cold rolled, low-carbon steel. Provide coating able to withstand infrared heater operating temperatures.

2.2.2 Unvented Gas Infrared Heater

ANSI Z83.6 and AGA approved.

2.2.2.1 Heating Element

Perforated ceramic capable of withstanding thermal shock in 3 minutes from 2000 to 32 degrees F without fatigue and of minimum 1600 degrees F operating temperature. When re-radiating screens are used to obtain operating temperature, provide stainless-steel or chromized-steel matching screen.

2.2.2.2 Reflector

Polished aluminum, stainless steel, or approved high infrared reflector materials. Provide reflector supports of manufacturer's standard.

2.2.2.3 Controls

Provide either an intermittent pilot ignition system or a solid-state direct ignition system. Provide automatic gas safety valve capable of withstanding a 10 percent voltage fluctuation.

2.2.2.4 Ventilation

Section 15895, "Air Supply, Distribution, Ventilation, and Exhaust System."

2.2.3 Vented Gas Infrared Heater

ANSI Z83.6 with AGA label, single-burner power vented.

2.2.3.1 Vent

NFPA 54 and NFPA 211, Type 316 stainless steel or high-temperature corrosion-resistant plastic rated for minimum 400 degrees F. Vent flue gas to outdoors by induced draft.

2.2.3.2 Reflector

Polished aluminum, stainless steel, or approved high infrared reflector materials. Provide manufacturer's standard reflector supports.

2.2.3.3 Heat Exchanger and Combustion Chamber

Construct heat exchanger and combustion chamber of aluminum-clad steel, ceramic-coated steel, or stainless steel.

2.2.3.4 Controls

Incorporate either an intermittent pilot ignition system or a solid-state direct ignition system. Provide safety air-flow switch for each burner.

2.2.3.5 Fan or Vacuum Pump

Heater manufacturer's standard.

2.2.3.6 Performance

Provide sufficient radiant heating surface to attain a minimum steady-state thermal efficiency of 80 percent and a maximum heat release of 2,900 Btu per square foot.

2.2.4 Electric Infrared Heater

Self-contained, factory assembled, and UL listed and including the heating element, reflector, heater housing, mounting brackets, element holders, wire guards, and high-temperature internal wiring.

2.2.4.1 Heating Element

Minimum 3/8 inch diameter quartz tube or metal sheath with coiled resistor wire. Element operating temperature range shall be 1200 to 1800 degrees F.

2.2.4.2 Heater Housing

Weatherproof aluminum-clad steel, stainless-steel, aluminum, or low-carbon steel construction. Provide a baked enamel finish over a corrosion-resistant primer. Provide a chrome-plated or stainless-steel wire guard to prevent heating elements from accidental damage. Furnish swivel brackets to position heater in any horizontal angle.

2.2.4.3 Reflector

Polished aluminum or stainless steel.

2.2.4.4 Wiring

Fully enclosed internal wiring. Provide minimum 6 inch slack fixture wire for connection to branch circuit wiring.

2.2.4.5 Accessories

Equip controller with external indicating knob for manual adjustment from zero to 100 percent. Provide a connection wiring diagram on the inside cover of the enclosure. Where loads exceed the maximum available rating of controller, provide high duty-cycle contactors serving as pilot devices.

2.3 FAN

Provide steel or aluminum fans with ball or roller bearings for motors over 1/8 horsepower (hp) and sleeve bearings for motors 1/8 hp and under. Provide sleeve bearings with oil reservoir, if not permanently lubricated.

2.4 MOTOR AND STARTER

NEMA MG 1, and NEMA ICS 2, and NEMA ICS 6, respectively. Provide continuous-duty motor with built-in automatic reset thermal overload protection. For motors 1/2 hp and larger, use three-phase, otherwise provide single-phase motor of permanent split capacitor or capacitor start. Limit motor speed at 1800 r/min. Wire motor to heater power supply source.

2.5 GAS PIPING SYSTEM AND FLUE VENT

Comply with Section 15190, "Gas Piping Systems," for gas valves and piping. Use UL 441 flue vents and gas-vent roof jacks, of galvanized steel,aluminum, or stainless steel.

2.6 FUEL OIL TANK AND PIPING SYSTEM (Not Used)

2.7 HOT WATER PIPING SYSTEM (Not Used)

2.8 STEAM AND CONDENSATE PIPING SYSTEM (Not Used)

2.9 SOURCE QUALITY CONTROL

Special protection is not required for equipment that has a zinc coating conforming to ASTM A 123, ASTM A 653/A 653M. Otherwise, protect affected equipment items by manufacturers' corrosion-inhibiting coating or paint system that has proved capable of withstanding salt-spray test in accordance with ASTM B 117. Test indoor and outdoor equipment for 125 hours; test outdoor equipment used in a marine atmosphere for 500 hours. For each specimen, perform a scratch test as defined in ASTM D 1654.

PART 3 EXECUTION

3.1 INSTALLATION

Install equipment where indicated and as recommended by manufacturer's recommendations, NFPA 54, NFPA 90A, NFPA 90B, NFPA 91 and NFPA 211.

3.1.1 Suspensions of Equipment

Provide equipment supports including beam clamps, turnbuckles and twist links or weld-wire chains, wire ropes with rope clips and rope thimbles, threaded-eye rod hangers with lock nuts and heat-duct hangers, threaded-eye bolts with expansion screws, brackets, platform and mounting frame, and vibration isolators. Locate equipment in such a manner that working space is available for servicing, such as vacuum pump and burner removal, access

to automatic controls, and lubrication. Provide electrical isolation of dissimilar metals. Clean interior of casings or cabinets before and after completion of installation.

3.1.2 Vents

NFPA 54 and NFPA 211. Provide vents with weatherproofing flashings as specified.

3.1.3 Electrical Work

NFPA 70 and Division 16, "Electrical Work." When replacing original control wires, provide No. 16 AWG with minimum 105 degrees C insulation.

3.2 FIELD QUALITY CONTROL

Administer, schedule, and conduct specified tests. Furnish personnel, instruments and equipment for such tests. Correct defects and repeat the respective inspections and tests. Conduct inspections and testing in the presence of the Contracting Officer.

3.2.1 Test Instruments and Apparatus

Provide instruments and apparatus currently certified as being accurate to within one percent of their full scale. Use gages with a maximum scale between 1 1/2 and 2 times test pressure.

3.2.2 Field Inspection

Prior to initial operation, inspect equipment installation to ensure that indicated and specified requirements have been met.

3.2.3 Field Tests

3.2.3.1 Fuel Piping Pressure Tests

Pneumatically test gas piping at 1 1/2 times operating pressure and check for leakage with soap solution.

3.2.3.2 Fire Tests for Nonelectrical Heating Equipment

Test combustion controls and equipment with specified fuel at 100 percent full rated load. During tests, verify proper operation of controls. Adjust burners for maximum efficiency using Orsat or similar apparatus. Maintain firing for at least four hours, and where high-low-off combustion controls are provided, operate the heating equipment for one hour at low fire and 3 hours at high fire. For acceptable combustion efficiency, allow maximum 4.5 percent carbon dioxide in flue gases.

3.2.3.3 Insulation-Resistance Tests for Electrical Equipment

At the completion of wiring, test 600 volt wiring to verify that no short circuits exist before or after the attachment of electrical heating equipment to the power source. Make tests with an instrument which applies a voltage of approximately 500 volts for a direct reading of insulation resistance.

3.2.3.4 Operational Tests

After completing fire tests and insulation-resistance tests, operate equipment continuously under varying load conditions to verify functioning of combustion controls, electrical controls, flame safeguard controls, safety interlocks, and specified operating sequence. Run each test for a minimum period of one hour.

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SECTION 15895

AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI 410	(1991) Forced-Circulation Air-Cooling and Air-Heating Coils
ARI Guideline D	(1996) Application and Installation of Central Station Air-Handling Units

AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

AMCA 210	(1999) Laboratory Methods of Testing Fans for Rating
AMCA 300	(1996) Reverberant Room Method for Sound Testing of Fans

AMERICAN BEARING MANUFACTURERS ASSOCAITION (ABMA)

AFBMA Std 9	(1990) Load Ratings and Fatigue Life for Ball Bearings
AFBMA Std 11	(1990; R 1999) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123/A 123M	(2001) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 924/A 924M	(1999) General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B 117	(1997) Operating Salt Spray (Fog) Apparatus
ASTM D 1654	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D 3359	(1997) Measuring Adhesion by Tape Test
ASTM D 520	(2000) Zinc Dust Pigment

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING

ENGINEERS (ASHRAE)

ASHRAE 52.1	(1992) Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter

INSTITUTE OF ENVIRONMENTAL SCIENCES AND TECHNOLOGY (IES)

IES RP-CC-001.3	(1997) HEPA and ULPA Filters

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(1998) Motors and Generators

UNDERWRITERS LABORATORIES (UL)

UL 586	(1996; Rev thru Aug 1999) High-Efficiency, Particulate, Air Filter Units
UL 705	(1994; Rev thru Feb 1999) Power Ventilators
UL 900	(1994; Rev thru Nov 1999) Test Performance of Air Filter Units

1.2 COORDINATION OF TRADES

Piping offsets, fittings, and accessories shall be furnished as required to provide a complete installation and to eliminate interference with other construction.

1.3 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Drawings; GA
Installation; GA

Drawings shall consist of equipment layout including assembly and installation details and electrical connection diagrams; and piping layout showing the location of all guides and anchors, the load imposed on each support or anchor, and typical support details. Drawings shall include any information required to demonstrate that the system has been coordinated and will properly function as a unit and shall show equipment relationship to other parts of the work, including clearances required for operation and maintenance.

SD-03 Product Data

Components and Equipment; GA

Manufacturer's catalog data shall be included with the detail drawings for the following items. The data shall be highlighted to show model, size, options, etc., that are intended for consideration. Data shall be adequate to demonstrate compliance with contract requirements for the following:

a. Piping Components

b. Air Systems Equipment

c. Air Handling Units

d. Energy Recovery Devices

e. Terminal Units

Test Procedures; GA

Proposed test procedures for piping hydrostatic test and performance tests of systems, at least 2 weeks prior to the start of related testing.

Welding Procedures; GA

A copy of qualified welding procedures, at least 2 weeks prior to the start of welding operations.

System Diagrams; GA

Proposed diagrams, at least 2 weeks prior to start of related testing. System diagrams that show the layout of equipment and piping, and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system shall be framed under glass or laminated plastic. After approval, these items shall be posted where directed.

Similar Services; GA

Statement demonstrating successful completion of similar services on at least 5 projects of similar size and scope, at least 2 weeks prior to submittal of other items required by this section.

Welding Joints; GA

A list of names and identification symbols of qualified welders and welding operators, at least 2 weeks prior to the start of welding operations.

Testing, Adjusting and Balancing; GA

Proposed test schedules for hydrostatic test of piping and performance tests, at least 2 weeks prior to the start of related

testing.

Field Training; GA

Proposed schedule for field training, at least 2 weeks prior to the start of related training.

SD-06 Test Reports

Performance Tests; GA

Test reports for the piping hydrostatic test and performance tests in booklet form, upon completion of testing. Reports shall document phases of tests performed including initial test summary, repairs/adjustments made, and final test results.

SD-07 Certificates

Bolts; GA

Written certification from the bolt manufacturer that the bolts furnished comply with the requirements of this specification. The certification shall include illustrations of product markings, and the number of each type of bolt to be furnished.

SD-10 Operation and Maintenance Data

Operating and Maintenance Instructions; GA

Six manuals listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance, at least 2 weeks prior to field training. The manuals shall include the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the owner for routine maintenance including the name of a local supplier, simplified wiring and controls diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Each service organization submitted shall be capable of providing 24 hour onsite response to a service call on an emergency basis.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Components and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of products that are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years before bid opening. The 2-year experience shall include applications of components and equipment under similar circumstances and of similar size. The 2 years must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. The equipment items shall be supported by a service organization.

2.2 ASBESTOS PROHIBITION

Asbestos and asbestos-containing products shall not be used.

2.3 NAMEPLATES

Equipment shall have a nameplate that identifies the manufacturer's name, address, type or style, model or serial number, and catalog number.

2.4 EQUIPMENT GUARDS AND ACCESS

Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact shall be fully enclosed or guarded according to OSHA requirements. High temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard shall be properly guarded or covered with insulation of a type specified.

2.5 PIPING COMPONENTS

2.5.1 Condensate Drain Lines

Condensate drainage shall be provided for each item of equipment that generates condensate as specified for drain, waste, and vent piping systems in Section 15400 PLUMBING, GENERAL PURPOSE.

2.6 ELECTRICAL WORK

Electrical motor-driven equipment specified shall be provided complete with motor, motor starter, and controls. Unless otherwise specified, electric equipment, including wiring and motor efficiencies, shall be according to Section 16415 ELECTRICAL WORK, INTERIOR. Electrical characteristics and enclosure type shall be as shown. Unless otherwise indicated, motors of 1 hp and above shall be high efficiency type. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary. Each motor shall be according to NEMA MG 1 and shall be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Manual or automatic control and protective or signal devices required for the operation specified, and any control wiring required for controls and devices, but not shown, shall be provided.

2.7 CONTROLS

Controls shall be provided as specified in Section 15950 HEATING, VENTILATING AND AIR CONDITIONING (HVAC) CONTROL SYSTEMS.

2.8 DUCTWORK COMPONENTS (Not Used)

2.9 AIR SYSTEMS EQUIPMENT

2.9.1 Fans

Fans shall be tested and rated according to AMCA 210. Fans may be connected to the motors either directly or indirectly with V-belt drive. V-belt drives shall be designed for not less than 150 percent of the connected driving capacity. Motor sheaves shall be variable pitch for 15 hp and below and fixed pitch as defined by ARI Guideline D. Variable pitch sheaves shall be selected to drive the fan at a speed which will produce

the specified capacity when set at the approximate midpoint of the sheave adjustment. When fixed pitch sheaves are furnished, a replaceable sheave shall be provided when needed to achieve system air balance. Motors for V-belt drives shall be provided with adjustable rails or bases. Removable metal guards shall be provided for all exposed V-belt drives, and speed-test openings shall be provided at the center of all rotating shafts. Fans shall be provided with personnel screens or guards on both suction and supply ends. Fan and motor assemblies shall be provided with vibration-isolation supports or mountings as indicated. Vibration-isolation units shall be standard products with published loading ratings. Each fan shall be selected to produce the capacity required at the fan static pressure indicated. Sound power level shall be as indicated. The sound power level values shall be obtained according to AMCA 300. Standard AMCA arrangement, rotation, and discharge shall be as indicated.

2.9.1.1 Centrifugal Fans

Centrifugal fans shall be fully enclosed, single-width single-inlet, or double-width double-inlet, AMCA Pressure Class I, II, or III as required or indicated for the design system pressure. Impeller wheels shall be rigidly constructed, accurately balanced both statically and dynamically. Fan blades may be forward curved, backward-inclined or airfoil design in wheel sizes up to 30 inches unless otherwise noted. Fan blades for wheels over 30 inches in diameter shall be backward-inclined or airfoil design. Booster fans for exhaust dryer systems shall be the open-wheel radial type unless otherwise noted. These fans shall be suitable for conveying lint and the temperatures encountered. The fan shaft shall be provided with a heat slinger to dissipate heat buildup along the shaft. An access (service) door to facilitate maintenance shall be supplied with these fans. Fan wheels over 36 inches in diameter shall have overhung pulleys and a bearing on each side of the wheel unless otherwise noted. Fan wheels 36 inches or less in diameter may have one or more extra long bearings between the fan wheel and the drive. Bearings shall be sleeve type, self-aligning and self-oiling with oil reservoirs, or precision self-aligning roller or ball-type with accessible grease fittings or permanently lubricated type. Grease fittings shall be connected to tubing and serviceable from a single accessible point. Bearing life shall be L50 rated at not less than 200,000 hours as defined by AFBMA Std 9 and AFBMA Std 11. Fan shafts shall be steel, accurately finished, and shall be provided with key seats and keys for impeller hubs and fan pulleys. Each fan outlet shall be of ample proportions and shall be designed for the attachment of angles and bolts for attaching flexible connections. Motors, unless otherwise indicated, shall not exceed 1800 rpm and shall have open dripproof enclosures unless otherwise noted. Motor starters shall be reduced-voltage-start type unless otherwise noted with general-purpose enclosure unless otherwise noted. Remote manual switch with pilot indicating light shall be provided where indicated.

2.9.1.2 In-Line Centrifugal Fans

In-line fans shall have centrifugal backward inclined blades, stationary discharge conversion vanes, internal and external belt guards, and adjustable motor mounts. Fans shall be mounted in a welded tubular casing. Air shall enter and leave the fan axially. Inlets shall be streamlined with conversion vanes to eliminate turbulence and provide smooth discharge air flow. Fan bearings and drive shafts shall be enclosed and isolated from the air stream. Fan bearings shall be sealed against dust and dirt and shall be permanently lubricated, and shall be precision self aligning

ball or roller type. Bearing life shall be L50 rated at not less than 200,000 hours as defined by AFBMA Std 9 and AFBMA Std 11. Motors shall have open dripproof enclosure unless otherwise noted. Motor starters shall be magnetic across-the-line with general-purpose enclosuresunless otherwise noted. Remote manual switch with pilot indicating light shall be provided where indicated.

2.9.1.3 Axial Flow Fans

Axial flow fans shall be complete with drive components and belt guard, and shall have a steel housing, cast fan wheel, cast or welded steel diffusers, fan shaft, bearings, and mounting frame as a factory-assembled unit. Fan wheels shall have radially projecting blades of airfoil cross section and shall be dynamically balanced and keyed to the fan shaft. Fan bearings and drive shafts shall be enclosed and isolated from the air stream. Fan bearings shall be sealed against dust and dirt, shall be permanently lubricated or with accessible grease fittings, and shall be precision self-aligning ball or roller type. Bearing life shall be L50 rated at not less than 200,000 hours of operation as defined by AFBMA Std 9 and AFBMA Std 11. Fan inlets shall be provided with an aerodynamically shaped bell and an inlet cone. Diffuser or straightening vanes shall be provided at the fan discharge to minimize turbulence and provide smooth discharge air flow. Fan unit shall be provided with inlet and outlet flanges . Unless otherwise indicated, motors shall not exceed 1800 rpm and shall have open dripproof enclosure. Motor starters shall be magnetic across-the-line with general-purpose enclosure unless otherwise noted. Remote manual switch with pilot indicating light shall be provided where indicated.

2.9.1.4 Panel Type Power Wall Ventilators

Fans shall be propeller type, assembled on a reinforced metal panel with venturi opening spun into panel. Fans with wheels less than 24 inches diameter shall be direct or V-belt driven and fans with wheels 24 inches diameter and larger shall be V-belt drive type. Fans shall be furnished with wall mounting collar. Lubricated bearings shall be provided. Fans shall be fitted with wheel and motor side metal or wire guards which have a corrosion-resistant finish. Motor enclosure shall be dripproof type unless otherwise noted. Gravity backdraft dampers shall be provided where indicated unless otherwise noted.

2.9.1.5 Centrifugal Type Power Wall Ventilators

Fans shall be direct or V-belt driven centrifugal type with backward inclined, non-overloading wheel. Motor housing shall be removable and weatherproof. Unit housing shall be designed for sealing to building surface and for discharge and condensate drippage away from building surface. Housing shall be constructed of heavy gauge aluminum. Unit shall be fitted with an aluminum or plated steel wire discharge bird screen, anodized aluminum wall grille, manufacturer's standard gravity damper, unless otherwise noted, an airtight and liquid-tight metallic wall sleeve. Motor enclosure shall be dripproof type unless otherwise noted. Lubricated bearings shall be provided.

2.9.1.6 Centrifugal Type Power Roof Ventilators

Fans shall be direct or V-belt driven with backward inclined, non-overloading wheel. A speed controller rated for the service shall be provided where direct drives are used. Motor compartment housing shall be hinged or removable and weatherproof, constructed of heavy gauge aluminum.

Fans shall be provided with birdscreen, disconnect switch, gravity or motorized dampers,as specified, roof curb, and extended base. Motors enclosure shall be dripproof type, unless otherwise noted. Grease-laden kitchen exhaust fans shall be centrifugal type according to UL 705 and fitted with V-belt drive, round hood, and windband upblast discharge configuration, integral residue trough and collection device, motor and power transmission components located in outside positively air ventilated compartment. Lubricated bearings shall be provided.

2.9.1.7 Propeller Type Power Roof Ventilators

Fans shall be direct or V-belt driven. A speed controller rated for the service shall be provided where direct drives are used. Fan housing shall be hinged or removable weathertight, fitted with framed rectangular base constructed of aluminum or galvanized steel. Motors shall be totally enclosed fan cooled type unless otherwise noted. Motors shall be provided with nonfusible, horsepower rated, manual disconnect mount on unit. Fans shall be provided with gravity or motor operated dampers, as specified, birdscreen and roof curb. Lubricated bearings shall be provided.

2.9.1.8 Air-Curtain Fans (Not Used)

2.9.1.9 Ceiling Exhaust Fans

Suspended cabinet-type ceiling exhaust fans shall be centrifugal type, direct-driven. Fans shall have acoustically insulated housing. Integral backdraft damper shall be chatter-proof. The integral face grille shall be of egg-crate design or louver design. Fan motors shall be mounted on vibration isolators. Unit shall be provided with mounting flange for hanging unit from above. Fans shall be U.L. listed.

2.9.2 Coils

Coils shall be fin-and-tube type constructed of seamless copper or red brass tubes and aluminum or copper fins mechanically bonded or soldered to the tubes. Copper tube wall thickness shall be a minimum of 0.020 inches. Red brass tube wall thickness shall be a minimum of 0.035 inches. Aluminum fins shall be 0.0055 inch minimum thickness. Copper fins shall be 0.0045 inch minimum thickness. Casing and tube support sheets shall be not lighter than 16 gauge galvanized steel, formed to provide structural strength. When required, multiple tube supports shall be provided to prevent tube sag. Each coil shall be tested at the factory under water at not less than 400 psi air pressure and shall be suitable for 200 psi working pressure. Coils shall be mounted for counterflow service. Coils shall be rated and certified according to ARI 410.

2.9.2.1 Direct-Expansion Coils

Direct-expansion coils shall be suitable for the refrigerant involved. Suction headers shall be seamless copper tubing or seamless or resistance welded steel tube with copper connections. Supply headers shall consist of a distributor which shall distribute the refrigerant through seamless copper tubing equally to all circuits in the coil. Tubes shall be circuited to ensure minimum pressure drop and maximum heat transfer. Circuiting shall permit refrigerant flow from inlet to suction outlet without causing oil slugging or restricting refrigerant flow in coil. Each coil to be field installed shall be completely dehydrated and sealed at the factory upon completion of pressure tests.

2.9.2.2 Water Coils (Not Used)

2.9.2.3 Steam Heating Coils (Not Used)

2.9.2.4 Steam Preheat (Nonfreeze) Coils (Not Used)

2.9.3 Air Filters

Air filters shall be listed according to requirements of UL 900, except high efficiency particulate air filters of 99.97 percent efficiency by the DOP Test method shall be as listed under the Label Service and shall meet the requirements of UL 586.

2.9.3.1 Extended Surface Pleated Panel Filters

Filters shall be 2 inch depth, sectional, disposable type of the size indicated and shall have an average efficiency of 25 to 30 percent when tested according to ASHRAE 52.1. Initial resistance at 500 feet per minute shall not exceed 0.36 inches water gauge. Filters shall be UL Class 2. Media shall be nonwoven cotton and synthetic fiber mat. A wire support grid bonded to the media shall be attached to a moisture resistant fiberboard frame. All four edges of the filter media shall be bonded to the inside of the frame to prevent air bypass and increase rigidity.

2.9.3.2 Extended Surface Nonsupported Pocket Filters

Filters shall be 30 inch depth, sectional, replaceable dry media type of the size indicated and shall have an average efficiency of 80 to 85 percent when tested according to ASHRAE 52.1. Initial resistance at 500 feet per minute shall not exceed 0.45 inches water gauge. Filters shall be UL Class 1. Media shall be fibrous glass, supported in the air stream by a wire or non-woven synthetic backing and secured to a galvanized steel metal header. Pockets shall not sag or flap at anticipated air flows. Each filter shall be installed with an extended surface pleated panel filter as a prefilter in a factory preassembled, side access housing or a factory-made sectional frame bank, as indicated.

2.9.3.3 Sectional Cleanable Filters Not Used)

2.9.3.4 Replaceable Media Filters (Not Used)

2.9.3.5 Automatic Renewable Media Filters (Not Used)

2.9.3.6 Electrostatic Filters (Not Used)

2.9.3.7 High-Efficiency Particulate Air (HEPA) Filters

HEPA filters shall meet the requirements of IES RP-CC-001.3 and shall be individually tested and certified to have an efficiency of not less than 99.97. Initial resistance at 500 feet per minute shall not exceed 1.0 inches water gauge. Filters shall be constructed by pleating a continuous sheet of filter medium into closely spaced pleats separated by corrugated aluminum or mineral-fiber inserts, strips of filter medium, or by honeycomb construction of the pleated filter medium. Interlocking, dovetailed, molded neoprene rubber gaskets of 5-10 durometer shall be cemented to the perimeter of the upstream or downstream face of the filter cell sides in accordance with filter housing design. Adhesive sealer shall be of self-extinguishing rubber-base type or other materials conforming to fire hazard classification specified in Section 15080 THERMAL INSULATION FOR

MECHANICAL SYSTEMS. Filter cell sides shall be 3/4 inch thick exterior grade fire-retardant plywood or galvanized steel assembled in a rigid manner. Overall cell side dimensions shall be correct to 1/16 inch, and squareness shall be maintained to within 1/8 inch. Each holding frame shall use spring loaded fasteners or other devices to seal the filter tightly within it and to prevent any bypass leakage around the filter during its installed life. Air capacity and the nominal depth of the filter shall be as indicated. Each filter shall be installed in a factory preassembled side access housing or a factory-made sectional supporting frame as indicated. Prefilters of the type, construction and efficiency indicated, shall be provided.

2.9.3.8 Range and Griddle Hood Service (Not Used)

2.9.3.9 Holding Frames

Frames shall be fabricated from not lighter than 16 gauge sheet steel with rust-inhibitor coating. Each holding frame shall be equipped with suitable filter holding devices. Holding frame seats shall be gasketed. All joints shall be airtight.

2.9.3.10 Filter Gauges

Filter gauges shall be dial type, diaphragm actuated draft and shall be provided for all filter stations, including those filters which are furnished as integral parts of factory fabricated air handling units. Gauges shall be at least 3-7/8 inches in diameter, shall have white dials with black figures, and shall be graduated in 0.01 inch, and shall have a minimum range of 1 inch beyond the specified final resistance for the filter bank on which each gauge is applied. Each gauge shall incorporate a screw operated zero adjustment and shall be furnished complete with two static pressure tips with integral compression fittings, two molded plastic vent valves, two 5 foot minimum lengths of 1/4 inch diameter aluminum tubing, unless otherwise noted, and all hardware and accessories for gauge mounting.

2.10 AIR HANDLING UNITS (Not Used)

2.11 TERMINAL UNITS (Not Used)

2.12 ENERGY RECOVERY DEVICES (Not Used)

2.13 FACTORY PAINTING

Units which are not of galvanized construction according to ASTM A 123/A 123M or ASTM A 924/A 924M shall be factory painted with a corrosion resisting paint finish. Internal and external ferrous metal surfaces shall be cleaned, phosphatized and coated with a paint finish which has been tested according to ASTM B 117, ASTM D 1654, and ASTM D 3359. Evidence of satisfactory paint performance for a minimum of 125 hours for units to be installed indoors and 500 hours for units to be installed outdoors shall be submitted. Rating of failure at the scribe mark shall be not less than 6, average creepage not greater than 1/8 inch. Rating of the inscribed area shall not be less than 10, no failure. On units constructed of galvanized steel which have been welded, exterior surfaces of welds or welds that have burned through from the interior shall receive a final shop docket of zinc-rich protective paint according to ASTM D 520 Type I.

PART 3 EXECUTION

3.1 INSTALLATION

Work shall be installed as shown and according to the manufacturer's diagrams and recommendations.

3.1.1 Piping (Not Used)

3.1.2 Supports (Not Used)

3.1.3 Anchors (Not Used)

3.1.4 Pipe Sleeves (Not Used)

3.1.5 Condensate Drain Lines

Water seals shall be provided in the condensate drain from all units. The depth of each seal shall be 2 inches plus the number of inches, measured in water gauge, of the total static pressure rating of the unit to which the drain is connected. Water seals shall be constructed of 2 tees and an appropriate U-bend with the open end of each tee plugged. Pipe cap or plug cleanouts shall be provided where indicated. Drains indicated to connect to the sanitary waste system shall be connected by an indirect waste fitting. Air conditioner drain lines shall be insulated as specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.1.6 Pipe-Alignment Guides (Not Used)

3.1.7 Air Vents and Drains (Not Used)

3.1.8 Valves (Not Used)

3.1.9 Equipment and Installation

Frames and supports shall be provided for tanks, compressors, pumps, valves, air handling units, fans, coils, dampers, and other similar items requiring supports. Air handling units shall be floor mounted or ceiling hung, as indicated. The method of anchoring and fastening shall be as detailed. Floor-mounted equipment, unless otherwise indicated, shall be set on not less than 6 inch concrete pads or curbs doweled in place. Concrete foundations for circulating pumps shall be heavy enough to minimize the intensity of the vibrations transmitted to the piping and the surrounding structure, as recommended in writing by the pump manufacturer. In lieu of a concrete pad foundation, a concrete pedestal block with isolators placed between the pedestal block and the floor may be provided. The concrete foundation or concrete pedestal block shall be of a mass not less than three times the weight of the components to be supported. Lines connected to the pump mounted on pedestal blocks shall be provided with flexible connectors. Foundation drawings, bolt-setting information, and foundation bolts shall be furnished prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Concrete for foundations shall be as specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.

3.1.10 Access Panels

Access panels shall be provided for concealed valves, vents, controls, dampers, and items requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced and maintained or completely removed and replaced. Access panels

shall be as specified in Section 05500 MISCELLANEOUS METAL.

3.1.11 Flexible Connectors

Pre-insulated flexible connectors and flexible duct shall be attached to other components in accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Hangers, when required to suspend the connectors, shall be of the type recommended by the connector or duct manufacturer and shall be provided at the intervals recommended.

3.1.12 Sleeved and Framed Openings

Space between the sleeved or framed opening and the duct or the duct insulation shall be packed as specified in Section 07840 FIRESTOPPING for fire rated penetrations. For non-fire rated penetrations, the space shall be packed as specified in Section 07900 JOINT SEALING.

3.1.13 Metal Ductwork (Not Used)

3.1.14 Fibrous Glass Ductwork (Not Used)

3.1.15 FRP Ductwork (Not Used)

3.1.16 Kitchen Exhaust Ductwork (Not Used)

3.1.17 Acoustical Duct Lining (Not Used)

3.1.18 Dust Control

To prevent the accumulation of dust, debris and foreign material during construction, temporary dust control protection shall be provided. The distribution system (supply and return) shall be protected with temporary seal-offs at all inlets and outlets at the end of each day's work. Temporary protection shall remain in place until system is ready for startup.

3.1.19 Insulation

Thickness and application of insulation materials for piping and equipment shall be according to Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.1.20 Duct Test Holes (Not Used)

3.1.21 Power Roof Ventilator Mounting

Foamed 1/2 inch thick, closed-cell, flexible elastomer insulation shall cover width of roof curb mounting flange. Where wood nailers are used, holes shall be pre-drilled for fasteners.

3.1.22 Power Transmission Components Adjustment

V-belts and sheaves shall be tested for proper alignment and tension prior to operation and after 72 hours of operation at final speed. Belts on drive side shall be uniformly loaded, not bouncing. Alignment of direct driven couplings shall be to within 50 percent of manufacturer's maximum allowable range of misalignment.

3.2 FIELD PAINTING AND COLOR CODE MARKING

Finish painting of items only primed at the factory, surfaces not specifically noted otherwise, and color code marking for piping shall be as specified in Section 09900 PAINTING, GENERAL.

3.3 PIPING HYDROSTATIC TEST (Not Used)

3.4 DUCTWORK LEAK TEST (Not Used)

3.5 CLEANING AND ADJUSTING

Inside of ducts, plenums, and casing shall be thoroughly cleaned of debris and blown free of small particles of rubbish and dust and then shall be vacuum cleaned before installing outlet faces. Equipment shall be wiped clean, with traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided prior to startup of all fans that are operated during construction, and new filters shall be installed after all construction dirt has been removed from the building, and the ducts, plenums, casings, and other items specified have been vacuum cleaned. System shall be maintained in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Dampers and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions.

3.6 TESTING, ADJUSTING, AND BALANCING

Testing, adjusting, and balancing shall be as specified in Section 15990 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS. Testing, adjusting, and balancing shall begin only when the air supply and distribution, including controls, has been completed, with the exception of performance tests.

3.7 PERFORMANCE TESTS

After testing, adjusting, and balancing has been completed as specified, each system shall be tested as a whole to see that all items perform as integral parts of the system and temperatures and conditions are evenly controlled throughout the building. Corrections and adjustments shall be made as necessary to produce the conditions indicated or specified. Capacity tests and general operating tests shall be conducted by an experienced engineer. Where required, tests shall cover a period of not less than2 days for each system and shall demonstrate that the entire system is functioning according to the specifications. Coincidental chart recordings shall be made at points indicated on the drawings for the duration of the time period and shall record the temperature at space thermostats or space sensors, the humidity at space humidistats or space sensors and the ambient temperature and humidity in a shaded and weather protected area.

3.8 FIELD TRAINING

The Contractor shall conduct a training course for operating and maintenance personnel as designated by the Contracting Officer. Training shall be provided for a period of4 hours of normal working time and shall start after the system is functionally complete but prior to the performance tests. The field instruction shall cover all of the items contained in the approved Operating and Maintenance Instructions.

-- End of Section --

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DIVISION 15 - MECHANICAL

SECTION 15950

HEATING, VENTILATING AND AIR CONDITIONING (HVAC) CONTROL SYSTEMS

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SECTION 15950

HEATING, VENTILATING AND AIR CONDITIONING (HVAC) CONTROL SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

AMCA 500-D	(1997) Laboratory Methods of Testing Dampers for Rating

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 269	(2000) Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM B 88	(1999) Seamless Copper Water Tube
ASTM D 1693	(2000) Environmental Stress-Cracking of Ethylene Plastics
ASTM D 635	(1998) Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1997) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2002) National Electrical Code
NFPA 90A	(1999) Installation of Air Conditioning and Ventilating Systems

UNDERWRITERS LABORATORIES (UL)

UL 508	(1999) Industrial Control Equipment
UL 555S	(1999) Safety for Smoke Dampers
UL 94	(1996; Rev thru Jul 1998) Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation;

submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Drawings; GA

Drawings on A1 34 by 22 inch sheets in the form and arrangement shown. The drawings shall use the same abbreviations, symbols, nomenclature and device identifiers shown. Each control-system element on a drawing shall have a unique identifier as shown. All HVAC control system drawings shall be delivered together as a complete submittal. Drawings shall be submitted for each HVAC system.

a. HVAC control system drawings shall include the following:

Sheet One: Drawing index, HVAC control system legend.

Sheet Two: Valve schedule, damper schedule.

Sheet Three: HVAC control system schematic and equipment schedule.

Sheet Four: HVAC control system sequence of operation and ladder diagram.

Sheet Five: HVAC control panel arrangement, control panel cross-section, and control panel inner door layout.

Sheet Six: HVAC control panel back-panel layout.

Sheet Seven: Control loop wiring diagrams.

Sheet Eight: Motor starter and relay wiring diagram.

Note: Repeat sheets three through eight for each AHU system.

b. An HVAC control system drawing index showing the name and number of the building, military site, State or other similar designation, and Country. The drawing index shall list all HVAC control system drawings, including the drawing number, sheet number, drawing title, and computer filename when used.

c. An HVAC control system legend showing generic symbols and the name of devices shown on the HVAC control system drawings.

d. A damper schedule showing each damper and actuator's identifier, nominal and actual sizes, orientation of axis and frame, direction of blade rotation, spring ranges, operation rate, positive positioner ranges, locations of actuators and damper end switches, arrangement of sections in multi-section dampers, and methods of connecting dampers, actuators, and linkages. The damper schedule shall include the maximum leakage rate at the operating static-pressure differential. The damper schedule shall contain actuator selection data supported by calculations of the torque required to move and seal the dampers, access and clearance requirements where applicable.

e. An HVAC control system equipment schedule showing the control loop, device unique identifier, device function, setpoint, input range, and additional important parameters (i.e. output range).

f. An HVAC control system sequence of operation.

g. An HVAC control system ladder diagram showing all relays, contacts, pilot lights, switches, fuses and starters connected to the control system.

h. HVAC control panel arrangement drawings showing both side and front views of the panel. The drawing shall show panel and mounting dimensions.

i. HVAC control panel cross-section drawings showing mounting rails and standoffs for devices.

j. HVAC control panel inner door layout drawings showing both front and rear views of the inner door. The drawings shall show device locations, labels, nameplate legends, and fabrication details.

k. HVAC control panel back-panel layout drawings showing device locations, labels, nameplate legends, terminal block layout, fabrication details, and enclosure operating temperature-rise calculations.

l. HVAC control system wiring diagrams showing functional wiring diagrams of the interconnection of conductors and cables to HVAC control panel terminal blocks and to the identified terminals of devices, starters and package equipment. The wiring diagrams shall show all necessary jumpers and ground connections. The wiring diagrams shall show the labels of all conductors. Sources of power required for HVAC control systems and for packaged-equipment control systems shall be identified back to the panel-board circuit breaker number, HVAC system control panel, magnetic starter, or packaged equipment control circuit. Each power supply and transformer not integral to a controller, starter, or packaged equipment shall be shown. The connected volt-ampere load and the power supply volt-ampere rating shall be shown.

SD-03 Product Data

HVAC Control System; GA
Service Organizations; GA

Six (6) copies of a list of service organizations qualified to service the HVAC control system. The list shall include the service organization name, address, technical point of contact and telephone number, and contractual point of contact and telephone number.

Equipment Compliance Booklet; GA

An HVAC control system equipment compliance booklet (ECB) in indexed booklet form with numbered tabs separating the information

on each device. It shall consist of, but not be limited to, data sheets and catalog cuts which document compliance of all devices and components with the specifications. The ECB shall be indexed in alphabetical order by the unique identifiers. Devices and components which do not have unique identifiers shall follow the devices and components with unique identifiers and shall be indexed in alphabetical order according to their functional name. The ECB shall include a bill of materials for each HVAC control system. The bill of materials shall function as the table of contents for the ECB and shall include the device's unique identifier, device function, manufacturer, model/part/catalog number used for ordering, and tab number where the device information is located in the ECB.

Commissioning Procedures; GA

a. Six (6) copies of the HVAC control system commissioning procedures, in indexed booklet form, 60 days prior to the scheduled start of commissioning. Commissioning procedures shall be provided for each HVAC control system, and for each type of terminal-unit control system. The commissioning procedures shall reflect the format and language of this specification, and refer to devices by their unique identifiers as shown. The commissioning procedures shall be specific for each HVAC system, and shall give detailed step-by-step procedures for commissioning of the system.

b. Commissioning procedures documenting detailed, product-specific set-up procedures, configuration procedures, adjustment procedures, and calibration procedures for each device. Where the detailed product-specific commissioning procedures are included in manufacturer supplied manuals, reference may be made in the HVAC control system commissioning procedures to the manuals.

c. Commissioning procedures documenting controller configuration checksheets for each controller listing all configuration parameters, dip switch and jumper settings, and initial recommended P, I and D values. The configuration parameters shall be listed in the order in which they appear during the configuration process. Each configuration parameter shall be noted as being: set per specs with no field adjustment required, set per specs but field adjustable, or not applicable.

d. Commissioning procedures showing a time clock configuration checksheet listing all parameters, and switch settings. The parameters shall be listed in the order which they appear during the setup process.

e. An HVAC control system commissioning procedures equipment list that lists the equipment to be used to accomplish commissioning. The list shall include manufacturer name, model number, equipment function, the date of the latest calibration, and the results of the latest calibration.

Performance Verification Test Procedures; GA

Six (6) copies of the HVAC control system performance verification test procedures, in indexed booklet form, 60 days before the Contractor's scheduled test dates. The performance

verification test procedures shall refer to the devices by their unique identifiers as shown, shall explain, step-by-step, the actions and expected results that will demonstrate that the HVAC control system performs in accordance with the sequences of operation. An HVAC control system performance verification test equipment list shall be included that lists the equipment to be used during performance verification testing. The list shall include manufacturer name, model number, equipment function, the date of the latest calibration, and the results of the latest calibration.

Training Course Requirements; GA

Six (6) copies of HVAC control system training course material 30 days prior to the scheduled start of the training course. The training course material shall include the operation manual, maintenance and repair manual, and paper copies of overheads used in the course. An HVAC control system training course, in outline form, with a proposed time schedule. Approval of the planned training schedule shall be obtained from the Government at least 60 days prior to the start of the training.

SD-06 Test Reports

Commissioning Report; GA

Six (6) copies of the HVAC control system commissioning report, in indexed booklet form, within 30 days after completion of the system commissioning. The commissioning report shall include data collected during the HVAC control system commissioning and shall follow the format of the commissioning procedures. The commissioning report shall include all controller and time clock checksheets with final values listed for all parameters, setpoints, P, I, D setting constants, calibration data for all devices, and results of adjustments.

Performance Verification Test; GA

Six (6) copies of the HVAC control system performance verification test report, in indexed booklet form, within 30 days after completion of the test. The HVAC control system performance verification test report shall include data collected during the HVAC control system performance verification test. The original copies of data gathered during the performance verification test shall be turned over to the Government after Government approval of the test results.

SD-10 Operation and Maintenance Data

Operation Manual; GA
Maintenance and Repair Manual; GA

Six (6) copies of the HVAC control system operation manual and HVAC control system maintenance and repair manual for each HVAC control system 30 days before the date scheduled for the training course.

1.3 GENERAL REQUIREMENTS

1.3.1 Verification of Dimensions

The Contractor shall become familiar with all details of the work, shall verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

1.3.2 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall investigate the mechanical, electrical, and finish conditions that could affect the work to be performed, shall arrange such work accordingly, and shall furnish all work necessary to meet such conditions.

1.4 DELIVERY AND STORAGE

Products shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, and other contaminants, within the storage-condition limits published by the equipment manufacturer. Dampers shall be stored so that seal integrity, blade alignment and frame alignment are maintained.

1.5 OPERATION MANUAL

An HVAC control system operation manual for each HVAC control system, in indexed booklet form, shall be provided. The operation manual shall include the HVAC control system sequence of operation, and procedures for the HVAC system start-up, operation and shut-down. The operation manual shall include as-built HVAC control system detail drawings. The operation manual shall include the as-built controller configuration checksheets, the as-built time clock configuration checksheet, the HVAC control system front panel description, the procedures for changing HVAC system controller setpoints, the procedures for gaining manual control of processes, the time clock manufacturer's manual control of processes, the time clock manufacturer's operation manual, and the controller manufacturer's operation manual.

a. The HVAC control system front panel description shall explain the meaning and use of the lights, switches, gauges, and controller displays located in the front panel. Each light, switch, gauge, and display described shall be numbered and referenced to a drawing of the front panel.

b. The procedures for changing HVAC system controller setpoints shall describe the step-by-step procedures required to change: the process variable setpoints of controllers, the alarm setpoints of controllers, the controller bias settings, and controller setpoint reset schedules.

c. The procedures for gaining manual control of processes shall describe step-by-step procedures required to gain manual control of devices and manually adjust their positions.

1.6 MAINTENANCE AND REPAIR MANUAL

An HVAC control system maintenance and repair manual for each HVAC control system, in indexed booklet form in either hardback or softbound binders, shall be provided. The maintenance and repair manual shall include the

routine maintenance checklist, a recommended repair methods list, a list of recommended maintenance and repair tools, the qualified service organization list, the as-built commissioning procedures and report, the as-built performance verification test procedures and report, and the as-built equipment data booklet (EDB).

a. The routine maintenance checklist shall be arranged in a columnar format. The first column shall list all devices listed in the equipment compliance booklet (ECB), the second column shall state the maintenance activity or state no maintenance required, the third column shall state the frequency of the maintenance activity, and the fourth column for additional comments or reference.

b. The recommended repair methods list shall be arranged in a columnar format and shall list all devices in the equipment compliance booklet (ECB) and state the guidance on recommended repair methods, either field repair, factory repair, or whole-item replacement.

c. The as-built equipment data booklet (EDB) shall include the equipment compliance booklet (ECB) and all manufacturer supplied user manuals and information.

d. If the operation manual and the maintenance and repair manual are provided in a common volume, they shall be clearly differentiated and separately indexed.

PART 2 PRODUCTS

2.1 MATERIAL AND EQUIPMENT

Material and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products which are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. The equipment items shall be supported by a service organization. The Contractor shall submit a certified list of qualified permanent service organizations and qualifications. These service organizations shall be reasonably convenient to the equipment on a regular and emergency basis during the warranty period.

2.2 GENERAL EQUIPMENT REQUIREMENTS

2.2.1 Electrical and Electronic Devices

All electrical, electronic, and electro-pneumatic devices not located within an HVAC control panel shall have a NEMA Type 1 enclosure in accordance with NEMA 250 unless otherwise shown.

2.2.2 Standard Signals

The output of all analog transmitters and the analog input and output of all single-loop controllers and function modules shall be 4-to-20 mAdc signals. The signal shall originate from current-sourcing devices and shall be received by current-sinking devices.

2.2.3 Ambient Temperature Limits

Ambient Temperature Actuators and positive positioners, and transmitters shall operate within temperature limit ratings of minus 10 to 140 degrees F. All panel-mounted instruments shall operate within limit ratings of minus 10 to 120 degrees F and 10 percent to 95 percent relative humidity, noncondensing. All devices installed outdoors shall operate within limit ratings of minus 40 to plus 150 degrees F.

2.2.4 Nameplates, Lens Caps, and Tag Nameplates

Nameplates, lens caps, and lens caps bearing legends as shown and tags bearing device-unique identifiers as shown shall have engraved or stamped characters. A plastic or metal tag shall be mechanically attached directly to each device or attached by a metal chain or wire. Each air flow measurement station shall have a tag showing flow rate range for signal output range and identifier as shown.

2.3 MATERIALS

Construction/fabrication materials shall contain no hazardous materials. Asbestos, lead, cadmium, mercury, PCBs, and other hazardous material shall not be used.

Suspect/Counterfeit Items (S/CIs) shall not be used.

Provide Material Safety Data Sheets (MSDSs) as applicable.

2.3.1 Tubing

2.3.1.1 Copper

Copper tubing shall conform to ASTM B 88 and shall have sweat fittings and valves.

2.3.1.2 Plastic

Plastic tubing shall have barbed fittings and valves. Plastic tubing shall have the burning characteristics of linear low-density polyethylene tubing, shall be self-extinguishing when tested in accordance with ASTM D 635, shall have UL 94 V-2 flammability classification, and shall withstand stress cracking when tested in accordance with ASTM D 1693. Plastic-tubing bundles shall be provided with Mylar barrier and flame-retardant polyethylene jacket.

2.3.1.3 Stainless Steel

Stainless steel tubing shall conform to ASTM A 269, and shall have stainless steel compression fittings.

2.3.2 Wiring

2.3.2.1 Terminal Blocks

Terminal blocks shall be insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, shall be suitable for rail mounting, and shall have end plates and partition plates for separation or shall have enclosed sides.

2.3.2.2 Control Wiring for 24-Volt Circuits

Control wiring for 24-volt circuits shall be 18 AWG minimum, stranded copper and shall be rated for 300-volt service.

2.3.2.3 Wiring for 120-Volt Circuits

Wiring for 120-volt circuits shall be 18 AWG minimum, stranded copper and shall be rated for 600-volt service.

2.3.2.4 Analog Signal Wiring Circuits

Analog signal wiring circuits within control panels shall not be less than 20 AWG and shall be rated for 300-volt service.

2.3.2.5 Instrumentation Cable

Instrumentation cable shall be 18 AWG, stranded copper, single or multiple-twisted, minimum 2 inch lay of twist, 100 percent shielded pairs, and shall have a 300-volt insulation. Each pair shall have a 20 AWG tinned-copper drain wire and individual overall pair insulation. Cables shall have an overall aluminum-polyester or tinned-copper cable-shield tape, overall 20 AWG tinned-copper cable drain wire, and overall cable insulation.

2.3.2.6 Nonconducting Wiring Duct

Nonconducting wiring duct in control panels shall have wiring duct in control panels shall have slotted sides, snap-on duct covers, have slotted sides, snap-on duct covers, fittings for connecting ducts, mounting clips for securing ducts, and wire-retaining clips.

2.3.2.7 Transformers

Step-down transformers shall be provided where control equipment operates at lower than line circuit voltage. Transformers, other than transformers in bridge circuits, shall have primaries wound for the voltage available and secondaries wound for the correct control circuit voltage. Transformers shall be sized so that the connected load is 80 percent of the rated capacity or less. Transformers shall conform to UL 508.

2.4 ACTUATORS

Actuators shall be pneumatic, electric or electronic as shown and shall be provided with mounting and connecting hardware. Actuators shall fail to their spring-return positions on signal or power failure. The actuator stroke shall be limited in the direction of power stroke by an adjustable stop. Actuators shall have a visible position indicator. Actuators shall smoothly open or close the devices to which they are applied and shall have a full stroke response time of 90 seconds or less. Electric actuators shall have an oil-immersed gear train. Electric or electronic actuators operating in series shall have an auxiliary actuator driver. Electric or electronic actuators used in sequencing applications shall have an

adjustable operating range and start point. Pneumatic actuators shall be rated for 25 psig operating pressure except for high-pressure cylinder-type actuators.

2.4.1 Valve Actuators

Not used.

2.4.2 Positive Positioners

Positive positioners are required for pneumatic actuators. Each positive positioner shall be a pneumatic relay with a mechanical feedback mechanism and an adjustable operating range and starting point.

2.5 AUTOMATIC CONTROL VALVES

Not used.

2.6 DAMPERS

2.6.1 Damper Assembly

A single damper section shall have blades no longer than 48 inches and shall be no higher than 72 inches. Maximum damper blade width shall be 8 inches. Larger sizes shall be made from a combination of sections. Dampers shall be steel, or other materials where shown. Flat blades shall be made rigid by folding the edges. All blade-operating linkages shall be within the frame so that blade-connecting devices within the same damper section will not be located directly in the air stream, unless otherwise noted. Damper axles shall be 0.5 inch (minimum) plated steel rods supported in the damper frame by stainless steel or bronze bearings. Blades mounted vertically shall be supported by thrust bearings. Pressure drop through dampers shall not exceed 0.04 inch water gauge at 1,000 fpm in the wide-open position. Frames shall not be less than 2 inches in width. Dampers shall be tested in accordance with AMCA 500-D.

2.6.1.1 Operating Links

Operating links external to dampers shall withstand a load equal to at least twice the maximum required damper-operating force. Rod lengths shall be adjustable. Links shall be brass, bronze, zinc-coated steel, or stainless steel. Working parts of joints and clevises shall be brass, bronze, or stainless steel. Adjustments of crankarms shall control the open and closed positions of dampers.

2.6.1.2 Damper Types

Dampers shall be opposed blade type, unless otherwise noted.

2.6.2 Outside-Air, Return-Air, and Relief-Air Dampers

The dampers shall be provided where shown. Blades shall have interlocking edges and shall be provided with compressible seals at points of contact. The channel frames of the dampers shall be provided with jamb seals to minimize air leakage. Dampers shall not leak in excess of 20 cfm per square foot at 4 inches water gaugestatic pressure when closed. Seals shall be suitable for an operating temperature range of minus 40 to plus 200 degrees F. Dampers shall be rated at not less than 2000 fpm air velocity.

2.6.3 Mechanical and Electrical Space Ventilation Dampers

The dampers shall be as shown. Dampers shall not leak in excess of 80 cfm per square foot at 4 inches water (gauge) static pressure when closed. Dampers shall be rated at not less than 1500 fpm air velocity.

2.6.4 Smoke Dampers

Smoke-damper and actuator assembly required per NFPA 90A shall meet the Class II leakage requirements of UL 555S. Dampers shall be rated at not less than 2000 fpm air velocity.

2.6.5 Damper End Switches

Each end switch shall be a hermetically-sealed switch with a trip lever and over-travel mechanism. The switch enclosure shall be suitable for mounting on the duct exterior and shall permit setting the position of the trip lever that actuates the switch. The trip lever shall be aligned with the damper blade.

2.7 DUCT SMOKE DETECTORS

Not used.

2.8 INSTRUMENTATION

2.8.1 Measurements

Transmitters shall be factory calibrated to provide an output of 4 to 20 mAdc, unless otherwise noted, over the indicated ranges:

a. Conditioned space temperature, from 50 to 85 degrees F.

b. Outside-air temperature, from minus 30 to 130 degrees F.

c. Relative humidity, 0 to 100 percent for space applications.

2.8.2 Temperature Instruments

Not used.

2.8.3 Relative-Humidity Instruments

Not used.

2.8.4 Electronic Air-Flow-Measurement Stations and Transmitters

Not used.

2.8.5 Pitot-Tube Air-Flow-Measurement Stations and Transmitters

Not used.

2.8.6 Differential Pressure Instruments

Not used.

2.8.7 Thermowells

Not used.

2.8.8 Sunshields

Not used.

2.9 THERMOSTATS

Thermostat ranges shall be selected so that the setpoint is adjustable a minimum of plus or minus 10 degrees F of the setpoint shown. Thermostats shall be electronic or electric.

2.9.1 Nonmodulating Room Thermostats

Contacts shall be single-pole double-throw (SPDT), hermetically sealed, and wired to identified terminals. Maximum differential shall be 5 degrees F. Room thermostats shall be enclosed with separate locking covers (guards). Thermostats shall have manual switches as required by the application. Mercury shall not be used.

2.9.2 Microprocessor-Based Room Thermostats

Microprocessor-based thermostats shall have built-in keypads for scheduling of day and night temperature settings. When out of the scheduling mode, thermostats shall have continuous display of time, with AM and PM indicator, continuous display of day of week, and either continuous display of room temperature with display of temperature setpoint on demand, or continuous display of temperature setpoint with display of room temperature on demand. In the programmable mode, the display shall be used for interrogating time program ON-OFF setpoints for all 7 days of the week. The time program shall allow 2 separate temperature-setback intervals per day. The thermostats shall have a means for temporary and manual override of the program schedule, with automatic program restoration on the following day. Thermostats shall have a replaceable battery to maintain the timing and maintain the schedule in memory for 1 year in the event of a power outage. Maximum differential shall be 2 degrees F. When used for heat-pump applications, the thermostat shall have an emergency heat switch.

2.9.3 Modulating Room Thermostats

Modulating room thermostats shall have either one output signal, two output signals operating in unison, or two output signals operating in sequence, as required for the application. Each thermostat shall have an adjustable throttling range of 4 to 8 degrees F for each output. Room thermostats shall be enclosed with separate locking covers (guards).

2.9.4 Nonmodulating Capillary Thermostats and Aquastats

Not used.

2.9.5 Low-Temperature-Protection Thermostats

Not used.

2.9.6 Modulating Capillary Thermostats

Each thermostat shall have either one output signal, two output signals operating in unison, or two output signals operating in sequence, as

required for the application. Thermostats shall have adjustable throttling ranges of 4 to 8 degrees F for each output. Mercury-filled thermostats shall not be used.

2.9.7 Fan-Coil Unit Room Thermostats

Not used.

2.10 PRESSURE SWITCHES AND SOLENOID VALVES

Not used.

2.11 INDICATING DEVICES

2.11.1 Thermometers

Not used.

2.11.2 Pressure Gauges

Not used.

2.11.3 Low Differential Pressure Gauges

Gauges for low differential-pressure measurements shall be a minimum of 3.5 inch (nominal) size with two sets of pressure taps, and shall have a diaphragm-actuated pointer, white dial with black figures, and pointer zero adjustment. Gauges shall have ranges and graduations as shown. Accuracy shall be plus or minus 2 percent of scale range.

2.12 SINGLE-LOOP CONTROLLERS

2.12.1 Controller Features

The controller shall be a microprocessor-based single-loop device that does not require Contractor generated software. The controller shall be mountable in a panel cutout measuring 3.62 by 3.62 inches. The controller shall have field scalable process variable, a remote setpoint analog input, which is field scalable independent of the process variable, and an analog output with adjustable high and low end limits and proportional control manual reset adjustment. The analog output shall result from proportional, integral and derivative (PID) control. The analog output shall be configurable as direct acting and reverse acting. The controller shall have keyboard, display, auto/manual selection for control of its analog output, remote setpoint adjustment/local setpoint adjustment selection with adjustable high-end and low-end limits, ratio and bias adjustments on remote setpoint input, operator-initiated self-tune/manual-tune selection, anti-reset wind-up feature, and 2 independent SPDT contact-closure outputs (PV alarm and deviation alarm). The controller shall be configurable to power-up in automatic with local setpoint control and in automatic with remote setpoint control. The range of hysteresis adjustment shall be not smaller than from 1 percent to 5 percent of process variable input span. The controller shall power the analog output loop to 20 milliamperes when connected to a load of 600 ohms. The controller shall be capable of retransmitting the process variable to 20 milliamperes when connected to 600 ohms. The controller shall have 5-year battery backup to store operating parameters or shall have nonvolatile memory.

2.12.2 Parameter Input and Display

Control parameters shall be entered and displayed directly, in the correct engineering units, through a series of keystrokes on a front-panel display with a 3-1/2 digit, 7-segment display, with decimal point and polarity indication. The use of this display shall allow manual interrogation of setpoint, mode constants, and values of the process variable and output.

2.12.3 Controller Electrical Requirements

Each controller shall be powered by 120 volts ac. Power consumption shall not be greater than 25 watts. Each controller shall provide electrical noise isolation between the ac power line and the process variable input, remote setpoint input, and output signals and of not less than 100 db at 60 Hz common-mode rejection ratio, and not less than 60 db at 60 Hz normal-mode rejection ratio.

2.12.4 Controller Accuracy

The controller shall have an accuracy of plus or minus 0.30 percent of input span, plus or minus 1 digit.

2.12.5 Self-Tuning

The controller self-tuning operation shall apply proportional, integral, and derivative modes of control and shall modify the mode constants as required. Self-tuning shall only be in operation when selected from the front panel.

2.12.6 Manual-Tuning

The controller manual-tuning operation shall provide proportional, integral, and derivative control modes, or any combination thereof, by means of individual mode constant adjustments. These adjustments shall be set for the appropriate value if a particular control mode action is desired, or to zero if that particular mode is not desired. The proportional-mode constant shall be adjustable from 0 to 200 percent of input signal range, the integral-mode constant shall be adjustable from 0 to 20 repeats per minute, and derivative-mode constant shall be adjustable from 0 to 5 minutes.

2.13 CONTROL DEVICES AND ACCESSORIES

Not used.

2.14 PILOT LIGHTS AND MANUAL SWITCHES

Not used.

2.15 HVAC SYSTEM CONTROL PANELS

Not used.

2.16 COMPRESSED-AIR STATIONS

Not used.

2.17 ELECTRONIC VARIABLE AIR VOLUME (VAV) TERMINAL UNIT CONTROLS

Not used.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION CRITERIA

The HVAC control system shall be installed and ready for operation, as specified and shown. Dielectric isolation shall be provided where dissimilar metals are used for connection and support. Penetrations through and mounting holes in the building exterior shall be made watertight. The HVAC control system installation shall provide clearance for control system maintenance by maintaining access space required to calibrate, remove, repair, or replace system devices.

3.1.1 Device Mounting Criteria

Devices mounted in or on piping, on building surfaces, in mechanical/electrical spaces, or in occupied space ceilings shall be installed in accordance with manufacturer's recommendations and as shown. Control devices to be installed in piping shall be provided with all required gaskets, flanges, thermal compounds, insulation, piping, fittings, and other accessories required. Strap-on temperature sensing elements shall not be used except as specified.

3.1.2 Wiring Criteria

Wiring external to control panels, including low-voltage wiring, shall be installed in metallic raceways. Nonmetallic-sheathed cables or metallic-armored cables may be installed in areas permitted by NFPA 70. Wiring shall be installed without splices between control devices and HVAC control panels. Cables and conductors shall be tagged at both ends, with the identifier shown on the shop drawings, in accordance with the requirements of Section 16415 ELECTRICAL WORK, INTERIOR. Other electrical work shall be as specified in Section 16415 ELECTRICAL WORK, INTERIOR and as shown.

3.2 CONTROL SYSTEM INSTALLATION

3.2.1 Damper Actuators

Actuators shall not be mounted in the air stream. Multiple actuators operating a common damper shall be connected to a common drive shaft. Actuators shall be installed so that their action shall seal the damper to the extent required to maintain leakage at or below the specified rate and shall move the blades smoothly.

3.2.2 Local Gauges for Actuators

Not used.

3.2.3 Room-Instrument Mounting

Room instruments, such as wall mounted thermostats, shall be mounted 5 feet above the floor unless otherwise noted. Temperature setpoint device shall be recess mounted.

3.2.4 Smoke Detectors

Not used.

3.2.5 Manual Emergency Fan Shutdown Switches

Manual emergency fan shutdown switches shall be provided for air distribution fans in accordance with NFPA 90A. Switches shall be the manual-reset type. Switches shall be located and mounted in an accessible manner, approximately 48 inches above the finished floor. Switches shall be properly identified in etched rigid plastic placards.

3.2.6 Low-Temperature-Protection Thermostats

Not used.

3.2.7 Averaging-Temperature Sensing Elements

Not used.

3.2.8 Foundations and Housekeeping Pads

Not used.

3.2.9 Compressed-Air Stations

Not used.

3.2.10 Duct Static-Pressure Sensing Elements and Transmitters

Not used.

3.2.11 Indication Devices Installed in Piping and Liquid Systems

Not used.

3.2.12 Control System Tubing

Not used.

3.3 CONTROL SEQUENCES OF OPERATION

3.3.1 System Requirements

These requirements shall apply to all primary HVAC systems unless modified herein. The sequences describe the actions of the control system for one direction of change in the HVAC process analog variable, such as temperature, humidity or pressure. The reverse sequence shall occur when the direction of change is reversed.

3.3.1.1 HVAC System Supply Fan Operating

HVAC system outside-air, return-air, and relief-air dampers shall be manually set to maintain the air flows shown on drawings. Interlocked exhaust fans shall run simultaneously with the supply fan.

3.3.1.2 HVAC System Supply Fan Not Operating

When an HVAC system is stopped, interlocked fans shall stop and all stages of direct-expansion cooling shall stop.

3.3.2 Perimeter-Radiation Control Sequence

Not used.

3.3.3 Unit-Heater and Cabinet-Unit-Heater

A wall-mounted thermostat with an "AUTO-OFF" switch shall cycle the fan to maintain its setpoint as shown when the switch is in the "AUTO" position. When the switch is in the "OFF" position, the fan shall be stopped.

3.3.4 Gas-Fired Infrared-Heater

An "AUTO-OFF" switch shall control infrared heaters. When the switch is in the "AUTO" position, the thermostat shall cycle the infrared heater to maintain the setpoint. When the switch is in the "OFF" position, the infrared heater shall be off.

3.3.5 All-Air Packaged Unitary System

A microprocessor-based room temperature sensor/controller, located as shown, with an "ON-OFF-AUTO" switch shall control the heating/cooling system. When the unit is in the "HEATING" mode, the cooling shall be off, and heating shall be active. The controller shall operate the heat to maintain day and night setpoints specified. Programmed occupied times shall be considered "day" and programmed unoccupied times shall be considered "night."

When the unit is in the "COOLING" mode, the heating shall be off. The controller shall operate the condensing units and "Hot Gas Bypass" system to maintain the setpoint as specified during the day. The condensing unit shall be off at night.

When the switch is in the "OFF" position, the system shall be off. The system fan shall run continuously during all "occupied" periods and shall cycle on with the heating or cooling system during "unoccupied" periods.

The temperature controller shall automatically switch to either the heating or cooling mode as required without excessive cycling to maintain space temperature within plus or minus 2 degrees F of setpoint.

3.3.6 Dual-Temperature Fan-Coil Unit

Not used.

3.3.7 Central Plant Hydronic-Heating with Steam/Hot Water Converter

Not used.

3.3.8 Single Building Hydronic Heating with Hot Water Boiler

Not used.

3.3.9 Central Plant High-Temperature Hot-Water Hydronic Heating

Not used.

3.3.10 Central Plant Steam Dual-Temperature Hydronic

Not used.

3.3.11 Central Plant High-Temperature Hot-Water Dual-Temperature Hydronic

Not used.

3.3.12 Single Building Dual-Temperature Hydronic

Not used.

3.3.13 Heating and Ventilating Sequence

3.3.13.1 Emergency Fan Shutdown

Activation of a manual emergency fan shutdown switch shall cause the associated fan to shutdown in accordance with NFPA 90A. Activation of these devices shall operate a pilot light on the HVAC control panel. The panel shall require manual resetting after the detector and the manual switch are reset.

3.3.14 Multizone Control Sequence with Return Fan

Not used.

3.3.15 Dual-Duct Multizone Control Sequence with Return Fan

Not used.

3.3.16 Bypass Multizone Control Sequence with Return Fan

Not used.

3.3.17 Variable Air Volume Control Sequence without Return Fan

Not used.

3.3.18 Variable Air Volume Control Sequence with Return Fan

Not used.

3.3.19 Single-Zone with Hydronic Heating/Cooling Coils No Return Fan

Not used.

3.3.20 Single-Zone with Dual-Temperature Coil; No Return Fan

Not used.

3.3.21 Single-Zone Control Sequence with Humidity Control; No Return Fan

Not used.

3.3.22 Single-Zone - Hydronic Heating and Direct-Expansion Cooling Coils

Not used.

3.4 COMMISSIONING PROCEDURES

3.4.1 General Procedures

3.4.1.1 Evaluations

The Contractor shall make the observations, adjustments, calibrations, measurements, and tests of the control systems, tune the controllers, set the time clock schedule, and make any necessary control-system corrections to ensure systems function as described in the control sequences as shown on drawings. The Contractor shall permanently record, on system equipment schedule, the final setting of controller proportional, integral and derivative constant settings, setpoint, manual reset setting, maximum and minimum controller output, and ratio and bias settings, in units and terminology specific to the controller.

3.4.1.2 Item Check

An item-by-item check of the sequence of operation requirement shall be performed using Steps 1 through 4 in the specified control system commissioning procedures. Steps 1, 2, and 3 shall be performed with the HVAC system shutdown; Step 4 shall be performed after the HVAC systems have been started. Signals used to change the mode of operation shall originate from the actual HVAC control device intended for the purpose, such as the time clock. External input signals to the HVAC control panel (such as interlocks, starter auxiliary contacts, and external systems) may be simulated in Steps 1, 2, and 3. With each operational-mode change signal, pilot lights and HVAC-panel output-relay contacts shall be observed to ensure that they function.

3.4.1.3 Weather-Dependent Test Procedures

Weather-dependent test procedures that cannot be performed by simulation shall be performed in the appropriate climatic season. When simulation is used, the Contractor shall verify the actual results in the appropriate season.

3.4.1.4 Configuration

The Contractor shall configure each controller for its specified service.

3.4.1.5 Two-Point Accuracy Check

A two-point accuracy check of the calibration of each HVAC-control-system sensing element and transmitter shall be performed by comparing the HVAC-control-panel readout to the actual value of the variable measured at the sensing element and transmitter or airflow measurement station location. Digital indicating test instruments shall be used, such as digital thermometers, motor-driven psychrometers, and tachometers. Generally, the test instruments shall be at least twice as accurate as the specified sensing element-to-controller readout accuracy. The calibration of the test instruments shall be traceable to NIST standards. The first check point shall be with the HVAC system in the shutdown condition, and the second check point shall be with the HVAC system in an operational condition. Calibration checks shall verify that the sensing element-to-controller readout accuracies at two points are within the specified product accuracy tolerances. If not, the device shall be recalibrated or replaced and the calibration check repeated.

3.4.1.6 Insertion, Immersion Temperature

Insertion-temperature and immersion-temperature sensing element and transmitter-to-controller readout calibration accuracy shall be checked at one physical location along the axis of the sensing element.

3.4.1.7 Averaging Temperature

Averaging-temperature sensing element and transmitter-to-controller readout calibration accuracy shall be checked every 2 feet along the axis of the sensing element in the proximity of the sensing element, for a maximum of 10 readings. These readings shall then be averaged.

3.4.1.8 Controller Stations

The Contractor shall use the controllers' MANUAL/AUTOMATIC stations as the means of manipulating control devices, such as dampers and valves, to check IP operation and to effect stable conditions prior to making measurement checks.

3.4.1.9 Controller-Tuning Procedure

Where applicable, the Contractor shall perform a controller-tuning procedure, which shall consist of setting the initial proportional, integral, and derivative (PID) mode constants, controller setpoints, and logging the settings. Tuning shall be self-tuning operation by the controller unless manual tuning is necessary.

3.4.1.10 Controller Manual-Tuning Procedure

Where required, the controller manual-tuning procedure shall be performed in three steps. Using a constant-temperature-setpoint controller as an example, these steps are:

a. Step A:

(1) The controller MANUAL/AUTO station shall be indexed to the AUTO position and the integral- and derivative-mode constants set to zero.

(2) The proportional-mode constant shall be set to an initial setting of 8 percent. (This corresponds to 1.5 psig per degree F or 2.0 ma per degree Fproportional controller output change for a 100 degree F transmitter span.) This causes the controller output signal to vary from live zero output to full output for an input signal change representing an 8 degree F change.

(3) Controllers for other variables, such as relative humidity and static pressure, shall have their proportional-mode constants set initially in a similar manner for an achievable output range proportional to the transmitter span.

b. Step B:

(1) The controller temperature setpoint shall be set at an achievable temperature. The controller output and transmitter input shall be observed.

(2) If the transmitter input continuously oscillates above and below the setpoint without settling at a fixed value, or if such oscillation increases, the proportional-mode constant is too small.

(3) If the proportional-mode constant is too small, increase it in steps until the transmitter input indicates stable control at any temperature, provided that the controller output is not at

either extreme of the output range.

(4) If the temperature control point slowly drifts toward or away from the controller setpoint, the proportional-mode constant is too large. Its setting shall be decreased in steps until oscillations occur as described in the preceding paragraphs, and then the setting shall be increased until stable control occurs.

(5) A step change in controller setpoint shall be introduced. This should cause the controller to overshoot the setpoint slightly, with each subsequent overshoot peak value decreasing by a factor of 2/3 until stable control is achieved at, above, or below the setpoint.

(6) Next, the integral-mode constant setting shall be increased in small steps, and setpoint changes shall be introduced until control point and controller setpoint coincide at stable control. This should happen consistently after a setpoint change within a short time, such as 5 to 10 minutes.

c. Step C:

(1) Unless the HVAC process variable changes rapidly, the derivative-mode constant setting can remain at zero.

(2) If derivative control is needed, the derivative-mode constant shall be gradually increased.

(3) Step changes in controller setpoint shall be introduced, and the derivative-mode constant setting adjusted until stable control is achieved.

3.4.1.11 Setting the Controller

After the controller manual-tuning procedure is complete, the controller shall be set at the setpoint as shown.

3.4.2 Space-Temperature-Controlled Perimeter Radiation

Not used.

3.4.3 Unit Heater and Cabinet Unit Heater

The "OFF/AUTO" switch shall be placed in the "OFF" position. Each space-thermostat temperature setting shall be turned up so that it makes contact to turn on the unit-heater fans. The unit-heater fans shall not start. The "OFF/AUTO" switch shall be placed in the "AUTO" position. The unit-heater fans shall start. Each space-thermostat temperature setting shall be turned down, and the unit-heater fans shall stop. The thermostats shall be set at their temperature setpoints shown. The results of testing one of each type unit shall be logged.

3.4.4 Gas-Fired Infrared-Heater

Each space-thermostat temperature setting shall be turned up so that it makes contact to energize the infrared heater; the heater shall turn on. Each space-thermostat temperature shall be turned down and the infrared heater shall turn off. The thermostats shall be set at their temperature setpoints as shown. The results of testing one of each type unit shall be

logged.

3.4.5 All-Air Small Packaged Unitary

Schedules shall be manually entered for day-temperature and night-temperature setpoints as shown. The fan "ON-OFF-AUTO" switch shall be set to "ON". The time shall be manually entered as "DAY". The heating mode shall be selected and cooling shall be off. The temperature setpoint shall be raised and heating shall start. The cooling mode shall be selected and heat shall be off. The temperature setpoint shall be lowered and cooling shall start.

The time shall be manually entered as "NIGHT". The foregoing procedures shall be repeated. The fans shall start and stop automatically with the starting and stopping of heating and cooling. When the system is verified as operational, the correct "DAY" and "NIGHT" temperature settings shall be restored and the correct time restored. Power to the controller shall be shut off and it shall be verified that the clock keeps time. The results of testing shall be logged. The controller shall be set into either the "AUTO" or "OFF" mode as directed by the Contracting Officer.

3.4.6 Fan-Coil-Unit

Not used.

3.4.7 Central Plant Hydronic-Heating with Steam/Hot Water Converter

Not used.

3.4.8 Single Building Hydronic-Heating with Hot Water Boiler

Not used.

3.4.9 Central Plant High-Temperature Hot-Water Hydronic-Heating

Not used.

3.4.10 Central Plant Dual-Temperature Hydronic

Not used.

3.4.11 Central Plant High-Temperature Hot-Water Dual-Temperature Hydronic

Not used.

3.4.12 Single Building Dual-Temperature Hydronic

Not used.

3.4.13 Wall Heating and Ventilating Units

Not used.

3.4.14 Multizone Control System with Return Fan

Not used.

3.4.15 Dual-Duct Multizone Control System with Return Fan

Not used.

3.4.16 Bypass Multizone with Return Fan

Not used.

3.4.17 Variable Air Volume, Without Return Fan

Not used.

3.4.18 Variable Air Volume Control

Not used.

3.4.19 Single-Zone with Hydronic Heating and Cooling Coils; No Return Fan

Not used.

3.4.20 Single-Zone with Dual-Temperature Coil; No Return Fan

Not used.

3.4.21 Single-Zone with Humidification; No Return Fan

Not used.

3.4.22 Single-Zone with Hydronic-Heating, Direct-Expansion Cooling

Not used.

3.5 BALANCING, COMMISSIONING, AND TESTING

3.5.1 Coordination with HVAC System Balancing

Commissioning of the control system, except for tuning of controllers, shall be performed prior to or simultaneous with HVAC system balancing. The Contractor shall tune the HVAC control system after all air-system balancing has been completed, damper positions set and a report has been issued.

3.5.2 Control System Calibration, Adjustments, and Commissioning

Control system commissioning shall be performed for each HVAC system, using test plans and procedures previously approved by the Government. The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform commissioning and testing of the HVAC control system. All instrumentation and controls shall be calibrated and the specified accuracy shall be verified using test equipment with calibration traceable to NIST standards. Wiring shall be tested for continuity and for ground, open, and short circuits. Tubing systems shall be tested for leaks. Mechanical control devices shall be adjusted to operate as specified. HVAC control panels shall be pretested off-site as a functioning assembly ready for field connections, calibration, adjustment, and commissioning of the operational HVAC control system. Written notification of any planned commissioning or testing of the HVAC Control systems shall be given to the Government at least 14 calendar days in advance.

3.5.3 Performance Verification Test

The Contractor shall demonstrate compliance of the HVAC control system with the contract documents. Using test plans and procedures previously approved by the Government, the Contractor shall demonstrate all physical and functional requirements of the system. The performance verification test shall show, step-by-step, the actions and results demonstrating that the control systems perform in accordance with the sequences of operation. The performance verification test shall not be started until after receipt by the Contractor of written permission by the Government, based on Government approval of the commissioning report and completion of balancing. The tests shall not be conducted during scheduled seasonal off-periods of base heating and cooling systems.

3.5.4 Posted and Panel Instructions

Posted and panel instructions, showing the final installed conditions, shall be provided for each system. The posted instructions shall consist of half-size laminated drawings and shall include the control system schematic, equipment schedule, ladder diagram, sequence of operation, panel arrangement drawings, wiring diagram, and valve and damper schedules. The posted instructions shall be permanently affixed, by mechanical means, to a wall near the control panel. Panel instructions shall consist of laminated letter-size sheets and shall include a routine maintenance checklist and controller configuration check sheets with final configuration record for each controller. Panel instructions and one copy of the operation and maintenance manuals, previously described herein, shall be placed inside each control panel.

3.6 TRAINING

3.6.1 Training-Course Requirements

A training course shall be conducted for 4 operating staff members designated by the Contracting Officer. The training period, for a total of 8 hours of normal working time, shall be conducted within 30 days after successful completion of the performance verification test. The training course shall be conducted at the project site. Audiovisual equipment and 7 sets of all other training materials and supplies shall be provided. A training day is defined as 8 hours of classroom instruction, including two 15-minute breaks and excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility.

3.6.2 Training-Course Content

For guidance in planning the required instruction, the Contractor shall assume that attendees will have a high school education or equivalent, and are familiar with HVAC systems. The training course shall cover all of the material contained in the operating and maintenance instructions, the layout and location of each HVAC control panel, the layout of one of each type of unitary equipment and the locations of each, the location of each system-control device external to the panels, preventive maintenance, troubleshooting, diagnostics, calibration, adjustment, commissioning, tuning, and repair procedures. Typical systems and similar systems may be treated as a group, with instruction on the physical layout of one such system. The results of the performance verification test and the calibration, adjustment and commissioning report shall be presented as benchmarks of HVAC control-system performance by which to measure operation and maintenance effectiveness.

-- End of Section --

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DIVISION 15 - MECHANICAL

SECTION 15990

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SECTION 15990

TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ASSOCIATED AIR BALANCE COUNCIL (AABC)

AABC MN-1	(1989) National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB Procedural Stds	(1993) Procedural Standards for Testing Adjusting Balancing of Environmental Systems

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

TAB Schematic Drawings and Report Forms; GA.

Three copies of the TAB Schematic Drawings and Report Forms, no later than 21 days prior to the start of TAB field measurements.

SD-03 Product Data

TAB Related HVAC Submittals; GA.

A list of the TAB Related HVAC Submittals, no later than 7 days after the approval of the TAB Specialist.

TAB Procedures; GA.

Proposed procedures for TAB, submitted with the TAB Schematic Drawings and Report Forms.

Calibration; GA.

List of each instrument to be used during TAB, stating calibration requirements required or recommended by both the TAB Standard and the instrument manufacturer and the actual calibration history of the instrument, submitted with the TAB

Procedures. The calibration history shall include dates calibrated, the qualifications of the calibration laboratory, and the calibration procedures used.

Systems Readiness Check; GA.

Proposed date and time to begin the Systems Readiness Check, no later than 7 days prior to the start of the Systems Readiness Check.

TAB Execution; GA.

Proposed date and time to begin field measurements, making adjustments, etc., for the TAB Report, submitted with the Systems Readiness Check Report.

TAB Verification; GA.

Proposed date and time to begin the TAB Verification, submitted with the TAB Report.

SD-06 Test Reports

Design Review Report; GA.

A copy of the Design Review Report, no later than 14 days after approval of the TAB Firm and the TAB Specialist.

Systems Readiness Check; GA.

A copy of completed checklists for each system, each signed by the TAB Specialist, at least 7 days prior to the start of TAB Execution. All items in the Systems Readiness Check Report shall be signed by the TAB Specialist and shall bear the seal of the Professional Society or National Association used as the TAB Standard.

TAB Report; GA.

Three copies of the completed TAB Reports, no later that 7 days after the execution of TAB. All items in the TAB Report shall be signed by the TAB Specialist and shall bear the seal of the Professional Society or National Association used as the TAB Standard.

TAB Verification Report; GA.

Three copies of the completed TAB Verification Report, no later that 7 days after the execution of TAB Verification. All items in the TAB Verification Report shall be signed by the TAB Specialist and shall bear the seal of the Professional Society or National Association used as the TAB Standard.

SD-07 Certificates

TAB Firm; GA.

Certification of the proposed TAB Firm's qualifications by either AABC or NEBB to perform the duties specified herein and in

other related Sections, with the proposal. Documentation shall include the date Certification was initially granted and the date current Certification expires. Any lapses in Certification of the proposed TAB Firm or disciplinary action taken by AABC or NEBB against the proposed TAB Firm shall be described in detail.

TAB Specialist; GA.

Certification of the proposed TAB Specialist's qualifications by either AABC or NEBB to perform the duties specified herein and in other related Sections, with the proposal. Documentation shall include the date Certification was initially granted and the date current Certification expires. Any lapses in Certification of the proposed TAB Specialist or disciplinary action taken by AABC or NEBB against the proposed TAB Specialist shall be described in detail.

1.3 SIMILAR TERMS

In some instances, terminology differs between the Contract and the TAB Standard primarily because the intent of this Section is to use the industry standards specified, along with additional requirements listed herein to produce optimal results. The following table of similar terms is provided for clarification only. Contract requirements take precedent over the corresponding AABC or NEBB requirements where differences exist.

SIMILAR TERMS

Contract Term	AABC Term	NEBB Term
TAB Standard	National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems	Procedural Standards for Testing Adjusting Balancing of Environmental Systems.
TAB Specialist	TAB Engineer	TAB Supervisor
Systems Readiness Check	Construction Phase Inspection	Field Readiness Check & Preliminary Field Procedures.

1.4 TAB STANDARD

TAB shall be performed in accordance with the requirements of the standard under which the TAB Firm's qualifications are approved, i.e., AABC MN-1 or NEBB Procedural Stds, unless otherwise specified herein. All recommendations and suggested practices contained in the TAB Standard shall be considered mandatory. The provisions of the TAB Standard, including checklists, report forms, etc., shall, as nearly as practical, be used to satisfy the Contract requirements. The TAB Standard shall be used for all aspects of TAB, including qualifications for the TAB Firm and Specialist and calibration of TAB instruments. Where the instrument manufacturer calibration recommendations are more stringent than those listed in the TAB Standard, the manufacturer's recommendations shall be adhered to. All quality assurance provisions of the TAB Standard such as performance guarantees shall be part of this contract. For systems or system components not covered in the TAB Standard, TAB procedures shall be

developed by the TAB Specialist. Where new procedures, requirements, etc., applicable to the Contract requirements have been published or adopted by the body responsible for the TAB Standard used (AABC or NEBB), the requirements and recommendations contained in these procedures and requirements shall be considered mandatory.

1.5 QUALIFICATIONS

1.5.1 TAB Firm

The TAB Firm shall be either a member of AABC or certified by the NEBB and certified in all categories and functions where measurements or performance are specified on the plans and specifications, outlining TAB requirements of environmental systems. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the firm loses subject certification during this period, the Contractor shall immediately notify the Contracting Officer and submit another TAB Firm for approval. Any firm that has been the subject of disciplinary action by either the AABC or the NEBB within the five years preceding Contract Award shall not be eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections to be performed by the TAB Firm shall be considered invalid if the TAB Firm loses its certification prior to Contract completion and must be performed by an approved successor. These TAB services are to assist the prime Contractor in performing the quality oversight for which it is responsible. The TAB Firm shall be a subcontractor of the prime Contractor, and shall report to and be paid by the prime Contractor.

1.5.2 TAB Specialist

The TAB Specialist shall be either a member of AABC or an experienced technician of the Firm certified by the NEBB. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the Specialist loses subject certification during this period, the Contractor shall immediately notify the Contracting Officer and submit another TAB Specialist for approval. Any individual that has been the subject of disciplinary action by either the AABC or the NEBB within the five years preceding Contract Award shall not be eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections performed by the TAB Specialist shall be considered invalid if the TAB Specialist loses its certification prior to Contract completion and must be performed by the approved successor.

1.6 TAB SPECIALIST RESPONSIBILITIES

All TAB work specified herein and in related sections shall be performed under the direct guidance of the TAB Specialist. The TAB Specialist shall participate in the commissioning process.

PART 2 PRODUCTS

2.1 MATERIALS

Construction/fabrication and other materials brought onto the job site shall contain no hazardous materials. Asbestos, lead, cadmium, mercury, PCBs and other hazardous material shall <u>not</u> be used.

Suspect/Counterfeit Items (S/CIs) shall not be used.

Provide Material Safety Data Sheets (MSDSs) as required.

PART 3 EXECUTION

3.1 DESIGN REVIEW

The TAB Specialist shall review the Contract Plans and Specifications and advise the Contracting Officer of any deficiencies that would prevent the HVAC systems from effectively operating in accordance with the sequence of operation specified or prevent the effective and accurate TAB of the system. The TAB Specialist shall provide a Design Review Report individually listing each deficiency and the corresponding proposed corrective action necessary for proper system operation.

3.2 TAB RELATED HVAC SUBMITTALS

The TAB Specialist shall prepare a list of the submittals from the Contract Submittal Register that relate to the successful accomplishment of all HVAC TAB. The submittals identified on this list shall be accompanied by a letter of approval signed and dated by the TAB Specialist when submitted to the Government. The TAB Specialist shall also ensure that the location and details of ports, terminals, connections, etc., necessary to perform TAB are identified on the submittals.

3.3 TAB SCHEMATIC DRAWINGS AND REPORT FORMS

A schematic drawing showing each system component, including balancing devices, shall be provided for each system. Each drawing shall be accompanied by a copy of all report forms required by the TAB Standard used for that system. Where applicable, the acceptable range of operation or appropriate setting for each component shall be included on the forms or as an attachment to the forms. The schematic drawings shall identify all testing points and cross reference these points to the report forms and procedures.

3.4 DUCTWORK LEAK TESTING

Not used.

3.5 TESTING, ADJUSTING, AND BALANCING

3.5.1 TAB Procedures

Step by step procedures for each measurement required during TAB Execution shall be provided. The procedures shall be oriented such that there is a separate section for each system. The procedures shall include measures to demonstrate each system performs as specified in all operating modes, and interactions with other components (such as exhaust fans, kitchen hoods, fume hoods, relief vents, etc.) and systems, and with all seasonal operating differences, diversity, simulated loads, and pressure relationships are acceptable.

3.5.2 Systems Readiness Check

The TAB Specialist shall inspect each system to ensure that it is complete, including installation and operation of controls, and that all aspects of the facility that have any bearing on the HVAC systems, including installation of ceilings, walls, windows, doors, and partitions, are

complete to the extent that TAB results will not be affected by incomplete details or work remaining. The TAB Specialist shall also verify that all items such as piping ports, terminals, connections, etc., necessary to perform TAB shall be complete during the Systems Readiness Check.

3.5.3 Preparation of TAB Report

Preparation of the TAB Report shall begin only after the Systems Readiness Report has been approved. The Report shall be oriented so that there is a separate section for each system. The Report shall include a copy of the appropriate approved Schematic Drawings and TAB Related Submittals, such as pump curves, fan curves, etc., along with completed report forms for each system. The operating points measured during successful TAB Execution and the theoretical operating points listed in the approved submittals shall be marked on the performance curves and tables. Where possible, adjustments shall be made using an "industry standard" technique which would result in the greatest energy savings, such as adjusting the speed of a fan instead of throttling the flow. Any deficiencies outside of the realm of normal adjustments and balancing during TAB Execution shall be noted along with a description of corrective action performed to bring the measurement into the specified range. If, for any reason, the TAB Specialist determines during TAB Execution that any Contract requirement cannot be met, the TAB Specialist shall immediately provide a written description of the deficiency and the corresponding proposed corrective action necessary for proper system operation to the Contracting Officer.

3.5.4 TAB Verification

The TAB Specialist shall recheck ten percent of the measurements listed in the Tab Report and prepare a TAB Verification Report. The measurements selected for verification and the individuals that witness the verification will be selected by the Contracting Officer's Representative (COR). The measurements will be recorded in the same manner as required for the TAB Report. All measurements that fall outside the acceptable operating range specified shall be accompanied by an explanation as to why the measurement does not correlate with that listed in the TAB Report and a description of corrective action performed to bring the measurement into the specified range. The TAB Specialist shall update the original TAB report to reflect any changes or differences noted in the TAB verification report and submit the updated TAB report. If over 20 percent of the measurements selected by the COR for verification fall outside of the acceptable operating range specified, the COR will select an additional ten percent for verification. If over 20 percent of the total tested (including both test groups) fall outside of the acceptable range, the TAB Report shall be considered invalid and all contract TAB work shall be repeated beginning with the Systems Readiness Check.

3.5.5 Marking of Setting

Following approval of TAB Verification Report, the setting of all HVAC adjustment devices including valves, splitters, and dampers shall be permanently marked by the TAB Specialist so that adjustment can be restored if disturbed at any time.

3.5.6 Identification of Test Ports

Not used.

-- End of Section --

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SECTION 16050

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SECTION 16050

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C2	(1997) National Electrical Safety Code
ANSI C57.12.28	(1988; Correction 1988) Switchgear and Transformers - Pad-Mounted Equipment - Enclosure Integrity

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 709	(1992; R 1997) Laminated Thermosetting Material

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1910.147	Control of Hazardous Energy (Lock Out/Tag Out)

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC. (IEEE)

IEEE 100	(1996) Dictionary of Electrical and Electronics Terms

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6	(1993) Industrial Control and Systems Enclosures
NEMA MG 1	(1998; Errata 1999) Motors and Generators
NEMA MG 10	(1994) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors
NEMA MG 11	(1977; R 1992) Energy Management Guide of Selection and Use of Single-Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2002) National Electrical Code

1.2 RELATED REQUIREMENTS

This section applies to certain sections of Division 13, "Special

Construction" and Division 15, "Mechanical". This section applies to all sections of Division 16, "Electrical," of this project specification unless specified otherwise in the individual sections.

1.3 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE 100.

b. The technical sections referred to herein are those specification sections that describe products, installation procedures, and equipment operations and that refer to this section for detailed description of submittal types.

c. The technical paragraphs referred to herein are those paragraphs in PART 2 - PRODUCTS and PART 3 - EXECUTION of the technical sections that describe products, systems, installation procedures, equipment, and test methods.

1.4 ELECTRICAL CHARACTERISTICS

Electrical characteristics for this project shall be 13.2 kV, three phase, three wire, 60 Hz utility power to the step down transformer, and 480Y/277 volts, three phase, four wire power distribution inside the building. Final connections to the power distribution system at the existing manhole shall be made by the Contractor as directed by the Contracting Officer.

1.5 SUBMITTALS

Submittals required in the sections which refer to this section shall conform to the requirements of Section 01330, "Submittal Procedures" and to the following additional requirements. Submittals shall include the manufacturer's name, trade name, place of manufacture, catalog model or number, nameplate data, size, layout dimensions, capacity, project specification and technical paragraph reference. Submittals shall also include applicable federal, military, industry, and technical society publication references, and years of satisfactory service, and other information necessary to establish contract compliance of each item to be provided. Photographs of existing installations are unacceptable and will be returned without approval.

1.5.1 Manufacturer's Catalog Data

Submittals for each manufactured item shall be current manufacturer's descriptive literature of cataloged products, equipment drawings, diagrams, performance and characteristic curves, and catalog cuts. Handwritten and typed modifications and other notations not part of the manufacturer's preprinted data will result in the rejection of the submittal. Should manufacturer's data require supplemental information for clarification, the supplemental information shall be submitted as specified for certificates of compliance.

1.5.2 Drawings

Submit drawings a minimum of 14 by 20 inches in size using a minimum scale of 1/8 inch per foot. Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown

to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.

1.5.3 Instructions

Where installation procedures or part of the installation procedures are required to be in accordance with manufacturer's instructions, submit printed copies of those instructions prior to installation. Installation of the item shall not proceed until manufacturer's instructions are received. Failure to submit manufacturer's instructions shall be cause for rejection of the equipment or material.

1.5.4 Certificates

Submit manufacturer's certifications as required for products, materials, finishes, and equipment as specified in the technical sections. Certificates from material suppliers are not acceptable. Preprinted certifications and copies of previously submitted documents will not be acceptable. The manufacturer's certifications shall name the appropriate products, equipment, or materials and the publication specified as controlling the quality of that item. Certification shall not contain statements to imply that the item does not meet requirements specified, such as "as good as"; "achieve the same end use and results as materials formulated in accordance with the referenced publications"; or "equal or exceed the service and performance of the specified material." Certifications shall simply state that the item conforms to the requirements specified. Certificates shall be printed on the manufacturer's letterhead and shall be signed by the manufacturer's official authorized to sign certificates of compliance.

1.5.4.1 Reference Standard Compliance

Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations such as American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturers Association (NEMA), Underwriters Laboratories Inc. (UL), and Association of Edison Illuminating Companies (AEIC), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance.

1.5.4.2 Independent Testing Organization Certificate

In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Contracting Officer. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

1.5.5 Operation and Maintenance Manuals

Comply with the requirements of the technical sections.

1.5.5.1 Operating Instructions

Submit text of posted operating instructions for each system and principal item of equipment as specified in the technical sections.

1.6 QUALITY ASSURANCE

1.6.1 Material and Equipment Qualifications

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in the technical section.

1.6.2 Regulatory Requirements

Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70.

1.6.3 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.6.4 Service Support

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.6.5 Manufacturer's Nameplate

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.6.6 Modification of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer.

1.6.7 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.7 POSTED OPERATING INSTRUCTIONS

Provide for each system and principal item of equipment as specified in the

technical sections for use by operation and maintenance personnel. The operating instructions shall include the following:

a. Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.

b. Start up, proper adjustment, operating, lubrication, and shutdown procedures.

c. Safety precautions.

d. The procedure in the event of equipment failure.

e. Other items of instruction as recommended by the manufacturer of each system or item of equipment.

Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. For operating instructions exposed to the weather, provide weather-resistant materials or weatherproof enclosures. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

1.8 NAMEPLATES

ASTM D 709. Provide laminated plastic nameplates for each panelboard, equipment enclosure, relay, switch, and device; as specified in the technical sections or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inch thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one by 2.5 inches. Lettering shall be a minimum of 0.25 inch high normal block style.

1.9 WARNING SIGNS

Provide warning signs for the enclosures of electrical equipment including substations, pad-mounted transformers, pad-mounted switches, generators, and switchgear having a nominal rating exceeding 600 volts.

a. When the enclosure integrity of such equipment is specified to be in accordance with ANSI C57.12.28, such as for pad-mounted transformers and pad-mounted SF6 switches, provide a self-adhesive warning signs on the outside of the high voltage compartment door(s). Sign shall be a decal and shall have nominal dimensions of 7 by 10 inches with the legend "DANGER HIGH VOLTAGE" printed in two lines of nominal 2 inch high letters. The word "DANGER" shall be in white letters on a red background and the words "HIGH VOLTAGE" shall be in black letters on a white background. Decal shall be Panduit No. PPSO710D72 or approved equal.

b. When such equipment is guarded by a fence, mount signs on the fence. Provide metal signs having nominal dimensions of 14 by 10 inches with the legend "DANGER HIGH VOLTAGE KEEP OUT" printed in three lines of nominal 3 inch high white letters on a red and black field.

1.10 CABLE TAGS IN MANHOLES, HANDHOLES, AND VAULTS

Provide tags for each cable or wire located in manholes, handholes, and vaults. Tag legend shall be as indicated. The tags shall be polyethylene. Do not provide handwritten letters. As an example, a tag could have the following designation: "11.5 NAS 1-8(Phase A)500," denoting that the tagged cable is on the 11.5kV system circuit number NAS 1-8, underground, Phase A, sized at 500 kcmil.

1.10.1 Polyethylene Cable Tags

Provide tags of polyethylene that have an average tensile strength of 3250 pounds per square inch; and that are 0.08 inch thick (minimum), non-corrosive non-conductive; resistive to acids, alkalis, organic solvents, and salt water; and distortion resistant to 170 degrees F. Provide 0.05 inch (minimum) thick black polyethylene tag holder. Provide a one-piece nylon, self-locking tie at each end of the cable tag. Ties shall have a minimum loop tensile strength of 175 pounds. The cable tags shall have black block letters, numbers, and symbols one inch high on a yellow background. Letters, numbers, and symbols shall not fall off or change positions regardless of the cable tags' orientation.

1.11 ELECTRICAL REQUIREMENTS

Electrical installations shall conform to ANSI C2, NFPA 70, and requirements specified herein.

1.11.1 Motors and Equipment

Provide electrical components of mechanical equipment, such as motors, motor starters, control or push-button stations, float or pressure switches, solenoid valves, and other devices functioning to control mechanical equipment, including control wiring and conduit for circuits rated 100 volts or less, to conform with the requirements of the section covering the mechanical equipment. Extended voltage range motors shall not be permitted. The interconnecting power wiring and conduit, control wiring rated 120 volts (nominal) and conduit, the motor control equipment forming a part of motor control centers, and the electrical power circuits shall be provided under Division 16.

Provide motors, controllers, integral disconnects, and contactors with their respective pieces of equipment, except controllers indicated as part of the motor control centers. Extended voltage range motors shall not be permitted. Control voltage for controllers and contactors shall not exceed 120 volts nominal. When motors and equipment furnished are larger than sizes indicated, the cost of additional electrical service and related work shall be included under the section that specified that motor or equipment. Where fuse protection is specifically recommended by the equipment manufacturer, provide fused switches in lieu of non-fused switches indicated.

1.11.2 Wiring and Conduit

Provide internal wiring for components of packaged equipment as an integral part of the equipment. Provide power wiring and conduit for field-installed equipment and motor control equipment forming part of motor control centers, the conduit and wiring connecting such centers, assemblies, or other power sources to equipment under Section 16415, "Electrical Work, Interior." Power wiring and conduit shall conform to Section 16415, "Electrical Work, Interior." Control wiring and conduit

shall be provided under, and conform to the requirements of the section specifying the associated equipment.

1.11.3 New Work

Provide electrical components of mechanical equipment, such as motors, motor starters (except starters/controllers which are indicated as part of a motor control center), control or push-button stations, float or pressure switches, solenoid valves, integral disconnects, and other devices functioning to control mechanical equipment, as well as control wiring and conduit for circuits rated 100 volts or less, to conform with the requirements of the section covering the mechanical equipment. Extended voltage range motors shall not be permitted. The interconnecting power wiring and conduit, control wiring rated 120 volts (nominal) and conduit, the motor control equipment forming a part of motor control centers, and the electrical power circuits shall be provided under Division 16, except internal wiring for components of packaged equipment shall be provided as an integral part of the equipment. When motors and equipment furnished are larger than sizes indicated, provide any required changes to the electrical service as may be necessary and related work as a part of the work for the section specifying that motor or equipment.

1.11.4 Modifications to Existing Systems

Where existing mechanical systems and motor-operated equipment require modifications, provide electrical components under Division 16.

1.11.5 High Efficiency Motors

1.11.5.1 High Efficiency Single-Phase Motors

Unless otherwise specified, single-phase fractional-horsepower alternating-current motors shall be high efficiency types corresponding to the applications listed in NEMA MG 11.

1.11.5.2 High Efficiency Polyphase Motors

Unless otherwise specified, polyphase motors shall be selected based on high efficiency characteristics relative to the applications as listed in NEMA MG 10. Additionally, polyphase squirrel-cage medium induction motors with continuous ratings shall meet or exceed energy efficient ratings in accordance with Table 12-10 of NEMA MG 1.

1.12 INSTRUCTION TO GOVERNMENT PERSONNEL

Where specified in the technical sections, furnish the services of competent instructors to give full instruction to designated Government personnel in the adjustment, operation, and maintenance of the specified systems and equipment, including pertinent safety requirements as required. Instructors shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work. Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be as specified in the individual section.

1.13 LOCKOUT REQUIREMENTS

Provide disconnecting means capable of being locked out for machines and

other equipment to prevent unexpected startup or release of stored energy in accordance with 29 CFR 1910.147. Mechanical isolation of machines and other equipment shall be in accordance with requirements of Division 15, "Mechanical."

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 PAINTING OF EQUIPMENT

3.1.1 Factory Applied

Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA ICS 6 corrosion-resistance test.

3.1.2 Field Applied

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria.

3.2 NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.3 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side, but space the signs a maximum of 30 feet apart.

3.4 CABLE TAG INSTALLATION

Install cable tags in each manhole, handhole, and vault as specified, including each splice. Install cable tags over the fireproofing, if any, and locate the tags so that they are clearly visible without disturbing any cabling or wiring in the manholes, handholes, and vaults.

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SECTION 16261

VARIABLE FREQUENCY DRIVE SYSTEMS UNDER 600 VOLTS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

CODE OF FEDERAL REGULATIONS (CFR)

47 CFR 15	Radio Frequency Devices

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC. (IEEE)

IEEE 519	(1992) Harmonic Control in Electrical Power Systems
IEEE C62.41	(1991) Surge Voltages in Low-Voltage AC Power Circuits

MILITARY STANDARDS (MIL-STD)

MIL-STD-461	(Rev. D) Control of Electromagnetic Interference Emissions and Susceptibility

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1991) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 3.1	(1990) Construction and Guide for Selection, Installation and Operation of Adjustable-Speed Drive Systems
NEMA ICS 6	(1993) Industrial Control and Systems Enclosures
NEMA ICS 7	(1993) Industrial Control and Systems Adjustable-Speed Drives

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2002) National Electrical Code

UNDERWRITERS LABORATORIES INC. (UL)

UL 489	(1996; R 1998) Molded-Case Circuit Breakers and Circuit-Breaker Enclosures
UL 508C	(1996) Power Conversion Equipment

1.2 SYSTEM DESCRIPTION

1.2.1 Performance Requirements

1.2.1.1 Electromagnetic Interference Suppression

Computing devices, as defined by 47 CFR 15, MIL-STD-461 rules and regulations, shall be certified to comply with the requirements for class A computing devices and labeled as set forth in part 15.

1.2.1.2 Electromechanical and Electrical Components

Electrical and electromechanical components of the Variable Frequency Drive (VFD) shall not cause electromagnetic interference to adjacent electrical or electromechanical equipment while in operation.

1.2.2 Electrical Requirements

1.2.2.1 Power Line Surge Protection

IEEE C62.41, IEEE 519 Control panel shall have surge protection, included within the panel to protect the unit from damaging transient voltage surges. Surge arrestor shall be mounted near the incoming power source and properly wired to all three phases and ground. Fuses shall not be used for surge protection.

1.2.2.2 Sensor and Control Wiring Surge Protection

I/O functions as specified shall be protected against surges induced on control and sensor wiring installed outdoors and as shown. The inputs and outputs shall be tested in both normal mode and common mode using the following two waveforms:

a. A 10 microsecond by 1000 microsecond waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.

b. An 8 microsecond by 20 microsecond waveform with a peak voltage of 1000 volts and a peak current of 500 amperes.

1.3 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

SD-02 Shop Drawings

Schematic diagrams; GA

Interconnecting diagrams; GA

Installation drawings; GA

Submit drawings for government approval prior to equipment construction or integration. Modifications to original drawings made during installation shall be immediately recorded for inclusion into the as-built drawings.

SD-03 Product Data

Variable frequency drives; GA

Include data indicating compatibility with motors being driven.

SD-08 Manufacturer's Instructions

Installation instructions; GA

SD-09 Manufacturer's Field Reports

VFD Factory Test Plan; GA

Factory test results; GA

SD-10 Operation and Maintenance Data

Variable frequency drives; GA

Provide service and maintenance information including preventive maintenance, assembly, and disassembly procedures. Include electrical drawings from electrical general sections. Submit additional information necessary to provide complete operation, repair, and maintenance information, detailed to the smallest replaceable unit. Include copies of as-built submittals. Provide routine preventative maintenance instructions, and equipment required. Provide instructions on how to modify program settings, and modify the control program. Provide instructions on drive adjustment, trouble-shooting, and configuration. Provide instructions on process tuning and system calibration.

1.4 QUALITY ASSURANCE

1.4.1 Schematic Diagrams

Show circuits and device elements for each replaceable module. Schematic diagrams of printed circuit boards are permitted to group functional assemblies as devices, provided that sufficient information is provided for government maintenance personnel to verify proper operation of the functional assemblies.

1.4.2 Interconnecting Diagrams

Show interconnections between equipment assemblies, and external interfaces, including power and signal conductors. Include for enclosures and external devices.

1.4.3 Installation Drawings

Show floor plan of each site, with V.F.D.'s and motors indicated. Indicate ventilation requirements, adequate clearances, and cable routes.

1.4.4 Installation instructions

Provide installation instructions issued by the manufacturer of the equipment, including notes and recommendations, prior to shipment to the site. Provide operation instructions prior to acceptance testing.

1.5 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, or

other contaminants.

1.6 WARRANTY

The complete system shall be warranted by the manufacturer for a period of one year, or the contracted period of any extended warrantee agreed upon by the Contractor and the Government, after successful completion of the acceptance test. Any component failing to perform its function as specified and documented shall be repaired or replaced by the Contractor at no additional cost to the Government. Items repaired or replaced shall be warranted for an additional period of at least one year from the date that it becomes functional again, as specified in the FAR CLAUSE 52.246-21.

1.7 MAINTENANCE

1.7.1 Spare Parts

Manufacturers provide spare parts in accordance with recommended spare parts list.

1.7.2 Maintenance Support

During the warranty period, the Contractor shall provide on-site, on-call maintenance services by Contractor's personnel on the following basis: The service shall be on a per-call basis with 36 hour response. Contractor shall support the maintenance of all hardware and software of the system. Various personnel of different expertise shall be sent on-site depending on the nature of the maintenance service required. Costs shall include travel, local transportation, living expenses, and labor rates of the service personnel while responding to the service request. The provisions of this Section are not in lieu of, nor relieve the Contractor of, warranty responsibilities covered in this specification. Should the result of the service request be the uncovering of a system defect covered under the warranty provisions, all costs for the call, including the labor necessary to identify the defect, shall be borne by the Contractor.

PART 2 PRODUCTS

2.1 VARIABLE FREQUENCY DRIVES (VFD)

Provide frequency drive to control the speed of induction motor(s). The VFD shall include the following minimum functions, features and ratings.

a. Input circuit breaker per UL 489 with a minimum of 10,000 amps symmetrical interrupting capacity and door interlocked external operator.

b. A converter stage per UL 508C shall change fixed voltage, fixed frequency, ac line power to a fixed dc voltage. The converter shall utilize a full wave bridge design incorporating diode rectifiers. Silicon Controlled Rectifiers (SCR) are not acceptable. The converter shall be insensitive to three phase rotation of the ac line and shall not cause displacement power factor of less than .95 lagging under any speed and load condition.

c. An inverter stage shall change fixed dc voltage to variable frequency, variable voltage, ac for application to a standard NEMA design B squirrel cage motor. The inverter shall be switched in a manner to produce a sine coded pulse width modulated (PWM) output

waveform.

d. The VFD shall be capable of supplying 120 percent of rated full load current for one minute at maximum ambient temperature.

e. The VFD shall be designed to operate from a 460 volt, + or - 10 percent, three phase, 60 Hz supply, and control motors with a corresponding voltage rating.

f. Acceleration and deceleration time shall be independently adjustable from one second to 60 seconds.

g. Adjustable full-time current limiting shall limit the current to a preset value which shall not exceed 120 percent of the controller rated current. The current limiting action shall maintain the V/Hz ratio constant so that variable torque can be maintained. Short time starting override shall allow starting current to reach 175 percent of controller rated current to maximum starting torque.

h. The controllers shall be capable of producing an output frequency over the range of 3 Hz to 60 Hz (20 to one speed range), without low speed cogging. Over frequency protection shall be included such that a failure in the controller electronic circuitry shall not cause frequency to exceed 110 percent of the maximum controller output frequency selected.

i. Minimum and maximum output frequency shall be adjustable over the following ranges: 1) Minimum frequency 3 Hz to 50 percent of maximum selected frequency; 2) Maximum frequency 40 Hz to 60 Hz.

j. The controller efficiency at any speed shall not be less than 96 percent.

k. The controllers shall be capable of being restarted into a motor coasting in the forward direction without tripping.

l. Protection of power semiconductor components shall be accomplished without the use of fast acting semiconductor output fuses. Subjecting the controllers to any of the following conditions shall not result in component failure or the need for fuse replacement:

1. Short circuit at controller output

2. Ground fault at controller output

3. Open circuit at controller output

4. Input undervoltage

5. Input overvoltage

6. Loss of input phase

7. AC line switching transients

8. Instantaneous overload

9. Sustained overload exceeding 115 percent of controller rated

current

10. Over temperature

11. Phase reversal

m. Solid state motor overload protection shall be included such that current exceeding an adjustable threshold shall activate a 60 second timing circuit. Should current remain above the threshold continuously for the timing period, the controller will automatically shut down.

n. A slip compensation circuit shall be included which will sense changing motor load conditions and adjust output frequency to provide speed regulation of NEMA B motors to within + / - 0.5 percent of maximum speed without the necessity of a tachometer generator.

o. The VFD shall be factory set for manual restart after the first protective circuit trip for malfunction (overcurrent,undervoltage, overvoltage or overtemperature) or an interruption of power. The VFD shall be capable of being set for automatic restart after a selected time delay. If the drive faults again within a specified time period (adjustable 0-60 seconds), a manual restart will be required.

p. The VFD shall include external fault reset capability. All the necessary logic to accept an external fault reset contact shall be included.

q. Provide critical speed lockout circuitry to prevent operating at frequencies with critical harmonics that cause resonant vibrations. The VFD shall have a minimum of three user selectable bandwidths.

r. Provide the following operator control and monitoring devices mounted on the front panel of the VFD:

1. Manual speed potentiometer.

2. Hand-Off-Auto (HOA) switch.

3. Power on light.

4. Drive run power light.

5. Local display.

s. Provide the following system interfaces:

1. Remote start-stop input signal (dry contact) when VFD control system is in Auto mode.

2. Remote 4-20 mAdc isolated signal for speed control when VFD control system is in auto mode.

3. One set of form C dry contact output for VFD fault indication.

4. One set of form C dry contact output for VFD run indication

5. 4-20 mAdc isolated loop powered signal output for remote speed indication.

2.2 ENCLOSURES

Provide equipment enclosures conforming to NEMA 250, NEMA ICS 7, NEMA ICS 6.

2.3 WIRES AND CABLES

All wires and cables shall conform to NEMA 250, NEMA ICS 7, NFPA 70.

2.4 NAMEPLATES

Nameplates external to NEMA enclosures and nameplates internal to enclosures shall be manufacturer's standard, with the exception that they must be permanent.

2.5 SOURCE QUALITY CONTROL

2.5.1 VFD Factory Test Plan

To ensure quality, each VFD shall be subject to a series of in-plant quality control inspections before approval for shipment from the manufacturer's facilities.

PART 3 EXECUTION

3.1 INSTALLATION

Per NEMA ICS 3.1, install equipment in accordance with the approved manufacturer's printed installation drawings, instructions, wiring diagrams, and as indicated on project drawings and the approved shop drawings.

3.2 FIELD QUALITY CONTROL

Specified products shall be tested as a system for conformance to specification requirements prior to scheduling the acceptance tests. Contractor shall conduct performance verification tests in the presence of Government representative, observing and documenting complete compliance of the system to the specifications. Contractor shall submit a signed copy of the test results, certifying proper system operation before scheduling tests.

3.2.1 Performance Verification Tests

"Performance Verification Test" plan shall provide the step by step procedure required to establish formal verification of the performance of the VFD. Compliance with the specification requirements shall be verified by inspections, review of critical data, demonstrations, and tests. The Government reserves the right to witness all tests, review data, and request other such additional inspections and repeat tests as necessary to ensure that the system and provided services conform to the stated requirements. The Contractor shall inform the Government 14 calendar days prior to the date the test is to be conducted.

3.2.2 Endurance Test

Immediately upon completion of the performance verification test, the endurance test shall commence. The system shall be operated at varying rates for not less than 192 consecutive hours, at an average effectiveness level of .9998, to demonstrate proper functioning of the complete PCS. Continue the test on a day-to-day basis until performance standard is met. During the endurance test, the Contractor shall not be allowed in the building. The system shall respond as designed.

-- End of Section --

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SECTION 16415

ELECTRICAL WORK, INTERIOR

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C37.16	(1997) Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors - Preferred Ratings, Related Requirements, and Application Recommendations
ANSI C39.1	(1981; R 1992) Requirements for Electrical Analog Indicating Instruments
ANSI C78.1	(1991; C78.1a; R 1996) Fluorescent Lamps - Rapid-Start Types - Dimensional and Electrical Characteristics
ANSI C78.20	(1995) Electric Lamps - Characteristics of Incandescent Lamps A, G, PS, and Similar Shapes with E26 Medium Screw Bases
ANSI C78.21	(1995) Physical and Electrical Characteristics - Incandescent Lamps - PAR and R Shapes
ANSI C78.1350	(1990) 400-Watt, 100-Volt, S51 Single-Ended High-Pressure Sodium Lamps
ANSI C78.1351	(1989) 250-Watt, 100-Volt S50 Single-Ended High-Pressure Sodium Lamps
ANSI C78.1352	(1990) 1000-Watt, 250-Volt, S52 Single-Ended High-Pressure Sodium Lamps
ANSI C78.1355	(1989) 150-Watt, 55-Volt S55 High-Pressure Sodium Lamps
ANSI C78.1375	(1996) 400-Watt, M59 Single-Ended Metal-Halide lamps
ANSI C78.1376	(1996) 1000-Watt, M47 Single-Ended Metal-Halide Lamps
ANSI C80.5	(1995) Rigid Aluminum Conduit
ANSI C82.1	(1997) Specifications for Fluorescent Lamp

	Ballasts
ANSI C82.4	(1992) Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 1	(1995) Hard-Drawn Copper Wire
ASTM B 8	(1999) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM D 709	(1992; R 1997) Laminated Thermosetting Materials

CODE OF FEDERAL REGULATIONS (CFR)

47 CFR 18	Industrial, Scientific, and Medical Equipment

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.13	(1990; R 1995) Low-Voltage AC Power Circuit Breakers Used in Enclosures
IEEE C57.12.00	(1993) IEEE Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C62.41	(1991; R 1995) Surge Voltages in Low-Voltage AC Power Circuits
IEEE Std 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA AB 1	(1993) Molded Case Circuit Breakers and Molded Case Switches
NEMA BU 1	(1994) Busways
NEMA ICS 1	(1993) Industrial Control and Systems
NEMA ICS 2	(1993) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated Not More Than 2,000 Volts AC or 750 Volts DC
NEMA ICS 3	(1993) Industrial Control and Systems Factory Built Assemblies
NEMA ICS 6	(1993) Industrial Control and Systems Enclosures
NEMA LE 4	(1987) Recessed Luminaires, Ceiling Compatibility

NEMA MG 1	(1993; Rev 1; Rev 2; Rev 3; Rev 4) Motors and Generators
NEMA MG 10	(1994) Energy Management Guide for Selection and Use of Polyphase Motors
NEMA OS 1	(1996) Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports
NEMA OS 2	(1986; Errata Aug 1986; R 1991) Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports
NEMA PB 1	(1995) Panelboards
NEMA SG 3	(1995) Power Switching Equipment
NEMA ST 20	(1992) Dry-Type Transformers for General Applications
NEMA TC 2	(1990) Electrical Polyvinyl Chloride (PVC) Tubing (EPT) and Conduit (EPC-40 and EPC-80)
NEMA WD 1	(1983; R 1989) General Requirements for Wiring Devices
NEMA WD 6	(1988) Wiring Devices - Dimensional Requirements

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2002) National Electrical Code
NFPA 101	(1997; Errata 97-1; TIA 97-1) Life Safety Code

UNDERWRITERS LABORATORIES (UL)

UL 1	(1993; Rev thru Jan 1995) Flexible Metal Conduit
UL 5	(1996) Surface Metal Raceways and Fittings
UL 6	(1997) Rigid Metal Conduit
UL 20	(1995; Rev thru Oct 1998) General-Use Snap Switches
UL 50	(1995; Rev thru Oct 1997) Enclosures for Electrical Equipment
UL 67	(1993; Rev thru Nov 1995) Panelboards
UL 83	(1998) Thermoplastic-Insulated Wires and Cables
UL 98	(1994; R thru Jun 1998) Enclosed and

	Dead-Front Switches
UL 360	(1996; Rev thru Oct 1997) Liquid-Tight Flexible Steel Conduit
UL 467	(1993; Rev thru Aug 1996) Grounding and Bonding Equipment
UL 486A	(1997; Rev thru Dec 1998) Wire Connectors and Soldering Lugs for Use with Copper Conductors
UL 486C	(1997; Rev thru Aug 1998) Splicing Wire Connectors
UL 486E	(1994; Rev thru Feb 1997) Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors
UL 489	(1996; Rev thru Dec 1998) Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
UL 506	(1994; Rev Oct 1997) Specialty Transformers
UL 508	(1999) Industrial Control Equipment
UL 510	(1994; Rev thru Apr 1998) Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape
UL 514A	(1996; Rev Jul 1998) Metallic Outlet Boxes
UL 514B	(1997; Rev Oct 1998) Fittings for Cable and Conduit
UL 514C	(1996; R Sep 1998) Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 651	(1995; Rev thru Oct 1998) Schedule 40 and 80 Rigid PVC Conduit
UL 651A	(1995; Rev thru Apr 1998) Type EB and A Rigid PVC Conduit and HDPE Conduit
UL 674	(1994; Rev thru Oct 1998) Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations
UL 817	(1994; Rev thru Jul 1998) Cord Sets and Power-Supply Cords
UL 844	(1995; Rev thru Aug 1997) Electric Lighting Fixtures for Use in Hazardous (Classified) Locations
UL 845	(1995; Rev Feb 1996) Motor Control Centers
UL 854	(1996; Rev Apr 1998) Service-Entrance

	Cables
UL 857	(1994; Rev thru May 1999) Busways and Associated Fittings
UL 869A	(1998) Reference Standard for Service Equipment
UL 877	(1993; Rev thru May 1997) Circuit Breakers and Circuit-Breaker Enclosures for Use in Hazardous (Classified) Locations
UL 943	(1993; Rev thru May 1998)Ground-Fault Circuit-Interrupters
UL 1004	(1994; Rev thru Dec 1997) Electric Motors
UL 1029	(1994; Rev thru Dec 1997) High-Intensity-Discharge Lamp Ballasts
UL 1242	(1996; Rev Mar 1998) Intermediate Metal Conduit
UL 1449	(1996; Rev thru Oct 1998) Transient Voltage Surge Suppressors
UL 1569	(1995; Rev thru Sep 1998) Metal-Clad Cables
UL 1570	(1995; Rev thru Jun 1997) Fluorescent Lighting Fixtures
UL 1571	(1995; Rev thru Jun 1997) Incandescent Lighting Fixtures
UL 1572	(1995; Rev thru Jun 1997) High Intensity Discharge Lighting Fixtures
UL 1660	(1994; Rev Apr 1998) Liquid-Tight Flexible Nonmetallic Conduit
UL Elec Const Dir	(1998) Electrical Construction Equipment Directory

1.2 GENERAL

1.2.1 Rules

The installation shall conform to the requirements of NFPA 70 and NFPA 101, unless more stringent requirements are indicated or shown.

1.2.2 Coordination

The drawings indicate the extent and the general location and arrangement of equipment, conduit, and wiring. The Contractor shall become familiar with all details of the work and verify all dimensions in the field so that the outlets and equipment shall be properly located and readily accessible. Lighting fixtures, outlets, and other equipment and materials shall be carefully coordinated with mechanical or structural features prior to installation and positioned according to architectural reflected ceiling plans; otherwise, lighting fixtures shall be symmetrically located

according to the room arrangement when uniform illumination is required, or asymmetrically located to suit conditions fixed by design and shown. Raceways, junction and outlet boxes, and lighting fixtures shall not be supported from sheet metal roof decks. If any conflicts occur necessitating departures from the drawings, details of and reasons for departures shall be submitted and approved prior to implementing any change. The Contractor shall coordinate the electrical requirements of the mechanical work and provide all power related circuits, wiring, hardware and structural support, even if not shown on the drawings.

1.2.3 Special Environments

1.2.3.1 Weatherproof Locations

Wiring, fixtures, and equipment in designated locations shall conform to NFPA 70 requirements for installation in damp or wet locations.

1.2.3.2 Ducts, Plenums and Other Air-Handling Spaces

Wiring and equipment in ducts, plenums and other air-handling spaces shall be installed using materials and methods in conformance with NFPA 70 unless more stringent requirements are indicated in this specification or on the contract drawings.

1.2.4 Standard Products

Material and equipment shall be a standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

1.2.5 Nameplates

1.2.5.1 Identification Nameplates

Major items of electrical equipment and major components shall be permanently marked with an identification name to identify the equipment by type or function and specific unit number as indicated. Designation of motors shall coincide with their designation in the motor control center or panel. Unless otherwise specified, identification nameplates shall be made of laminated plastic in accordance with ASTM D 709 with black outer layers and a white core. Edges shall be chamfered. Plates shall be fastened with black-finished round-head drive screws, except motors, or approved nonadhesive metal fasteners. When the nameplate is to be installed on an irregular-shaped object, the Contractor shall devise an approved support suitable for the application and ensure the proper installation of the supports and nameplates. In all instances, the nameplate shall be installed in a conspicuous location. At the option of the Contractor, the equipment manufacturer's standard embossed nameplate material with black paint-filled letters may be furnished in lieu of laminated plastic. The front of each panelboard, motor control center, switchgear, and switchboard shall have a nameplate to indicate the phase letter, corresponding color and arrangement of the phase conductors. The following equipment, as a minimum, shall be provided with identification nameplates:

Minimum 1/4 inch High Letters	Minimum 1/8 inch High Letters
Panelboards	Control Power Transformers

Minimum 1/4 inch High Letters	Minimum 1/8 inch High Letters
Starters	Control Devices
Safety Switches	Instrument Transformers
Motor Control Centers	
Transformers	
Equipment Enclosures	
Switchgear	
Switchboards	
Motors	

Each panel, section, or unit in motor control centers, switchgear or similar assemblies shall be provided with a nameplate in addition to nameplates listed above, which shall be provided for individual compartments in the respective assembly, including nameplates which identify "future," "spare," and "dedicated" or "equipped spaces."

1.2.5.2 Liquid-Filled Transformer Nameplates

Power transformers shall be provided with Nameplate C information in accordance with IEEE C57.12.00. Nameplates shall indicate percent impedance, voltage, kVA, frequency, number of phases, cooling class, insulation class, temperature rise, the number of gallons and composition of liquid-dielectric, and shall be permanently marked with a statement that the transformer dielectric to be supplied is non-polychlorinated biphenyl. The Contractor shall furnish manufacturer's certification for each transformer that the dielectric is non-PCB classified, with less than 2 ppm PCB content in accordance with paragraph LIQUID DIELECTRICS. Certifications shall be related to serial numbers on transformer nameplates. Transformer dielectric exceeding the 2 ppm PCB content or transformers without certification will be considered as PCB insulated and will not be accepted.

1.2.6 As-Built Drawings

Following the project completion or turnover, within 30 days the Contractor shall furnish 2 sets of as-built drawings to the Contracting Officer.

1.2.7 Recessed Light Fixtures (RLF) Option

The Contractor has the option to substitute inch-pound (I-P) RLF to metric RLF.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals not having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Interior Electrical Equipment; GA.

Detail drawings consisting of equipment drawings, illustrations, schedules, instructions, diagrams, and other information necessary to define the installation. Detail drawings shall show the rating of items and systems and how the components of an item and system

are assembled, function together, and how they will be installed on the project. Data and drawings for component parts of an item or system shall be coordinated and submitted as a unit. Data and drawings shall be coordinated and included in a single submission. Multiple submissions for the same equipment or system are not acceptable except where prior approval has been obtained from the Contracting Officer. In such cases, a list of data to be submitted later shall be included with the first submission. Detail drawings shall show physical arrangement, construction details, connections, finishes, materials used in fabrication, provisions for conduit or busway entrance, access requirements for installation and maintenance, physical size, electrical characteristics, foundation and support details, and equipment weight. Drawings shall be drawn to scale and/or dimensioned. Optional items shall be clearly identified as included or excluded. Detail drawings shall as a minimum include:

a. Transformers.

b. Switchgear.

c. Battery system including calculations for the battery and charger.

d. Voltage regulators.

e. Grounding resistors.

f. Motors and rotating machinery.

g. Motor control centers.

h. Busway systems.

i. Single line electrical diagrams including primary, metering, sensing and relaying, control wiring, and control logic.

j. Sway bracing for suspended luminaires.

Structural drawings showing the structural or physical features of major equipment items, components, assemblies, and structures, including foundations or other types of supports for equipment and conductors. These drawings shall include accurately scaled or dimensioned outline and arrangement or layout drawings to show the physical size of equipment and components and the relative arrangement and physical connection of related components. Weights of equipment, components and assemblies shall be provided when required to verify the adequacy of design and proposed construction of foundations or other types of supports. Dynamic forces shall be stated for switching devices when such forces must be considered in the design of support structures. The appropriate detail drawings shall show the provisions for leveling, anchoring, and connecting all items during installation, and shall include any recommendations made by the manufacturer.

Electrical drawings including single-line and three-line diagrams, and schematics or elementary diagrams of each electrical system; internal wiring and field connection diagrams of each

electrical device when published by the manufacturer; wiring diagrams of cabinets, panels, units, or separate mountings; interconnection diagrams that show the wiring between separate components of assemblies; field connection diagrams that show the termination of wiring routed between separate items of equipment; internal wiring diagrams of equipment showing wiring as actually provided for this project. Field wiring connections shall be clearly identified.

If departures from the contract drawings are deemed necessary by the Contractor, complete details of such departures, including changes in related portions of the project and the reasons why, shall be submitted with the detail drawings. Approved departures shall be made at no additional cost to the Government.

SD-03 Product Data

Manufacturer's Catalog; FIO.

Data composed of catalog cuts, brochures, circulars, specifications, product data, and printed information in sufficient detail and scope to verify compliance with the requirements of the contract documents.

Material, Equipment, and Fixture Lists; FIO.

A complete itemized listing of equipment and materials proposed for incorporation into the work. Each entry shall include an item number, the quantity of items proposed, and the name of the manufacturer of each item.

Installation Procedures; FIO.

Installation procedures for rotating equipment, transformers, switchgear, battery systems, voltage regulators, and grounding resistors. Procedures shall include diagrams, instructions, and precautions required to install, adjust, calibrate, and test devices and equipment.

As-Built Drawings; GA.

The as-built drawings shall be a record of the construction as installed. The drawings shall include all the information shown on the contract drawings, deviations, modifications, and changes from the contract drawings, however minor. The as-built drawings shall be kept at the job site and updated daily. The as-built drawings shall be a full-sized set of prints marked to reflect all deviations, changes, and modifications. The as-built drawings shall be complete and show the location, size, dimensions, part identification, and other information. Additional sheets may be added. The as-built drawings shall be jointly inspected for accuracy and completeness by the Contractor's quality control representative and by the Contracting Officer prior to the submission of each monthly pay estimate. Upon completion of the work, the Contractor shall submit three full sized sets of the marked prints to the Contracting Officer for approval. If upon review, the as-built drawings are found to contain errors and/or omissions, they will be returned to the Contractor for correction. The Contractor shall correct and return the as-built drawings to

the Contracting Officer for approval within ten calendar days from the time the drawings are returned to the Contractor.

Onsite Tests; GA.

A detailed description of the Contractor's proposed procedures for on-site tests.

SD-06 Test Reports

Field Test Plan; GA.

A detailed description of the Contractor's proposed procedures for onsite test submitted 20 days prior to testing the installed system. No field test will be performed until the test plan is approved. The test plan shall consist of complete field test procedures including tests to be performed, test equipment required, and tolerance limits.

Field Test Reports; GA.

Six (6) copies of the information described below in 8 1/2 x 11 inch binders having a minimum of 5 rings from which material may readily be removed and replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

a. A list of equipment used, with calibration certifications.

b. A copy of measurements taken.

c. The dates of testing.

d. The equipment and values to be verified.

e. The conditions specified for the test.

f. The test results, signed and dated.

g. A description of adjustments made.

h. Final position of controls and device settings.

SD-07 Certificates

Materials and Equipment; GA.

The label or listing of the Underwriters Laboratories, Inc., will be accepted as evidence that the materials or equipment conform to the applicable standards of that agency. In lieu of this label or listing, a statement from a nationally recognized, adequately equipped testing agency indicating that the items have been tested in accordance with required procedures and that the materials and equipment comply with all contract requirements will be accepted. However, materials and equipment installed in hazardous locations must bear the UL label unless the data submitted from other testing agency is specifically approved in writing by the Contracting Officer. Items which are required to be listed and labeled in accordance with Underwriters Laboratories

must be affixed with a UL label that states that it is UL listed. No exceptions or waivers will be granted to this requirement. Materials and equipment will be approved based on the manufacturer's published data.

For other than equipment and materials specified to conform to UL publications, a manufacturer's statement indicating complete compliance with the applicable standard of the American Society for Testing and Materials, National Electrical Manufacturers Association, or other commercial standard, is acceptable.

1.4 WORKMANSHIP

Materials and equipment shall be installed in accordance with NFPA 70, recommendations of the manufacturer, and as shown.

PART 2 PRODUCTS

Products shall conform to the respective publications and other requirements specified below. Materials and equipment not listed below shall be as specified elsewhere in this section. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

2.1 BUSWAYS

UL 857. Busses shall be copper. Enclosures shall be steel. Short-circuit ratings, except as indicated, shall be in accordance with NEMA BU 1.

2.1.1 Feeder Busways

Feeder busways shall be ventilated, except that vertical busways within 6 feet of floors shall be unventilated low-impedance busway.

2.1.2 Plug-In Busways

Plug-in busways shall be unventilated.

2.2 CABLES AND WIRES

All conductors shall be stranded. Conductor sizes and ampacities shown are based on copper, unless indicated otherwise. All conductors shall be copper.

2.2.1 Equipment Manufacturer Requirements

When manufacturer's equipment requires copper conductors at the terminations or requires copper conductors to be provided between components of equipment, provide copper conductors or splices, splice boxes, and other work required to meet manufacturer's requirements.

2.2.2 Aluminum Conductors

Aluminum conductors shall not be used.

2.2.3 Insulation

Unless indicated otherwise, or required by NFPA 70, power and lighting wires shall be 600-volt, Type THWN, THHN, or THW conforming to UL 83,

except that grounding wire may be type TW conforming to UL 83; remote-control and signal circuits shall be Type TW, THW or TF, conforming to UL 83. Where lighting fixtures require 90-degree Centigrade (C) conductors, provide only conductors with 90-degree C insulation or better.

2.2.4 Bonding Conductors

ASTM B 1, solid bare copper wire for sizes No. 8 AWG and smaller diameter; ASTM B 8, Class B, stranded bare copper wire for sizes No. 6 AWG and larger diameter.

2.2.5 Service Entrance Cables

Service entrance (SE) and underground service entrance (USE) cables, UL 854.

2.2.6 Metal-Clad Cable

UL 1569; NFPA 70, Type MC cable.

2.2.7 Tray Cable or Power Limited Tray Cable

UL listed; Type TC or PLTC.

2.2.8 Cord Sets and Power-Supply Cords

UL 817.

2.3 TRANSIENT VOLTAGE SURGE PROTECTION

Transient voltage surge suppressors shall be provided as indicated. Surge suppressors shall meet the requirements of IEEE C62.41 and be UL listed and labeled as having been tested in accordance with UL 1449. Surge suppressor ratings shall be as indicated.

2.4 CHARGERS, BATTERY

Battery chargers shall be general purpose, continuous current output, with solid state rectifiers. Means shall be provided to regulate and to adjust the dc output voltage. Chargers shall have continuous current ratings of 10 to 15 percent higher than battery current outputs based upon an 8-hour discharge.

2.5 CIRCUIT BREAKERS

2.5.1 Molded-Case Circuit Breakers

Molded-case circuit breakers shall conform to NEMA AB 1 and UL 489 and UL 877 for circuit breakers and circuit breaker enclosures located in hazardous (classified) locations. Circuit breakers may be installed in panelboards, switchboards, enclosures, motor control centers, or combination motor controllers.

2.5.1.1 Construction

Circuit breakers shall be suitable for mounting and operating in any position. Lug shall be listed for copper conductors only in accordance with UL 486E. Single-pole circuit breakers shall be full module size with not more than one pole per module. Multi-pole circuit breakers shall be of the common-trip type having a single operating handle such that an overload

or short circuit on any one pole will result in all poles opening simultaneously. Sizes of 100 amperes or less may consist of single-pole breakers permanently factory assembled into a multi-pole unit having an internal, mechanical, nontamperable common-trip mechanism and external handle ties. All circuit breakers shall have a quick-make, quick-break overcenter toggle-type mechanism, and the handle mechanism shall be trip-free to prevent holding the contacts closed against a short-circuit or sustained overload. All circuit breaker handles shall assume a position between "ON" and "OFF" when tripped automatically. All ratings shall be clearly visible.

2.5.1.2 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. The interrupting rating of the circuit breakers shall be at least equal to the available short-circuit current at the line terminals of the circuit breaker and correspond to the UL listed integrated short-circuit current rating specified for the panelboards and switchboards. Molded-case circuit breakers shall have nominal voltage ratings, maximum continuous-current ratings, and maximum short-circuit interrupting ratings in accordance with NEMA AB 1. Ratings shall be coordinated with system X/R ratio.

2.5.1.3 Cascade System Ratings

Circuit breakers used in series combinations shall be in accordance with UL 489. Equipment, such as switchboards and panelboards, which house series-connected circuit breakers shall be clearly marked accordingly. Series combinations shall be listed in the UL Recognized Component Directory under "Circuit Breakers-Series Connected."

2.5.1.4 Thermal-Magnetic Trip Elements

Thermal magnetic circuit breakers shall be provided as shown. Automatic operation shall be obtained by means of thermal-magnetic tripping devices located in each pole providing inverse time delay and instantaneous circuit protection. The instantaneous magnetic trip shall be adjustable and accessible from the front of all circuit breakers on frame sizes above 150 amperes.

2.5.2 Solid-State Trip Elements

Solid-state circuit breakers shall be provided as shown. All electronics shall be self-contained and require no external relaying, power supply, or accessories. Printed circuit cards shall be treated to resist moisture absorption, fungus growth, and signal leakage. All electronics shall be housed in an enclosure which provides protection against arcs, magnetic interference, dust, and other contaminants. Solid-state sensing shall measure true RMS current with error less than one percent on systems with distortions through the 13th harmonic. Peak or average actuating devices are not acceptable. Current sensors shall be torodial construction, encased in a plastic housing filled with epoxy to protect against damage and moisture and shall be integrally mounted on the breaker. Where indicated on the drawings, circuit breaker frames shall be rated for 100 percent continuous duty. Circuit breakers shall have tripping features as shown on the drawings and as described below:

a. Long-time current pick-up, adjustable from 50 percent to 100 percent of continuous current rating.

b. Adjustable long-time delay.

c. Short-time current pick-up, adjustable from 1.5 to 9 times long-time current setting.

d. Adjustable short-time delay.

e. Short-time I square times t switch.

f. Instantaneous current pick-up, adjustable from 1.5 to 9 times long-time current setting.

g. Ground-fault pick-up, adjustable from 20 percent to 60 percent of sensor rating, but not greater than 1200 amperes. Sensing of ground-fault current at the main bonding jumper or ground strap will not be permitted.

h. Adjustable ground-fault delay.

i. Ground-fault I square times t switch.

j. Overload and short-time and ground-fault trip indicators shall be provided.

2.5.3 SWD Circuit Breakers

Circuit breakers rated 15 amperes and intended to switch 277 volts or less fluorescent lighting loads shall be marked "SWD."

2.5.4 HACR Circuit Breakers

Circuit breakers 60 amperes or below, 240 volts, 1-pole or 2-pole, intended to protect multi-motor and combination-load installations involved in heating, air conditioning, and refrigerating equipment shall be marked "Listed HACR Type."

2.5.5 Low-Voltage Power

a. Construction:

Low-voltage power circuit breakers shall conform to IEEE C37.13, ANSI C37.16, and NEMA SG 3 and shall be three-pole, single-throw, stored energy, manually operated, with drawout mounting. Solid-state trip elements which require no external power connections shall be provided. Circuit breakers shall have an open/close contact position indicator, charged/discharged stored energy indicator, primary disconnect devices, and a mechanical interlock to prevent making or breaking contact of the primary disconnects when the circuit breaker is closed.

b. Ratings:

Voltage ratings shall be not less than the applicable circuit voltage. Circuit breakers shall be rated for 100 percent continuous duty and shall have trip current ratings and frame sizes as shown. Nominal voltage ratings, maximum continuous-current ratings, and maximum short-circuit interrupting ratings shall be in accordance with ANSI C37.16. Tripping features shall be as follows:

1. Long-time current pick-up, adjustable from 50 percent to 100

percent of sensor current rating.

2. Adjustable long-time delay.

3. Short-time current pick-up, adjustable from 1.5 to 9 times long-time current setting.

4. Adjustable short-time delay.

5. Short-time I square times t switch.

6. Instantaneous current pick-up, adjustable from 1.5 to 9 times long-time current setting.

7. Ground-fault pick-up, adjustable from 20 percent to 60 percent of sensor rating, but in no case greater than 1200 amperes. Sensing of ground-fault current at the main bonding jumper or ground strap shall not be permitted. Zone-selective interlocking shall be provided as shown.

8. Adjustable ground-fault delay.

9. Ground-fault I square times t switch.

10. Overload and short-circuit and ground-fault trip indicators shall be provided.

2.5.6 Ground Fault Circuit Interrupters

UL 943. Breakers equipped with ground fault circuit interrupters shall have ground fault class, interrupting capacity, and voltage and current ratings as indicated.

2.6 MOTOR SHORT-CIRCUIT PROTECTOR (MSCP)

Motor short-circuit protectors shall conform to UL 508 and shall be provided as shown. Protectors shall be used only as part of a combination motor controller which provides coordinated motor branch-circuit overload and short-circuit protection, and shall be rated in accordance with the requirements of NFPA 70.

2.6.1 Construction

Motor short-circuit protector bodies shall be constructed of high temperature, dimensionally stable, long life, nonhygroscopic materials. Protectors shall fit special MSCP mounting clips and shall not be interchangeable with any commercially available fuses. Protectors shall have 100 percent one-way interchangeability within the A-Y letter designations. All ratings shall be clearly visible.

2.6.2 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. Letter designations shall be A through Y for motor controller Sizes 0, 1, 2, 3, 4, and 5, with 100,000 amperes interrupting capacity rating. Letter designations shall correspond to controller sizes as follows:

CONTROLLER SIZE	MSCP DESIGNATION
NEMA O	A-N
NEMA 1	A-P
NEMA 2	A-S
NEMA 3	A-U
NEMA 4	A-W
NEMA 5	A-Y

2.7 CONDUIT

2.7.1 Flexible Conduit, Steel and Plastic

General-purpose type, UL 1; liquid tight, UL 360, and UL 1660.

2.7.2 Intermediate Metal Conduit

UL 1242.

2.7.3 Rigid Aluminum Conduit

ANSI C80.5 and UL 6.

2.7.4 Rigid Metal Conduit

UL 6.

2.7.5 Rigid Plastic Conduit

NEMA TC 2, UL 651 and UL 651A.

2.7.6 Surface Metal Electrical Raceways and Fittings

UL 5.

2.8 CONDUIT AND DEVICE BOXES AND FITTINGS

2.8.1 Boxes, Metallic Outlet

NEMA OS 1 and UL 514A.

2.8.2 Boxes, Nonmetallic, Outlet and Flush-Device Boxes and Covers

NEMA OS 2 and UL 514C.

2.8.3 Boxes, Switch (Enclosed), Surface-Mounted

UL 98.

2.8.4 Fittings for Conduit and Outlet Boxes

UL 514B.

2.8.5 Fittings, PVC, for Use with Rigid PVC Conduit and Tubing

UL 514B.

2.9 CONNECTORS, WIRE PRESSURE

2.9.1 For Use With Copper Conductors

UL 486A.

2.10 ELECTRICAL GROUNDING AND BONDING EQUIPMENT

UL 467.

2.10.1 Ground Rods

Ground rods shall be of copper-clad steel conforming to UL 467 not less than 5/8 inch in diameter by 8 feet in length of the sectional type driven full length into the earth.

2.10.2 Ground Bus

The ground bus shall be bare conductor or flat copper in one piece, if practicable.

2.11 ENCLOSURES

NEMA ICS 6 unless otherwise specified.

2.11.1 Cabinets and Boxes

Cabinets and boxes with volume greater than 100 cubic inches shall be in accordance with UL 50, hot-dip, zinc-coated, if sheet steel.

2.11.2 Circuit Breaker Enclosures

UL 489.

2.12 LIGHTING FIXTURES, LAMPS, BALLASTS, EMERGENCY EQUIPMENT, CONTROLS AND ACCESSORIES

The following specifications are supported and supplemented by information and details on the drawings. Additional fixtures, if shown, shall conform to this specification. Lighting equipment installed in classified hazardous locations shall conform to UL 844. Lamps, lampholders, ballasts, transformers, electronic circuitry and other lighting system components shall be constructed according to industry standards. Equipment shall be tested and listed by a recognized independent testing laboratory for the expected installation conditions. Equipment shall conform to the standards listed below.

2.12.1 Lamps

Lamps shall be constructed to operate in the specified fixture, and shall function without derating life or output as listed in published data. Lamps shall meet the requirements of the Energy Policy Act of 1992.

a. Incandescent and tungsten halogen lamps shall be designed for 125 volt operation (except for low voltage lamps), shall be rated for

minimum life of 2,000 hours, and shall have color temperature between 2,800 and 3,200 degrees Kelvin. Tungsten halogen lamps shall incorporate quartz capsule construction. Lamps shall comply with ANSI C78.20 and sections 238 and 270 of ANSI C78.21.

b. Fluorescent lamps shall have color temperature of 3,000 degrees Kelvin. They shall be designed to operate with the ballasts and circuitry of the fixtures in which they will be used. Fluorescent lamps, including spares, shall be manufactured by one manufacturer to provide for color and performance consistency. Fluorescent lamps shall comply with ANSI C78.1. Fluorescent tube lamp efficiencies shall meet or exceed the following requirements.

T8, 32 watts	(4' lamp)	2800 lumens
T12,34 watts	(4' lamp)	2800 lumens

(1) Linear fluorescent lamps, unless otherwise indicated, shall be 4 feet long 32 watt T8, 265 mA, with minimum CRI of 75. Lamps of other lengths or types shall be used only where specified or shown. Lamps shall deliver rated life when operated on rapid start ballasts.

c. High intensity discharge lamps, including spares, shall be manufactured by one manufacturer in order to provide color and performance consistency. High intensity discharge lamps shall be designed to operate with the ballasts and circuitry of the fixtures in which they will be used and shall have wattage, shape and base as shown. High intensity discharge lamps, unless otherwise shown, shall have medium or mogul screw base and minimum starting temperature of -20 degrees F. Metal halide lamps, unless otherwise shown, shall have minimum CRI of 65; color temperature of 4,300 degrees Kelvin; shall be -BU configuration if used in base-up position; and shall be -H or high output configuration if used in horizontal position. Lamps shall comply with all applicable ANSI C78.1350, ANSI C78.1351, ANSI C78.1352, ANSI C78.1355,ANSI C78.1375, and ANSI C78.1376.

2.12.2 Ballasts and Transformers

Ballasts or transformers shall be designed to operate the designated lamps within their optimum specifications, without derating the lamps. Lamp and ballast combinations shall be certified as acceptable by the lamp manufacturer.

a. Low voltage incandescent transformers shall be Class II UL listed 120/12 volt or 120/24 volt step-down transformers as required for the lamps shown. Transformers shall be high power factor type and shall be rated for continuous operation under the specified load. Transformers shall be encased or encased and potted, and mounted integrally within the lighting fixture unless otherwise shown.

b. Fluorescent ballasts shall comply with ANSI C82.1 and shall be mounted integrally within fluorescent fixture housing unless otherwise shown. Ballasts shall have maximum current crest factor of 1.7; high power factor; Class A sound rating; maximum operating case temperature of 77 degrees F above ambient; and shall be rated Class P. Unless otherwise indicated, the minimum number of

ballasts shall be used to serve each individual fixture.

(1) Electronic fluorescent ballasts shall comply with 47 CFR 18 for electromagnetic interference. Ballasts shall withstand line transients per IEEE C62.41, Category A. Ballasts shall have total harmonic distortion between 10 and 20%; minimum frequency of 20,000 Hz; filament voltage between 2.5 and 4.5 volts; maximum starting inrush current of 20 amperes; and shall comply with the minimum Ballast Efficacy Factors shown in the table below. Minimum starting temperature shall be 50 degrees F. Ballasts shall carry a manufacturer's full warranty of three years, including a minimum $10 labor allowance per ballast.

ELECTRONIC FLUORESCENT BALLAST EFFICACY FACTORS

LAMP TYPE	TYPE OF STARTER & LAMP	NOMINAL OPERATIONAL VOLTAGE	NUMBER OF LAMPS	MINIMUM BALLAST EFFICACY FACTOR
32W T8	rapid start linear & U-tubes	120 or 277 V	1	2.54
			2	1.44
			3	0.93
			4	0.73
34W T12	rapid start linear & U-tubes	120 or 277 V	1	2.64
			2	1.41
			3	0.93

c. High intensity discharge ballasts shall comply with UL 1029 and, if multiple supply types, with ANSI C82.4. Ballasts shall have minimum ballast factor of 0.9; high power factor; Class A sound rating; and maximum operating case temperature of 77 degrees F above ambient.

(1) Electronic high intensity discharge ballasts shall be constant wattage autotransformer type; shall have less than 10% ballast loss; shall have total harmonic distortion between 10 and 20%; and shall have a minimum starting temperature of 0 degrees F.

2.12.3 Fixtures

Fixtures shall be in accordance with the size, shape, appearance, finish, and performance shown. Unless otherwise indicated, lighting fixtures shall be provided with housings, junction boxes, wiring, lampholders, mounting supports, trim, hardware and accessories for a complete and operable installation. Recessed housings shall be minimum 20 gauge cold rolled or galvanized steel as shown. Extruded aluminum fixtures shall have minimum wall thickness of 0.125 inch. Plastic lenses shall be 100% virgin acrylic or as shown. Glass lenses shall be tempered. Heat resistant glass shall be borosilicate type. Conoid recessed reflector cones shall be Alzak with clear specular low iridescent finish.

a. Incandescent fixtures shall comply with UL 1571. Incandescent fixture specular reflector cone trims shall be integral to the

cone and shall be finished to match. Painted trim finishes shall be white with minimum reflectance of 88%. Low voltage incandescent fixtures shall have integral step-down transformers.

b. Fluorescent fixtures shall comply with UL 1570. Recessed ceiling fixtures shall comply with NEMA LE 4. Fixtures shall be plainly marked for proper lamp and ballast type to identify lamp diameter, wattage, color and start type. Marking shall be readily visible to service personnel, but not visible from normal viewing angles. Fluorescent fixture lens frames on recessed and surface mounted troffers shall be one assembly with mitered corners. Parabolic louvers shall have a low iridescent finish and 45 degree cut-off. Louver intersection joints shall be hairline type and shall conceal mounting tabs or other assembly methods. Louvers shall be free from blemishes, lines or defects which distort the visual surface. Integral ballast and wireway compartments shall be easily accessible without the use of special tools. Housings shall be constructed to include grounding necessary to start the lamps. Open fixtures shall be equipped with a sleeve, wire guard, or other positive means to prevent lamps from falling. Medium bi-pin lampholders shall be twist-in type with positive locking position. Long compact fluorescent fixtures and fixtures utilizing U-bend lamps shall have clamps or secondary lampholders to support the free ends of the lamps.

c. High intensity discharge fixture shall comply with UL 1572. Recessed ceiling fixtures shall comply with NEMA LE 4. Reflectors shall be anodized aluminum. Fixtures for horizontal lamps shall have position oriented lampholders. Lampholders shall be pulse-rated to 5,000 volts. Fixtures indicated as classified or rated for hazardous locations or special service shall be designed and independently tested for the environment in which they are installed. Recessed lens fixtures shall have extruded aluminum lens frames. Ballasts shall be integral to fixtures and shall be accessible without the use of special tools. Remote ballasts shall be encased and potted. Lamps shall be shielded from direct view with a UV absorbing material such as tempered glass, and shall be circuited through a cut-off switch which will shut off the lamp circuit if the lens is not in place.

d. Emergency lighting fixtures and accessories shall be constructed and independently tested to meet the requirements of applicable codes. Batteries shall be Nicad or equal with no required maintenance, and shall have a minimum life expectancy of five years and warranty period of three years.

e. Exit Signs

Exit signs shall be ENERGY STAR compliant, thereby meeting the following requirements. Input power shall be less than 5 watts per face. Letter size and spacing shall adhere to NFPA 101. Luminance contrast shall be greater than 0.8. Average luminance shall be greater than 15 cd/m^2 measured at normal (0 degree) and 45 degree viewing angles. Minimum luminance shall be greater than 8.6 cd/m^2 measured at normal and 45 degree viewing angles. Maximum to minimum luminance shall be less than 20:1 measured at normal and 45 degree viewing angles. The manufacturer warranty for defective parts shall be at least 5 years.

2.13 INSTRUMENTS, ELECTRICAL INDICATING

ANSI C39.1.

2.14 MOTORS, AC, FRACTIONAL AND INTEGRAL

Motors, ac, fractional and integral horsepower, 500 hp and smaller shall conform to NEMA MG 1 and UL 1004 for motors; NEMA MG 10 for energy management selection of polyphase motors; and UL 674 for use of motors in hazardous (classified) locations. In addition to the standards listed above, motors shall be provided with efficiencies as specified in the table "MINIMUM NOMINAL EFFICIENCIES" below.

2.14.1 Rating

The horsepower rating of motors should be limited to no more than 125 percent of the maximum load being served unless a NEMA standard size does not fall within this range. In this case, the next larger NEMA standard motor size should be used.

2.14.2 Motor Efficiencies

All permanently wired polyphase motors of 1 hp or more shall meet the minimum full-load efficiencies as indicated in the following table, and as specified in this specification. Motors of 1 hp or more with open, drip proof or totally enclosed fan cooled enclosures shall be high efficiency type, unless otherwise indicated. Motor efficiencies indicated in the tables apply to general-purpose, single-speed, polyphase induction motors. Applications which require definite purpose, special purpose, special frame, or special mounted polyphase induction motors are excluded from these efficiency requirements. Motors provided as an integral part of motor driven equipment are excluded from this requirement if a minimum seasonal or overall efficiency requirement is indicated for that equipment by the provisions of another section.

TOTALLY ENCLOSED FAN-COOLED MOTORS

HP	1200 RPM	1800 RPM	3600 RPM
1	82.5	85.5	78.5
1.5	87.5	86.5	85.5
2	88.5	86.5	86.5
3	89.5	89.5	88.5
5	89.5	89.5	89.5
7.5	91.7	91.7	91.0
10	91.7	91.7	91.7
15	92.4	92.4	91.7
20	92.4	93.0	92.4
25	93.0	93.6	93.0
30	93.6	93.6	93.0
40	94.1	94.1	93.6
50	94.1	94.5	94.1
60	94.5	95.0	94.1
75	95.0	95.4	94.5
100	95.4	95.4	95.0
125	95.4	95.4	95.4
150	95.8	95.8	95.4
200	95.8	96.2	95.8
250	95.6	96.2	95.9
300	95.4	96.1	95.8

350	94.5	96.2	94.8
400	94.5	95.8	94.5
450	94.5	94.5	94.5
500	94.5	94.5	94.5

2.15 MOTOR CONTROLS AND MOTOR CONTROL CENTERS

2.15.1 General

NEMA ICS 1, NEMA ICS 2, NEMA ICS 3 and NEMA ICS 6, and UL 508 and UL 845. Panelboards supplying non-linear loads shall have neutrals sized for 200 percent of rated current.

2.15.2 Motor Starters

Combination starters shall be provided with circuit breakers.

2.15.3 Thermal-Overload Protection

Each motor of 1/8 hp or larger shall be provided with thermal-overload protection. Polyphase motors shall have overload protection in each ungrounded conductor. The overload-protection device shall be provided either integral with the motor or controller, or shall be mounted in a separate enclosure. Unless otherwise specified, the protective device shall be of the manually reset type. Single or double pole tumbler switches specifically designed for alternating-current operation only may be used as manual controllers for single-phase motors having a current rating not in excess of 80 percent of the switch rating.

2.15.4 Low-Voltage Motor Overload Relays

2.15.4.1 General

Thermal overload relays shall conform to NEMA ICS 2 and UL 508. Overload protection shall be provided either integral with the motor or motor controller, and shall be rated in accordance with the requirements of NFPA 70. Standard units shall be used for motor starting times up to 7 seconds. Quick trip units shall be used on hermetically sealed, submersible pumps, and similar motors.

2.15.4.2 Construction

Manual reset type thermal relay shall be bimetallic construction. Automatic reset type thermal relays shall be bimetallic construction. Magnetic current relays shall consist of a contact mechanism and a dash pot mounted on a common frame.

2.15.4.3 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. Trip current ratings shall be established by selection of the replaceable overload device and shall not be adjustable. Where the controller is remotely-located or difficult to reach, an automatic reset, non-compensated overload relay shall be provided. Manual reset overload relays shall be provided otherwise, and at all locations where automatic starting is provided. Where the motor is located in a constant ambient temperature, and the thermal device is located in an ambient temperature that regularly varies by more than minus 18 degrees F, an ambient temperature-compensated overload relay shall be provided.

2.15.5 Automatic Control Devices

2.15.5.1 Direct Control

Automatic control devices (such as thermostats, float or pressure switches) which control the starting and stopping of motors directly shall be designed for that purpose and have an adequate horsepower rating.

2.15.5.2 Pilot-Relay Control

Where the automatic-control device does not have such a rating, a magnetic starter shall be used, with the automatic-control device actuating the pilot-control circuit.

2.15.5.3 Manual/Automatic Selection

a. Where combination manual and automatic control is specified and the automatic-control device operates the motor directly, a double-throw, three-position tumbler or rotary switch (marked MANUAL-OFF-AUTOMATIC) shall be provided for the manual control.

b. Where combination manual and automatic control is specified and the automatic-control device actuates the pilot control circuit of a magnetic starter, the magnetic starter shall be provided with a three-position selector switch marked MANUAL-OFF-AUTOMATIC.

c. Connections to the selector switch shall be such that; only the normal automatic regulatory control devices will be bypassed when the switch is in the Manual position; all safety control devices, such as low-or high-pressure cutouts, high-temperature cutouts, and motor-overload protective devices, shall be connected in the motor-control circuit in both the Manual and the Automatic positions of the selector switch. Control circuit connections to any MANUAL-OFF-AUTOMATIC switch or to more than one automatic regulatory control device shall be made in accordance with wiring diagram approved by the Contracting Officer unless such diagram is included on the drawings. All controls shall be 120 volts or less unless otherwise indicated.

2.15.6 Motor Control Centers

Control centers shall conform to the requirements of NEMA ICS 1, NEMA ICS 2, NEMA ICS 3 and NEMA ICS 6, and UL 508 and UL 845. Control centers shall be indoor type and shall contain combination starters and other equipment as indicated. Control centers shall be NEMA ICS 2, Class 1, Type B. Each control center shall be mounted on floor sills or mounting channels. Each circuit shall have a suitable metal or laminated plastic nameplate with white cut letters. Motor control centers shall be provided with a full-length ground bus bar.

2.16 PANELBOARDS

Dead-front construction, NEMA PB 1 and UL 67.

2.17 RECEPTACLES

2.17.1 Heavy Duty Grade

NEMA WD 1. Devices shall conform to all requirements for heavy duty receptacles.

2.17.2 Ground Fault Interrupters

UL 943, Class A or B.

2.17.3 NEMA Standard Receptacle Configurations

NEMA WD 6.

a. Single and Duplex, 15-Ampere and 20-Ampere, 125 Volt

15-ampere, non-locking: NEMA type 5-15R, locking: NEMA type L5-15R,
20-ampere, non-locking: NEMA type 5-20R, locking: NEMA type L5-20R.

2.18 SERVICE ENTRANCE EQUIPMENT

UL 869A.

2.19 SPLICE, CONDUCTOR

UL 486C.

2.20 SNAP SWITCHES

UL 20.

2.21 TAPES

2.21.1 Plastic Tape

UL 510.

2.21.2 Rubber Tape

UL 510.

2.22 TRANSFORMERS

Single- and three-phase transformers shall have two windings per phase. Full-capacity standard NEMA taps shall be provided in the primary windings of transformers unless otherwise indicated. Three-phase transformers shall be configured with delta-wye windings, except as indicated.

2.22.1 Transformers, Dry-Type

Transformers shall have 220 degrees C insulation system for transformers 15 kVA and greater, and shall have 180 degrees C insulation system for transformers rated 10 kVA and less, with temperature rise not exceeding 150 degrees C under full-rated load in maximum ambient temperature of 40 degrees C. Transformer of 150 degrees C temperature rise shall be capable of carrying continuously 100 percent of nameplate kVA without exceeding insulation rating.

a. 600 Volt or Less Primary:

NEMA ST 20, UL 506, general purpose, dry-type, self-cooled, ventilated. Transformers shall be provided in NEMA 1 enclosure. Transformers shall be

quiet type with maximum sound level at least 3 decibels less than NEMA standard level for transformer ratings indicated.

2.22.2 Average Sound Level

The average sound level in decibels (dB) of transformers shall not exceed the following dB level at 12 inches for the applicable kVA rating range listed unless otherwise indicated:

kVA Range	dB Sound Level
1-50	50
51-150	55
151-300	58
301-500	60

2.23 WIRING DEVICES

NEMA WD 1 for wiring devices, and NEMA WD 6 for dimensional requirements of wiring devices.

PART 3 EXECUTION

3.1 GROUNDING

Grounding shall be in conformance with NFPA 70, the contract drawings, and the following specifications.

3.1.1 Ground Rods

The resistance to ground shall be measured using the fall-of-potential method described in IEEE Std 81. The maximum resistance of a driven ground shall not exceed 25 ohms under normally dry conditions. In high-ground-resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately. Connections below grade shall be fusion welded. Connections above grade shall be fusion welded or shall use UL 467 approved connectors.

3.1.2 Ground Bus

Ground bus shall be provided in the electrical equipment rooms as indicated. Noncurrent-carrying metal parts of electrical equipment shall be effectively grounded by bonding to the ground bus. The ground bus shall be bonded to both the entrance ground, and to a ground rod or rods as specified above having the upper ends terminating approximately 4 inches above the floor. Connections and splices shall be of the brazed, welded, bolted, or pressure-connector type, except that pressure connectors or bolted connections shall be used for connections to removable equipment.

3.1.3 Grounding Conductors

A green equipment grounding conductor, sized in accordance with NFPA 70 shall be provided, regardless of the type of conduit. Equipment grounding bars shall be provided in all panelboards. The equipment grounding conductor shall be carried back to the service entrance grounding connection.

All equipment grounding conductors, including metallic raceway systems used as such, shall be bonded or joined together in each wiring box or equipment enclosure. Metallic raceways and grounding conductors shall be

checked to assure that they are wired or bonded into a common junction. Metallic boxes and enclosures, if used, shall also be bonded to these grounding conductors by an approved means per NFPA 70.

3.2 WIRING METHODS

Wiring shall conform to NFPA 70, the contract drawings, and the following specifications. Unless otherwise indicated, wiring shall consist of insulated conductors installed in rigid zinc-coated steel conduit. Wire fill in conduits shall be based on NFPA 70 for the type of conduit and wire insulations specified.

3.2.1 Conduit Systems

Rigid steel conduit systems shall be installed as indicated. Conduit sizes shown are based on use of copper conductors with insulation types as described in paragraph WIRING METHODS. Minimum size of raceways shall be 3/4 inch. Except as otherwise specified, IMC may be used as an option for rigid steel conduit in areas as permitted by NFPA 70. Raceways shall not be installed under the firepits of boilers and furnaces and shall be kept 6 inches away from parallel runs of flues, steam pipes and hot-water pipes. Raceways shall be concealed within finished walls, ceilings, and floors unless otherwise shown. Raceways crossing structural expansion joints or seismic joints shall be provided with suitable expansion fittings or other suitable means to compensate for the building expansion and contraction and to provide for continuity of grounding.

3.2.1.1 Pull Wires

A pull wire shall be inserted in each empty raceway in which wiring is to be installed if the raceway is more than 50 feet in length and contains more than the equivalent of two 90-degree bends, or where the raceway is more than 150 feet in length. The pull wire shall be of No. 14 AWG zinc-coated steel, or of plastic having not less than 200 pounds per square inch tensile strength. Not less than 10 inches of slack shall be left at each end of the pull wire.

3.2.1.2 Conduit Stub-Ups

Where conduits are to be stubbed up through concrete floors, a short elbow shall be installed below grade to transition from the horizontal run of conduit to a vertical run. A conduit coupling fitting, threaded on the inside shall be installed, to allow terminating the conduit flush with the finished floor. Wiring shall be extended in rigid threaded conduit to equipment, except that where required, flexible conduit may be used 6 inches above the floor. Empty or spare conduit stub-ups shall be plugged flush with the finished floor with a threaded, recessed plug.

3.2.1.3 Below Slab-on-Grade or in the Ground

Electrical wiring below slab-on-grade shall be protected by a conduit system. Conduit passing vertically through slabs-on-grade shall be rigid steel or IMC. Rigid steel or IMC conduits installed below slab-on-grade or in the earth shall be field wrapped with 0.010 inch thick pipe-wrapping plastic tape applied with a 50 percent overlay, or shall have a factory-applied polyvinyl chloride, plastic resin, or epoxy coating system.

3.2.1.4 Changes in Direction of Runs

Changes in direction of runs shall be made with symmetrical bends or cast-metal fittings. Field-made bends and offsets shall be made with an approved hickey or conduit-bending machine. Crushed or deformed raceways shall not be installed. Trapped raceways in damp and wet locations shall be avoided where possible. Lodgment of plaster, dirt, or trash in raceways, boxes, fittings and equipment shall be prevented during the course of construction. Clogged raceways shall be cleared of obstructions or shall be replaced.

3.2.1.5 Supports

Metallic conduits and tubing,and the support system to which they are attached, shall be securely and rigidly fastened in place to prevent vertical and horizontal movement at intervals of not more than 10 feet and within 3 feet of boxes, cabinets, and fittings, with approved pipe straps, wall brackets, conduit clamps, conduit hangers, threaded C-clamps, beam clamps, or ceiling trapeze. Loads and supports shall be coordinated with supporting structure to prevent damage or deformation to the structure. Loads shall not be applied to joist bridging. Attachment shall be by wood screws or screw-type nails to wood; by toggle bolts on hollow masonry units; by expansion bolts on concrete or brick; by machine screws, welded threaded studs, heat-treated or spring-steel-tension clamps on steel work. Nail-type nylon anchors or threaded studs driven in by a powder charge and provided with lock washers and nuts may be used in lieu of expansion bolts or machine screws. Raceways or pipe straps shall not be welded to steel structures. Cutting the main reinforcing bars in reinforced concrete beams or joists shall be avoided when drilling holes for support anchors. Holes drilled for support anchors, but not used, shall be filled. In partitions of light steel construction, sheet-metal screws may be used. Raceways shall not be supported using wire or nylon ties. Raceways shall be independently supported from the structure. Upper raceways shall not be used as a means of support for lower raceways. Supporting means shall not be shared between electrical raceways and mechanical piping or ducts. Cables and raceways shall not be supported by ceiling grids. Except where permitted by NFPA 70, wiring shall not be supported by ceiling support systems. Conduits shall be fastened to sheet-metal boxes and cabinets with two locknuts where required by NFPA 70, where insulating bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, a single locknut and bushing may be used.

3.2.1.6 Exposed Raceways

Exposed raceways shall be installed parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings. Raceways under raised floors and above accessible ceilings shall be considered as exposed installations in accordance with NFPA 70 definitions.

3.2.1.7 Exposed Risers

Exposed risers in wire shafts of multistory buildings shall be supported by U-clamp hangers at each floor level, and at intervals not to exceed 10 feet.

3.2.2 Cables and Conductors

Installation shall conform to the requirements of NFPA 70. Covered, bare or insulated conductors of circuits rated over 600 volts shall not occupy the same equipment wiring enclosure, cable, or raceway with conductors of circuits rated 600 volts or less.

3.2.2.1 Sizing

Unless otherwise noted, all sizes are based on copper conductors and the insulation types indicated. Sizes shall be not less than indicated. Branch-circuit conductors shall be not smaller than No. 12 AWG. Conductors for branch circuits of 120 volts more than 100 feet long and of 277 volts more than 230 feet long, from panel to load center, shall be no smaller than No. 10 AWG. Class 1 remote control and signal circuit conductors shall be not less than No. 14 AWG. Class 2 remote control and signal circuit conductors shall be not less than No. 16 AWG.

3.2.2.2 Cable Splicing

Splices shall be made in an accessible location. Crimping tools and dies shall be approved by the connector manufacturer for use with the type of connector and conductor.

a. Copper Conductors, 600 Volt and Under: Splices in conductors No. 10 AWG and smaller diameter shall be made with an insulated, pressure-type connector. Splices in conductors No. 8 AWG and larger diameter shall be made with a solderless connector and insulated with tape or heat-shrink type insulating material equivalent to the conductor insulation.

3.2.2.3 Conductor Identification and Tagging

Power, control, and signal circuit conductor identification shall be provided within each enclosure where a tap, splice, or termination is made. Where several feeders pass through a common pull box, the feeders shall be tagged to indicate clearly the electrical characteristics, circuit number, and panel designation. Phase conductors of low voltage power circuits shall be identified by color coding. Phase identification by a particular color shall be maintained continuously for the length of a circuit, including junctions.

a. Color coding shall be provided for service, feeder, branch, and ground conductors. Color shall be green for grounding conductors and white for neutrals; except where neutrals of more than one system are installed in the same raceway or box, other neutral shall be white with colored (not green) stripe. The color coding for 3-phase and single-phase low voltage systems shall be as follows:

   120/208-volt, 3-phase: Black(A), red(B), and blue(C).
   277/480-volt, 3-phase: Brown(A), orange(B), and yellow(C).

b. Conductor phase and voltage identification shall be made by color-coded insulation for all conductors smaller than No. 6 AWG. For conductors No. 6 AWG and larger, identification shall be made by color-coded insulation, or conductors with black insulation may be furnished and identified by the use of half-lapped bands of colored electrical tape wrapped around the insulation for a minimum of 3 inches of length near the end, or other method as submitted by the Contractor and approved by the Contracting Officer.

c. Control and signal circuit conductor identification shall be made by color-coded insulated conductors, plastic-coated self-sticking printed markers, permanently attached stamped metal foil markers,

or equivalent means as approved. Control circuit terminals of equipment shall be properly identified. Terminal and conductor identification shall match that shown on approved detail drawings. Hand lettering or marking is not acceptable.

3.3 BOXES AND SUPPORTS

Boxes shall be provided in the wiring or raceway systems where required by NFPA 70 for pulling of wires, making connections, and mounting of devices or fixtures. Pull boxes shall be furnished with screw-fastened covers. Indicated elevations are approximate, except where minimum mounting heights for hazardous areas are required by NFPA 70. Unless otherwise indicated, boxes for wall switches shall be mounted 48 inches above finished floors. Switch and outlet boxes located on opposite sides of fire rated walls shall be separated by a minimum horizontal distance of 24 inches. The total combined area of all box openings in fire rated walls shall not exceed 100 square inches per 100 square feet.

3.3.1 Box Applications

Each box shall have not less than the volume required by NFPA 70 for number of conductors enclosed in box. Boxes for metallic raceways shall be listed for the intended use when located in normally wet locations, when flush or surface mounted on outside of exterior surfaces, or when located in hazardous areas. Boxes installed in process area and boxes installed flush with the outside of exterior surfaces shall be gasketed. Boxes for mounting lighting fixtures shall be not less than 4 inches square, or octagonal, except smaller boxes may be installed as required by fixture configuration, as approved. Cast-metal boxes with 3/32 inch wall thickness are acceptable. Large size boxes shall be NEMA 12 or as shown. Boxes in other locations shall be sheet steel except that aluminum boxes may be used with aluminum conduit, and nonmetallic boxes may be used with nonmetallic conduit and tubing or nonmetallic sheathed cable system, when permitted by NFPA 70. Boxes for use in masonry-block or tile walls shall be square-cornered, tile-type, or standard boxes having square-cornered, tile-type covers.

3.3.2 Brackets and Fasteners

Boxes and supports shall be fastened to wood with wood screws or screw-type nails of equal holding strength, with bolts and metal expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screw or welded studs on steel work. Threaded studs driven in by powder charge and provided with lockwashers and nuts, or nail-type nylon anchors may be used in lieu of expansion shields, or machine screws. Penetration of more than 1-1/2 inches into reinforced-concrete beams or more than 3/4 inch into reinforced-concrete joists shall avoid cutting any main reinforcing steel. The use of brackets which depend on gypsum wallboard or plasterboard for primary support will not be permitted. In partitions of light steel construction, bar hangers with 1 inch long studs, mounted between metal wall studs or metal box mounting brackets shall be used to secure boxes to the building structure. When metal box mounting brackets are used, additional box support shall be provided on the side of the box opposite the brackets. This additional box support shall consist of a minimum 12 inch long section of wall stud, bracketed to the opposite side of the box and secured by two screws through the wallboard on each side of the stud. Metal screws may be used in lieu of the metal box mounting brackets.

3.3.3 Mounting in Walls, Ceilings, or Recessed Locations

In walls or ceilings of concrete, tile, or other non-combustible material, boxes shall be installed so that the edge of the box is not recessed more than 1/4 inch from the finished surface. Boxes mounted in combustible walls or ceiling material shall be mounted flush with the finished surface. The use of gypsum or plasterboard as a means of supporting boxes will not be permitted. Boxes installed for concealed wiring shall be provided with suitable extension rings or plaster covers, as required. The bottom of boxes installed in masonry-block walls for concealed wiring shall be mounted flush with the top of a block to minimize cutting of the blocks, and boxes shall be located horizontally to avoid cutting webs of block. Separate boxes shall be provided for flush or recessed fixtures when required by the fixture terminal operating temperature, and fixtures shall be readily removable for access to the boxes unless ceiling access panels are provided.

3.3.4 Installation in Overhead Spaces

In open overhead spaces, cast-metal boxes threaded to raceways need not be separately supported except where used for fixture support; cast-metal boxes having threadless connectors and sheet metal boxes shall be supported directly from the building structure or by bar hangers. Hangers shall not be fastened to or supported from joist bridging. Where bar hangers are used, the bar shall be attached to raceways on opposite sides of the box and the raceway shall be supported with an approved type fastener not more than 24 inches from the box.

3.4 DEVICE PLATES

One-piece type device plates shall be provided for all outlets and fittings. Plates on unfinished walls and on fittings shall be of zinc-coated sheet steel, cast-metal, or impact resistant plastic having rounded or beveled edges. Plates on finished walls shall be of steel with baked enamel finish or impact-resistant plastic and shall be ivory. Screws shall be of metal with countersunk heads, in a color to match the finish of the plate. Plates shall be installed with all four edges in continuous contact with finished wall surfaces without the use of mats or similar devices. Plaster fillings will not be permitted. Plates shall be installed with an alignment tolerance of 1/16 inch. The use of sectional-type device plates will not be permitted. Plates installed in process areas shall be gasketed and provided with a hinged, gasketed cover, unless otherwise specified.

3.5 RECEPTACLES

3.5.1 Duplex, 20-ampere, 125 volt

Duplex receptacles shall be rated 20 amperes, 125 volts, two-pole, three-wire, grounding type with polarized parallel slots. Bodies shall be of ivory to match color of switch handles in the same room or to harmonize with the color of the respective wall, and supported by mounting strap having plaster ears. Contact arrangement shall be such that contact is made on two sides of an inserted blade. Receptacle shall be side- or back-wired with two screws per terminal. The third grounding pole shall be connected to the metal mounting yoke. Switched receptacles shall be the same as other receptacles specified except that the ungrounded pole of each suitable receptacle shall be provided with a separate terminal. Only the top receptacle of a duplex receptacle shall be wired for switching

application. Receptacles with ground fault circuit interrupters shall have the current rating as indicated, and shall be UL Class A type unless otherwise shown. Ground fault circuit protection shall be provided as required by NFPA 70 and as indicated on the drawings.

3.5.2 Weatherproof Applications

Weatherproof receptacles shall be suitable for the environment, damp or wet as applicable, and the housings shall be labeled to identify the allowable use. Receptacles shall be marked in accordance with UL 514A for the type of use indicated; "Damp locations", "Wet Locations", "Wet Location Only When Cover Closed". Assemblies shall be installed in accordance with the manufacturer's recommendations.

3.5.2.1 Damp Locations

Receptacles in damp locations shall be mounted in an outlet box with a gasketed, weatherproof, cast-metal cover plate (device plate, box cover) and a gasketed cap (hood, receptacle cover) over each receptacle opening. The cap shall be either a screw-on type permanently attached to the cover plate by a short length of bead chain or shall be a flap type attached to the cover with a spring loaded hinge.

3.5.2.2 Wet Locations

Receptacles in wet locations shall be installed in an assembly rated for such use whether the plug is inserted or withdrawn, unless otherwise indicated. In a duplex installation, the receptacle cover shall be configured to shield the connections whether one or both receptacles are in use.

3.5.3 Special-Purpose or Heavy-Duty Receptacles

Special-purpose or heavy-duty receptacles shall be of the type and of ratings and number of poles indicated or required for the anticipated purpose. Contact surfaces may be either round or rectangular. One appropriate straight or angle-type plug shall be furnished with each receptacle. Locking type receptacles, rated 30 amperes or less, shall be locked by rotating the plug. Locking type receptacles, rated more than 50 amperes, shall utilize a locking ring.

3.6 WALL SWITCHES

Wall switches shall be of the totally enclosed tumbler type. The wall switch handle and switch plate color shall be ivory. Wiring terminals shall be of the screw type or of the solderless pressure type having suitable conductor-release arrangement. Not more than one switch shall be installed in a single-gang position. Switches shall be rated 20-ampere 120 -volt for use on alternating current only. Pilot lights indicated shall consist of yoke-mounted candelabra-base sockets rated at 75 watts, 125 volts, and fitted with glass or plastic jewels. A clear 6-watt lamp shall be furnished and installed in each pilot switch. Jewels for use with switches controlling motors shall be green, and jewels for other purposes shall be red. Dimming switches shall be solid-state flush mounted, sized for the loads.

3.7 PANELBOARDS AND LOADCENTERS

Circuit breakers and switches used as a motor disconnecting means shall be

capable of being locked in the open position. Door locks shall be keyed alike. Nameplates shall be as approved. Directories shall be typed to indicate loads served by each circuit and mounted in a holder behind a clear protective covering. Busses shall be copper.

3.7.1 Loadcenters

Loadcenters shall be circuit breaker equipped.

3.7.2 Panelboards

Panelboards shall be circuit breaker equipped as indicated on the drawings.

3.8 FUSES

Equipment provided under this contract shall be provided with a complete set of properly rated fuses when the equipment manufacturer utilize fuses in the manufacture of the equipment, or if current-limiting fuses are required to be installed to limit the ampere-interrupting capacity of circuit breakers or equipment to less than the maximum available fault current at the location of the equipment to be installed. Fuses shall have a voltage rating of not less than the phase-to-phase circuit voltage, and shall have the time-current characteristics required for effective power system coordination.

3.8.1 Cartridge Fuses; Noncurrent-Limiting Type

Cartridge fuses of the noncurrent-limiting type shall be Class H, nonrenewable, dual element, time lag type and shall have interrupting capacity of 10,000 amperes. At 500 percent current, cartridge fuses shall not blow in less than 10 seconds.

3.8.2 Motor and Transformer Circuit Fuses

Motor, motor controller, transformer, and inductive circuit fuses shall be Class RK1 or RK5, current-limiting, time-delay with 200,000 amperes interrupting capacity.

3.9 MOTORS

Each motor shall conform to the hp and voltage ratings indicated, and shall have a service factor and other characteristics that are essential to the proper application and performance of the motors under conditions shown or specified. Three-phase motors for use on 3-phase 208-volt systems shall have a nameplate rating of 200 volts. Unless otherwise specified, all motors shall have open frames, and continuous-duty classification based on a 40 degree C ambient temperature reference. Polyphase motors shall be squirrel-cage type, having normal-starting-torque and low-starting-current characteristics, unless other characteristics are specified in other sections of these specifications or shown on contract drawings. When electrically driven equipment furnished under other sections of these specifications materially differs from the design, the Contractor shall make the necessary adjustments to the wiring, disconnect devices and branch-circuit protection to accommodate the equipment actually installed.

3.10 MOTOR CONTROL

Each motor or group of motors requiring a single control and not controlled

from a motor-control center shall be provided under other sections of these specifications with a suitable controller and devices that will perform the functions as specified for the respective motors. Each motor of 1/8 hp or larger shall be provided with thermal-overload protection. Polyphase motors shall have overload protection in each ungrounded conductor. The overload-protection device shall be provided either integral with the motor or controller, or shall be mounted in a separate enclosure. Unless otherwise specified, the protective device shall be of the manually reset type. Single or double pole tumbler switches specifically designed for alternating-current operation only may be used as manual controllers for single-phase motors having a current rating not in excess of 80 percent of the switch rating. Automatic control devices such as thermostats, float or pressure switches may control the starting and stopping of motors directly, provided the devices used are designed for that purpose and have an adequate horsepower rating. When the automatic-control device does not have such a rating, a magnetic starter shall be used, with the automatic-control device actuating the pilot-control circuit. When combination manual and automatic control is specified and the automatic-control device operates the motor directly, a double-throw, three-position tumbler or rotary switch shall be provided for the manual control; when the automatic-control device actuates the pilot control circuit of a magnetic starter, the latter shall be provided with a three-position selector switch marked MANUAL-OFF-AUTOMATIC. Connections to the selector switch shall be such that only the normal automatic regulatory control devices will be bypassed when the switch is in the Manual position; all safety control devices, such as low- or high-pressure cutouts, high-temperature cutouts, and motor-overload protective devices, shall be connected in the motor-control circuit in both the Manual and the Automatic positions of the selector switch. Control circuit connections to any MANUAL-OFF-AUTOMATIC switch or to more than one automatic regulatory control device shall be made in accordance with wiring diagram approved by the Contracting Officer unless such diagram is included on the drawings. All controls shall be 120 volts or less unless otherwise indicated.

3.10.1 Motor Control Centers

Control centers shall be indoor type and shall contain combination starters and other equipment as indicated. Control centers shall be NEMA ICS 2, Class 1 Type B. Each control center shall be mounted on floor sills or mounting channels. Each circuit shall have a suitable metal or laminated plastic nameplate with white cut letters. Combination starters shall be provided with circuit breakers. Motor control centers shall be provided with a full-length ground bus bar.

3.10.2 Contacts

Unless otherwise indicated, contacts in miscellaneous control devices such as float switches, pressure switches, and auxiliary relays shall have current and voltage ratings in accordance with NEMA ICS 2 for rating designation B300.

3.11 MOTOR-DISCONNECT MEANS

Each motor shall be provided with a disconnecting means when required by NFPA 70 even though not indicated. For single-phase motors, a single or double pole toggle switch, rated only for alternating current, will be acceptable for capacities less than 30 amperes, provided the ampere rating of the switch is at least 125 percent of the motor rating. Switches shall disconnect all ungrounded conductors.

3.12 TRANSFORMER INSTALLATION

Three-phase transformers shall be connected only in a delta-wye or wye-delta configuration as indicated. "T" connections may be used for transformers rated at 15 kVA or below. Dry-type transformers shown located within 5 feet of the exterior wall shall be provided in a weatherproof enclosure. Transformers to be located within the building may be provided in the manufacturer's standard, ventilated indoor enclosure designed for use in 40 degrees C ambient temperature, unless otherwise indicated.

3.13 LIGHTING FIXTURES, LAMPS AND BALLASTS

This paragraph shall cover the installation of lamps, lighting fixtures and ballasts in interior or building mounted applications.

3.13.1 Lamps

Lamps of the type, wattage, and voltage rating indicated shall be delivered to the project in the original cartons and installed just prior to project completion. Lamps installed and used for working light during construction shall be replaced prior to turnover to the Government if more than 15% of their rated life has been used. Lamps shall be tested for proper operation prior to turn-over and shall be replaced if necessary with new lamps from the original manufacturer. 10% spare lamps of each type, from the original manufacturer, shall be provided.

3.13.2 Lighting Fixtures

Fixtures shall be as shown and shall conform to the specifications and shall be as detailed on the drawings. Illustrations shown on the drawings are indicative of the general type desired and are not intended to restrict selection to fixtures of any particular manufacturer. Fixtures of similar designs and equivalent energy efficiency, light distribution and brightness characteristics, and of equal finish and quality will be acceptable if approved. In suspended acoustical ceilings with fluorescent fixtures, the fluorescent emergency light fixtures shall be furnished with self-contained battery packs.

3.13.2.1 Accessories

Accessories such as straps, mounting plates, nipples, or brackets shall be provided for proper installation.

3.13.2.2 Ceiling Fixtures

Ceiling fixtures shall be coordinated with and suitable for installation in, on or from the ceiling as shown. Installation and support of fixtures shall be in accordance with NFPA 70 and manufacturer's recommendations. Where seismic requirements are specified herein, fixtures shall be supported as shown or specified. Recessed fixtures shall have adjustable fittings to permit alignment with ceiling panels. Recessed fixtures installed in fire-resistive ceiling construction shall have the same fire rating as the ceiling or shall be provided with fireproofing boxes having materials of the same fire rating as the ceiling, in conformance with UL Elec Const Dir. Surface-mounted fixtures shall be suitable for fastening to the ceiling panel structural supports.

3.13.2.3 Fixtures for Installation in Grid Type Ceilings

Fixtures for installation in grid type ceilings which are smaller than a full tile shall be centered in the tile. 1 by 4 foot fixtures shall be mounted along the grid rail as shown. Work above the ceiling shall be coordinated among the trades to provide the lighting layout shown. Fixtures mounted to the grid shall have trim exactly compatible with the grid. Contractor shall coordinate trims with ceiling trades prior to ordering fixtures. Metric fixtures shall be designed to fit the metric grid specified. Fixtures in continuous rows shall be coordinated between trades prior to ordering. Fixtures shall be mounted using independent supports capable of supporting the entire weight of the fixture. No fixture shall rest solely on the ceiling grid. Recessed fixtures installed in seismic areas should be installed utilizing specially designed seismic clips. Junction boxes shall be supported at four points.

3.13.2.4 Suspended Fixtures

Suspended fixtures shall be provided with swivel hangers or hand-straights so that they hang plumb. Pendants, rods, or chains 4 feet or longer excluding fixture shall be braced to prevent swaying using three cables at 120 degrees of separation. Fixture finishes shall be free of scratches, nicks, dents, and warps, and shall match the color and gloss specified. Pendants shall be finished to match fixtures. Aircraft cable shall be stainless steel. Canopies shall be finished to match the ceiling and shall be low profile unless otherwise shown. Maximum distance between suspension points shall be 10 feet or as recommended by the manufacturer, whichever is less.

3.13.3 Emergency Light Sets

Emergency light sets shall conform to UL 924 with the number of heads as indicated. Sets shall be permanently connected to the wiring system by conductors installed in short lengths of flexible conduit.

3.14 BATTERY CHARGERS

Battery chargers shall be installed in conformance with NFPA 70.

3.15 EQUIPMENT CONNECTIONS

Wiring not furnished and installed under other sections of the specifications for the connection of electrical equipment as indicated on the drawings shall be furnished and installed under this section of the specifications. Connections shall comply with the applicable requirements of paragraph WIRING METHODS. Flexible conduits 6 feet or less in length shall be provided to all electrical equipment subject to periodic removal, vibration, or movement and for all motors. All motors shall be provided with separate grounding conductors. Liquid-tight conduits shall be used in damp or wet locations.

3.15.1 Motors and Motor Control

Motors, motor controls, and motor control centers shall be installed in accordance with NFPA 70, the manufacturer's recommendations, and as indicated. Wiring shall be extended to motors, motor controls, and motor control centers and terminated.

3.15.2 Installation of Government-Furnished Equipment

Wiring shall be extended to the equipment and terminated.

3.16 CIRCUIT PROTECTIVE DEVICES

The Contractor shall calibrate, adjust, set and test each new adjustable circuit protective device to ensure that they will function properly prior to the initial energization of the new power system under actual operating conditions.

3.17 PAINTING AND FINISHING

Field-applied paint on exposed surfaces shall be provided under Section 09900 PAINTING, GENERAL.

3.18 REPAIR OF EXISTING WORK

The work shall be carefully laid out in advance, and where cutting, channeling, chasing, or drilling of floors, walls, partitions, ceiling, or other surfaces is necessary for the proper installation, support, or anchorage of the conduit, raceways, or other electrical work, this work shall be carefully done, and any damage to building, piping, or equipment shall be repaired by skilled mechanics of the trades involved at no additional cost to the Government.

3.19 FIELD TESTING

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 3 days prior to conducting tests. The Contractor shall furnish all materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform all tests and inspection recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of all tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. All field test reports will be signed and dated by the Contractor.

3.19.1 Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

3.19.2 Ground-Resistance Tests

The resistance of the grounding grid shall be measured using the fall-of-potential method defined in IEEE Std 81. Soil resistivity in the area of the grid shall be measured concurrently with the grid measurements. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

a. Single rod electrode - 25 ohms.

b. Grid electrode - 25 ohms.

3.19.3 Ground-Grid Connection Inspection

All below-grade ground-grid connections will be visually inspected by the Contracting Officer before backfilling. The Contractor shall notify the Contracting Officer 2 hours before the site is ready for inspection.

3.19.4 Cable Tests

The Contractor shall be responsible for identifying all equipment and devices that could be damaged by application of the test voltage and ensuring that they have been properly disconnected prior to performing insulation resistance testing. An insulation resistance test shall be performed on all low and medium voltage cables after the cables are installed in their final configuration and prior to energization. The test voltage shall be 500 volts DC applied for one minute between each conductor and ground and between all possible combinations of conductors. The minimum value of resistance shall be:

R in megohms = (rated voltage in kV + 1) x 1000/(length of cable in feet)

Each cable failing this test shall be repaired or replaced. The repaired cable system shall then be retested until failures have been eliminated.

3.19.4.1 Medium Voltage Cable Tests

a. Continuity test.

b. Insulation resistance test.

c. DC high-potential test.

3.19.4.2 Low Voltage Cable Tests

a. Continuity test.

b. Insulation resistance test.

3.19.5 Metal Enclosed Bus Duct Tests

a. Insulation Resistance phase-to-phase, all combinations.

b. Insulation resistance phase-to-ground, each phase.

c. AC or DC high-potential test.

d. Phase rotation test.

3.19.6 Motor Tests

a. Phase rotation test to ensure proper directions.

b. Operation and sequence of reduced voltage starters.

c. Insulation resistance of each winding to ground.

d. Vibration test.

3.19.7 Dry-Type Transformer Tests

The following field tests shall be performed on all dry-type transformers 50 kVA and above.

a. Insulation resistance test phase-to-ground, each phase.

b. Turns ratio test.

3.19.8 Circuit Breaker Tests

The following field tests shall be performed on circuit breakers.

3.19.8.1 Circuit Breakers, Low Voltage

a. Insulation resistance test phase-to-phase, all combinations.

b. Insulation resistance test phase-to-ground, each phase.

c. Closed breaker contact resistance test.

d. Manual and electrical operation of the breaker.

3.19.8.2 Circuit Breakers, Molded Case

a. Insulation resistance test phase-to-phase, all combinations.

b. Insulation resistance test phase-to-ground, each phase.

c. Closed breaker contact resistance test.

d. Manual operation of the breaker.

3.19.9 Motor Control Centers

a. Insulation resistance test phase-to-phase, all combinations.

b. Insulation resistance test phase-to-ground, each phase.

c. Manual and electrical operational tests.

3.20 OPERATING TESTS

After the installation is completed, and at such time as the Contracting Officer may direct, the Contractor shall conduct operating tests for approval. The equipment shall be demonstrated to operate in accordance with the specified requirements. An operating test report shall be submitted in accordance with paragraph FIELD TEST REPORTS.

3.21 ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation, material or operation have been corrected.

-- End of Section --

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SECTION 16510

INTERIOR LIGHTING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C78.42	(1995) Electric Lamps - Guideline for High-Pressure Sodium Lamps
ANSI C82.4	(1992) Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type)
ANSI C82.11	(1993; R 1998) High-Frequency Fluorescent Lamp Ballasts

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 641/A 641M	(1998) Zinc-Coated (Galvanized) Carbon Steel Wire

ILLUMINATING ENGINEERING SOCIETY OF NORTH AMERICA (IES)

IES LHBK	(1993) Lighting Handbook, Reference and Application

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(1993) Industrial Control and Systems Controllers, Contactors and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC
NEMA ICS 6	(1993) Industrial Control and Systems Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2002) National Electrical Code
NFPA 101	(1997) Life Safety Code

UNDERWRITERS LABORATORIES INC. (UL)

UL 924	(1995; R 1997, Bul. 1998) Emergency Lighting and Power Equipment
UL 935	(1995; R 1998) Fluorescent-Lamp Ballasts
UL 1029	(1994; R 1997) High-Intensity-Discharge

	Lamp Ballasts
UL 1570	(1995; R 1999) Fluorescent Lighting Fixtures
UL 1572	(1995; R 1999) High Intensity Discharge Lighting Fixtures

1.2 RELATED REQUIREMENTS

Section 16050, "Basic Electrical Materials and Methods," applies to this section, with the additions and modifications specified herein. Lighting fixtures and accessories mounted on exterior surfaces of buildings are specified in this section.

1.3 DEFINITIONS

1.3.1 Average Life

Time after which 50 percent will have failed and 50 percent will have survived under normal conditions.

1.3.2 Total Harmonic Distortion (THD)

The root mean square (RMS) of all the harmonic components divided by the total fundamental current.

1.4 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures." Data, drawings, and reports shall employ the terminology, classifications, and methods prescribed by the IES LHBK, as applicable, for the lighting system specified.

SD-03 Product Data

Fluorescent lighting fixtures; GA

Fluorescent electronic ballasts; GA

Fluorescent lamps; GA

High-intensity-discharge (HID) lighting fixtures; GA

HID ballasts; GA

High-pressure sodium (HPS) lamps; GA

Lighting contactor; GA

Time switch; GA

Photocell switch; GA

Power hook fixture hangers; GA

Exit signs; GA

Emergency lighting equipment; GA

SD-04 Samples

Lighting fixtures, complete with lamps and ballasts; GA

SD-06 Test Reports

Operating test; GA

Submit test results as stated in paragraph entitled "Field Quality Control."

SD-11 Closeout Submittals

Information card; GA

1.5 QUALITY ASSURANCE

1.5.1 Fluorescent Electronic Ballasts

Submit ballast catalog data as required in the paragraph entitled "Fluorescent Lamp Electronic Ballasts" contained herein. As an option, submit the fluorescent fixture manufacturer's electronic ballast specification information in lieu of the actual ballast manufacturer's catalog data. This information shall include published specifications and sketches, which covers the information required by the paragraph entitled "Fluorescent Lamp Electronic Ballasts" herein. This information may be supplemented by catalog data if required, and shall contain a list of vendors with vendor part numbers.

1.6 ELECTRONIC BALLAST WARRANTY

Furnish the electronic ballast manufacturer's warranty. The warranty period shall not be less than 5 years from the date of manufacture of the electronic ballast. Ballast assembly in the lighting fixture, transportation, and on-site storage shall not exceed 12 months, thereby permitting 4 years of the ballast 5 year warranty to be in service and energized. The warranty shall state that the malfunctioning ballast shall be exchanged by the manufacturer and promptly shipped to the using Government facility. The replacement ballast shall be identical to, or an improvement upon, the original design of the malfunctioning ballast.

PART 2 PRODUCTS

2.1 FLUORESCENT LIGHTING FIXTURES

UL 1570. Fluorescent fixtures shall have electronic ballasts unless specifically indicated otherwise.

2.1.1 Fluorescent Lamp Electronic Ballasts

The electronic ballast shall as a minimum meet the following characteristics:

a. Ballast shall comply with UL 935, ANSI C82.11, and NFPA 70 unless specified otherwise. Ballast shall be designed for the wattage of the lamps used in the indicated application. Ballasts shall be designed to operate on the voltage system to which they are connected.

b. Power factor shall be 0.95 (minimum).

c. Ballast shall operate at a frequency of 20,000 Hertz (minimum).

d. Ballast shall have light regulation of plus or minus 10 percent lumen output with a plus or minus 10 percent input voltage regulation. Ballast shall have 10 percent flicker (maximum) using any compatible lamp.

e. Ballast shall be UL listed Class P with a sound rating of "A."

f. Ballast enclosure size shall conform to standards of electromagnetic ballasts. Ballast shall have circuit diagrams and lamp connections displayed on ballast packages. Ballast shall operate lamps in a parallel circuit configuration that permits the operation of remaining lamps if one or more lamps fail or are removed.

g. Ballast shall operate in an instant start mode.

h. Electronic ballast shall have a full replacement warranty of 5 years from date of manufacture as specified in paragraph entitled "Electronic Ballast Warranty" herein.

2.1.1.1 T-8 Lamp Ballast

a. Ballast shall be capable of starting and maintaining operation at a minimum of 50 degrees F for F32T8 lamps, unless otherwise indicated.

b. Total harmonic distortion (THD): Shall be 20 percent(maximum).

c. Input wattage.

(1) 32 watts (maximum) when operating one F32T8 lamp.

(2) 62 watts (maximum) when operating two F32T8 lamps

(3) 92 watts (maximum) when operating three F32T8 lamps

(4) 114 watts (maximum) when operating four F32T8 lamps

2.1.2 Fluorescent Lamps

a. T-8 rapid start lamps shall be rated 32 watts (maximum), 2800 initial lumens (minimum), CRI of 75 (minimum), color temperature of 3500 K, and an average rated life of 20,000 hours.

Average rated life is based on 3 hours operating per start.

2.2 HIGH-INTENSITY-DISCHARGE (HID) LIGHTING FIXTURES

UL 1572. Provide HID fixtures with tempered glass lenses when using metal-halide lamps.

2.2.1 HID Ballasts

UL 1029 and ANSI C82.4 and shall be constant wattage autotransformer (CWA)

or regulator, high power factor type. Provide single-lamp ballasts which shall have a minimum starting temperature of minus 30 degrees C. Ballasts shall be:

a. Designed to operate on the voltage system to which they are connected.

b. Designed for installation in a normal ambient temperature of 40 degrees C.

c. Constructed so that open circuit operation will not reduce the average life.

High-pressure sodium (HPS) ballasts shall have a solid-state igniter/starter with an average life in the pulsing mode of 3500 hours at the intended ambient temperature. Igniter case temperature shall not exceed 90 degrees C in any mode.

2.2.2 High-Pressure Sodium (HPS) Lamps

ANSI C78.42 wattage as indicated. 150 watt lamps, if required, shall be 55 volt type.

2.2.2.1 Standby HPS Lamps

Standby HPS lamps shall have two arc tubes and an average rated life of 40,000 hours (minimum) and hot restart instant lumen output shall be 8 percent, minimum, of total light output.

2.3 RECESS- AND FLUSH-MOUNTED FIXTURES

Provide type that can be relamped from the bottom. Access to ballast shall be from the bottom. Trim for the exposed surface of flush-mounted fixtures shall be as indicated.

2.4 SUSPENDED FIXTURES

Provide hangers capable of supporting twice the combined weight of fixtures supported by hangers. Hangers shall allow fixtures to swing within an angle of 20 degrees. Brace pendants 4 feet or longer to limit swinging. Single-unit suspended fluorescent fixtures shall have twin-stem hangers. Multiple-unit or continuous row fluorescent fixtures shall have a tubing or stem for wiring at one point and a tubing or rod suspension provided for each unit length of chassis, including one at each end. Rods shall be a minimum 0.18 inch diameter.

2.5 LIGHTING CONTACTOR

NEMA ICS 2, electrically held contactor. Contacts shall be rated 120 volts, 30 amperes, and 2 poles. Coils shall be rated 120 volts. Provide in NEMA 1 enclosure conforming to NEMA ICS 6. Contactor shall have silver alloy double-break contacts. Provide contactor with hand-off-automatic on-off selector switch.

2.6 EXIT SIGNS

UL 924, NFPA 70, and NFPA 101. Exit signs shall be self-powered type.

2.6.1 Self-Powered LED Type Exit Signs (Battery Backup)

Provide with automatic power failure device, test switch, pilot light, integral self-testing module and fully automatic high/low trickle charger in a self-contained power pack. Battery shall be sealed electrolyte type, shall operate unattended, and require no maintenance, including no additional water, for a period of not less than 5 years. LED exit sign shall have emergency run time of 1 1/2 hours (minimum).

2.7 EMERGENCY LIGHTING EQUIPMENT

UL 924, NFPA 70, and NFPA 101. Provide lamps in wattage indicated.

2.7.1 Emergency Lighting Unit

Provide as indicated. Equip units with brown-out sensitive circuit to activate battery when ac input falls to 75 percent of normal voltage and 15 minute time delay feature for areas with HID lighting.

2.7.2 Fluorescent Emergency System

Each system shall consist of an automatic power failure device, test switch operable from outside of the fixture, pilot light visible from outside the fixture, and fully automatic solid-state charger in a self-contained power pack. Provide self-testing module integral to the fixture. Charger shall be either trickle, float, constant current or constant potential type, or a combination of these. Battery shall be sealed electrolyte type with capacity as required to supply power to 1 lamps for 90 minutes at a minimum of 600 lumens per lamp output. Battery shall operate unattended and require no maintenance, including no additional water, for a period of not less than 5 years.

2.8 SELF-TESTING MODULE

Self-testing module for exit signs and emergency lighting equipment shall perform the following functions:

a. Continuous monitoring of charger operation and battery voltage with visual indication of normal operation and of malfunction.

b. Monthly discharge cycling of battery with monitoring of transfer circuit function, battery capacity and emergency lamp operation with visual indication of malfunction. The battery capacity test may be conducted by using a synthetic load.

c. Manual test switch to simulate a discharge test cycle.

d. Module shall have low voltage battery disconnect (LVD) and brown-out protection circuit.

2.9 SUPPORT HANGERS FOR LIGHTING FIXTURES IN SUSPENDED CEILINGS

2.9.1 Wires

ASTM A 641/A 641M, Class 3, soft temper, zinc-coated finish, 12 gage.

2.9.2 Rods

Threaded steel rods, 3/16 inch diameter, zinc or cadmium coated.

PART 3 EXECUTION

3.1 INSTALLATION

Set lighting fixtures plumb, square, and level with ceiling and walls, in alignment with adjacent lighting fixtures, and secure in accordance with manufacturers' directions and approved drawings. Installation shall meet requirements of NFPA 70. Mounting heights specified or indicated shall be to the bottom of fixture for ceiling-mounted fixtures and to center of fixture for wall-mounted fixtures. Obtain approval of the exact mounting for lighting fixtures on the job before commencing installation and, where applicable, after coordinating with the type, style, and pattern of the ceiling being installed. Recessed and semi-recessed fixtures may be supported from suspended ceiling support system ceiling tees when the ceiling system support wires are provided at a minimum of four wires per fixture and located not more than 6 inches from each corner of each fixture. For recessed fixtures, provide support clips securely fastened to ceiling grid members, a minimum of one at or near each corner of each fixture. For round fixtures or fixtures smaller in size than the ceiling grid, provide a minimum of four wires per fixture and locate at each corner of the ceiling grid in which the fixture is located. Do not support fixtures by ceiling acoustical panels. Where fixtures of sizes less than the ceiling grid are indicated to be centered in the acoustical panel, support such fixtures independently or with at least two 3/4 inch metal channels spanning, and secured to, the ceiling tees. Provide wires for lighting fixture support in this section.

3.1.1 Electronic Dimming Ballast

All electronic dimming ballasts controlled by the same controller shall be of the same manufacturer. All fluorescent lamps on electronic dimming ballast control shall be seasoned or burned in at full light output for 100 hours before dimming.

3.1.2 Exit Signs and Emergency Lighting Units

Wire exit signs and emergency lighting units ahead of the switch to the normal lighting circuit located in the same room or area.

3.1.2.1 Exit Signs

Wire exit signs on separate circuits and serve from a separate breaker. Signs shall have only one control, which shall be the separate breaker. Paint control device red and provide lockout.

3.2 FIELD QUALITY CONTROL

Upon completion of installation, conduct an operating test to show that equipment operates in accordance with requirements of this section.

FORM 1, ELECTRONIC BALLAST WARRANTY

1. Location _____ 2. Bldg. Name _____

3. Bldg. No. _____ 4. Installation Areas _____

5. Contract No. _____

6. Ballast Manufacturer Name/Address _____

7. Exchange Information _____

8. Warranty Return Number: _____

9. Warranty Period: From _____ To _____

10. Acceptance Date: _____ 11. Inspector: _____

12. Prime Contractor Name/Address: _____

Signature: _____ Date: _____

INSTRUCTIONS FOR FORM 1

1. Location: Name of activity as shown on contract.

2. Bldg. Name: As shown on contract or as provided by Contracting Officer.

3. Bldg. No.: As provided by Contracting Officer.

4. Installation Areas: Main areas in the building where ballasts are installed; floors, room numbers, lean-to, etc. A separate form is required for each ballast manufacturer used in the contract.

5. Contract No.: As shown on the contract.

6. Ballast Manufacturer Name/Address: Ballast manufacturer's name, address, and telephone number.

7. Exchange Information: Ballast exchange information such as point of contact, telephone number, shipping address if different from item 6, and any special shipping instructions.

8. Warranty Return Number: Return authorization number if required.

9. Warranty Period: Insert estimated start and end dates.

10. Acceptance Date: Show date ballasts were accepted by the Contracting Officer.

11. Inspector: Show Government inspector's name.

12. Prime Contractor Name/Address/Signature/Date: Shall be signed and dated by an official of the contracting firm.

-- End of Section --

1.5 NAMEPLATES

The clarifier shall have the manufacturer's name, address, type or style model or catalog number, and serial number on a plate secured to the item of equipment, and tag number as specified by Foster Wheeler.

1.6 VERIFICATION OF DIMENSIONS

The Subcontractor shall become familiar with all details of the work, and shall advise Foster Wheeler of any discrepancy before performing any work. Materials and equipment shall fit into the space allotted without interference to building features or other equipment and with adequate and acceptable clearances allowed for entry, maintenance and operation.

1.7 FACTORY TEST

1.7.1 Quality Control

The manufacturer shall have quality control procedures adequate to ensure that all fabrications comply with these specifications. Quality control shall include a final inspection by the manufacturer and a written record of this final inspection. All tests shall be witnessed by the manufacturer's design engineer and quality control inspector.

1.7.2 Inspection

The manufacturer's inspection shall include the following:

Thickness measurements.

Measurements showing compliance with dimensions and tolerance of clarifier walls, bottoms, tops, and flanges, and flatness of flanges.

1.7.3 Testing

Clarifiers shall be hydrostatically tested for leaks by filling with water. Tanks shall be checked for leaks after they have been filled for at least one hour prior to painting. Foster Wheeler may request that this be performed in their presence at the time of inspection.

1.7.4 Inspection and Test Report

A separate inspection and test record shall be made for each tank. Inspection and test records shall be submitted to Foster Wheeler for review prior to delivery and shall contain certification that the above referenced tests have been performed and have been witnessed by the design engineer and the quality control inspector.

1.8 MANUFACTURER'S SERVICES

The clarifier manufacturer shall provide the services of a factory trained representative for a minimum period of two days per unit to supervise installation, perform initial start-up of the equipment, to instruct the Owner's operating personnel in the operation and maintenance of the equipment, and to adjust the equipment for satisfactory operation after installation. The manufacturer's representative performing this service shall be a direct employee of the equipment manufacturer, normally engaged

in this type of service work.

1.9 DELIVERY AND STORAGE

The Subcontractor shall require the manufacturer to assume responsibility for packaging to prevent normal transit and handling damage.

Flange faces shall be protected from damage.

All openings shall be covered to prevent entrance of dirt, water and debris.

Clarifier shall be mounted on skids or a protective framework so constructed as to provide easy handling for fork truck or similar device, and/or shall be provided with lifting lugs, cleats, etc., to permit handling by crane. Nozzles, manholes, or other fittings shall not be used for lifting.

A detail plan shall be provided for unloading and installation of the clarifier.

1.10 GUARANTEE

The Vendor shall guarantee in writing that the equipment furnished shall be free of manufacturing and fabrication defects in material and workmanship for a period of 12 months after the equipment is satisfactorily placed in service. Should defects be identified, the vendor shall provide all labor, equipment, materials and transportation to repair such defects at no cost to Foster Wheeler

PART 2 PRODUCTS

2.1 CLARIFIER

The inclined plate clarifier shall have a maximum height of 25 feet and sufficient clearance to allow for manual removal and cleaning of the inclined plates. The maximum area available for the clarifier is 18 feet by 35 feet.

The inclined plate clarifier shall be epoxy lined carbon steel or equivalent and shall have a total flow of 2,000 GPM when operated at an overflow rate of 1.0 GPM/sq.ft. The inclined plates shall have a total horizontal projected setting area of 2,400 sq.ft. (minimum) and shall be set at an angle of 55 to 60 deg.

Flanged connections shall be provided for influent, effluent and sludge drain connections. Flanges shall be flat-faced, slip on welded flanges with a hole pattern for a standard 150 lb. flange.

The inclined plate clarifier shall be designed to operate with the flow in an upward direction. The horizontal spacing of the plates shall be a minimum of 1.25 inches.

The inclined plates shall be fiber reinforced plastic. Each plate pack shall be individually installed in the clarifier so that cranes are not required to remove a plate pack for inspection of the plates and/or the interior of the clarifier tank.

Velocity within the rapid mix tank, slow mix tank and clarifier shall be

appropriate to avoid the shearing of floc. The rapid mix and slow mix tanks shall be integral units to the clarifier and properly designed for discharge into the clarifier influent chamber. The influent chamber shall be designed to ensure even cross sectional distribution of the influent.

The effluent shall be collected by an overflow box. The trough shall be equipped on each side with an adjustable fiberglass weir plate for collecting water from the individual plates. By leveling the adjustable weir, an even overflow across each plate shall be positively assured by simple visual inspection of the weir.

a. Flow Rate

Minimum: 700 gpm
Maximum: 2,000 gpm

b. Water Temperature

Maximum: 70 degrees F
Minimum: 32 degrees F

c. Influent/Effluent pH

	Influent	Effluent
Maximum:	9.0	9.0
Minimum:	6.0	6.0

d. Space Availability

Maximum Area: 18 feet by 35 feet

2.2 RAPID FLASH MIX TANK

The inclined plate clarifier shall have a rapid mix system as an integral unit to the system. The rapid mix system shall include a tank mixer, motor and any other accessories required for the systems installation and operation.

The tank shall be epoxy lined carbon steel or equivalent. The tank dimensions shall be selected to insure maximum effective mixing. The maximum tank width shall not exceed the width of the clarifier. The mixer shall be propeller-type, fixed speed drive designed to operate on 230/460 volts, three phase, 60 Hz electric power.

2.3 SLOW MIX FLOCCULATION TANK

The inclined plate clarifier shall have a slow mix system as an integral unit to the system. The slow mix system shall include a tank, mixer, motor and other accessories required for the systems installation and operation.

The tank shall be epoxy lined carbon steel or equivalent. The tank dimensions shall be selected to insure maximum effective mixing while minimizing floc break-up. The maximum tank width shall not exceed that of the clarifier. The flocculation mixer shall be picket-type, variable-speed drive designed to operate on 230/460 V, three phase, 60 Hz electrical power.

2.4 SLUDGE THICKENING TANK

The clarifier shall have a sludge thickening/holding tank with a volume as recommended by the manufacturer. The tank shall have a picket fence type thickener with scraper; augar or vibratory thickener designed to operate on 230/460 V, three pahse, 60 Hz electrical power. A level control for sludge removal shall be provided.

2.5 MOTOR REQUIREMENTS

Each electric motor-driven mixer shall be driven by a totally-enclosed fancooled continuous-duty electric motor. Motor shall have a 1.15 service factor. Motors shall be high efficiency type, squirrel-cage induction motors having normal-starting-torque and low-current characterisitcs, and shall be of sufficient size so that the nameplate horsepower rating will not be exceeded throughout the entire published pump characeristic curve. Motor bearings shall provide smooth operations under the conditions encountered for the life of the motor. Adequate thrust bearing shall be provided in the motor to carry the weight of all rotating parts plus the hydraulic thrust and shall be capable of withstanding upthrust imposed during pump starting and under variable pumping head conditions specified. Calss F insulation with a class B temperature rise at 40 degrees C ambient. Motors shall conform to NEMA 4Text

2.6 CLARIFIER ACCESSORIES

2.6.1 Clarifier Cover

The clarifier shall be provided with a clear removable cover to allow access to the top of the clarifier during operation. The cover will allow for removal of the inclined plates when the cover is removed. The cover shall provide an air tight seal when closed.

2.6.2 Steel Pipe Fittings

Steel pipe fitting shall conform to the following and shall be reinforced.

2.6.3 Flanged Fittings

Flanged Fittings: Carbon steel, 150 lb, ASNI B16.5, ASTM A181, or A105.

2.6.4 Flange Gaskets

Gaskets shall be fabricated from a resin base material. Gasket stock shall be approximately 3/22-in. thick in its free state and 1/16-in. thick after compression in a flanged joint.

2.6.5 Platforms and Walkways

Clarifier shall be supplied with a steel platform around the perimeter complete with ladder, handrails and toe plates per 29CFR1926 Subpart L.

2.6.5.1 Level Sensor for Sludge

An infrared or ultrasonic level sensor and switch shall be included in the sludge thickening tank. The sensor shall be capable of detecting the interface between the sludge blanket and water. The switch will be capable of interfacing with PLC and SCADA systems. The switch will generate an

output signal indicating a high sludge level before the sludge blanket rises above the bottom of the plate packs.

PART 3 EXECUTION3.1 INSTALLATION

The subcontracor shall install the inclined plate clarifier in accordance with the manufacurer's instructions. TIt shall be the responsibility of the subcontractor to coordinate the delivery and installation of the clarifer to minimize interference and/or delays.

Should any defect become evident during installation, testing, or within the guarranty period, the sibcontractor shall repair or replace the tank and/or fittings as approved by Foster Wheeler.Text

3.2 INSPECTIONS AND TESTING

Tank Inspection and testing shall be in accordance with Section 11 of AWWA D100. Mill and Shop inspections are not required. Contractor shall perform the hydrostatic test. Final hydrostatic test shall be performed before painting.

3.3 PAINTING

The subcontractor shall paint the inclined plate clarifier at the factory in accordance with the recommendations of the manufacturer.

3.3.1 Surface Preparation

All steel surfaces shall receive a commercial blast in accordance with SSPC-SP-6-63 to remove rust, mill scale and weld slag. All weld splatter and surface roughness shall be removed by chipping and grinding smooth.

All prepared surfaces shall be thoroughly dry and free from preparation dust and foreign matter prior to the application of any coating. Craftsmen applying protective coatings shall be thoroughly familiar with the application guidelines and preparation requirements of the product to be applied. All materials shall be evenly applied and shall be free from obvious defects.Text

3.3.2 Application

Immediately after surface preparation, a polyamide-cured epoxy designed for protection of steel shall be applied. No discoloration of the clean area shall occur prior to the application of this coat. All steel surfaces shall receive a 3 mil film thickness of this protective coating.

Dry film thickness of all coats shall be made by employing standard calibrated dry film thickness gauges.

3.4 Paint Touch-Up Kit

A paint touch-up kit shall be provided for repair of any scratches or marks that occur during shipment or installation. Detailed instructions shall be included and the materials shall be compatible with the coatings as outlined above.

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SECTION 13120

STANDARD METAL BUILDING SYSTEMS

PART 1 GENERAL

1.1 CODES AND REFERENCES

The codes and reference publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. Commonwealth of Massachusetts State Building Code is the basic code governing the Project. In case of contradiction, the most stringent code applies.

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 101	(1997) Voluntary Specifications for Aluminum, Vinyl (PVC) and Wood Windows and Glass Doors

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC FCD	(1995a) Quality Certification Program
AISC Pub No. S303	(1992) Code of Standard Practice for Steel Buildings and Bridges
AISC Pub No. S329	(1985; Appx A June 1994) Allowable Stress Design Specification for Structural Joints Using ASTM A 325 or A 490 Bolts
AISC Pub No. S342 L	(1993) Load and Resistance Factor Design Specification for Structural Steel Buildings
AISC ASD Spec S335	(1989) Specification for Structural Steel Buildings - Allowable Stress Design, Plastic Design

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI Cold-Formed Mnl	(1996) Cold-Formed Steel Design Manual

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36/A 36M	(1997ael) Carbon Structural Steel
ASTM A 53/A 53M	(1999b) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 252	(1998) Welded and Seamless Steel Pipe Piles
ASTM A 325	(1997) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

ASTM A 463/A 463M	(1999a) Steel Sheet, Aluminum-Coated by the Hot-Dip Process
ASTM A 490	(1997) Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength
ASTM A 490M	(1993) High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints (Metric)
ASTM A 500	(1999) Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 501	(1999) Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
ASTM A 529/A 529M	(1996) High-Strength Carbon-Manganese Steel of Structural Quality
ASTM A 570/A 570M	(1998) Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality
ASTM A 572/A 572M	(1999b) High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A 588/A 588M	(1997a) High-Strength Low-Alloy Structural Steel with 50 ksi (345 MPa) Minimum Yield Point to 4 in. (100 mm) Thick
ASTM A 606	(1998) Steel, Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance
ASTM A 607	(1998) Steel, Sheet and Strip, High-Strength, Low-Alloy, Columbium or Vanadium, or Both, Hot-Rolled and Cold-Rolled
ASTM A 618	(1999) Hot-Formed Welded and Seamless High-Strength Low-Alloy Structural Tubing
ASTM A 653/A 653M	(1999a) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 792/A 792M	(1999) Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
ASTM C 518	(1998) Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM C 578	(1995) Rigid, Cellular Polystyrene Thermal Insulation
ASTM C 612	(1993) Mineral Fiber Block and Board Thermal Insulation

ASTM C 991	(1998) Flexible Glass Fiber Insulation for Pre-Engineered Metal Buildings
ASTM C 1289	(1998) Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
ASTM D 522	(1993a) Mandrel Bend Test of Attached Organic Coatings
ASTM D 523	(1989; R 1999) Specular Gloss
ASTM D 610	(1995) Evaluating Degree of Rusting on Painted Steel Surfaces
ASTM D 714	(1987; R 1994e1) Evaluating Degree of Blistering of Paints
ASTM D 968	(1993) Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM D 1308	(1987; R 1998) Effect of Household Chemicals on Clear and Pigmented Organic Finishes
ASTM D 1654	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D 2244	(1995) Calculation of Color Differences from Instrumentally Measured Color Coordinates
ASTM D 2247	(1999) Testing Water Resistance of Coatings in 100% Relative Humidity
ASTM D 2794	(1993; R 1999e1) Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D 3359	(1997) Measuring Adhesion by Tape Test
ASTM D 4214	(1998) Evaluating Degree of Chalking of Exterior Paint Films
ASTM D 4587	(1991) Conducting Tests on Paint and Related Coatings and Materials Using a Fluorescent UV-Condensation Light- and Water-Exposure Apparatus
ASTM D 5894	(1996) Standard Practice for Cyclic Salt Fog/UV Exposure of Painted Metal, (Alternating Exposures in a Fog/Dry Cabinet and a UV/Condensation Cabinet)
ASTM E 84	(1999) Surface Burning Characteristics of Building Materials
ASTM E 96	(1995) Water Vapor Transmission of

Materials

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7	(1998) Minimum Design Loads for Buildings and Other Structures

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	(2000) Structural Welding Code - Steel

COMMONWEALTH OF MASSACHUSETTS

780 CMR	(2001) Massachusetts State Building Code

ENGINEERING TECHNICAL INSTRUCTIONS AND ENERGY SAVINGS ANALYSIS

TI 809-04	(1998) Seismic Design for Buildings
TI 809-07	(1998) Design of Cold-Formed Load Bearing Steel Systems and Masonry Veneer/Steel Stud Walls

METAL BUILDING MANUFACTURERS ASSOCIATION (MBMA)

MBMA Low Rise Manual	(1996) Low Rise Building Systems Manual

SHEET METAL & AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA Arch. Manual	(1993; Errata; Addenda Oct 1997) Architectural Sheet Metal Manual

STEEL WINDOW INSTITUTE (SWI)

SWI Specifier's Guide	(1995) The Specifier's Guide to Steel Windows

UNDERWRITERS LABORATORIES (UL)

UL 580	(1994; Rev thru Feb 1998) Tests for Uplift Resistance of Roof Assemblies

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Drawings; GA

Detail foundation and building drawings consisting of specifications, catalog cuts, design and erection drawings shall contain an isometric view of the roof showing the design wind uplift pressure and dimensions of edge and corner zones; shop painting and finishing specifications.

SD-03 Product Data

Design Analysis; GA

Design analysis as one package with the detail drawings. The design shall meet the Massachusetts State Building Code and all other pertinent codes. The design analysis, signed by a Professional Engineer registered in the State of Massachusetts, shall include a list of the design loads, and complete calculations for the building, its components, and the building foundation system. Formulas and references shall be identified. Assumptions and conclusions shall be explained, and cross-referencing shall be clear. The design analysis shall include, but not be limited to, the following wind and seismic information:

a. Wind forces on various parts of the structure. Both positive and negative pressures shall be calculated with the controlling pressure summarized.

b. Lateral forces due to seismic loading.

Computer programmed designs shall be accompanied by stress values and a letter of certification, signed by a Professional Engineer registered in the State of Massachusetts, stating the design criteria and procedures used and attesting to the adequacy and accuracy of the design. A narrative of the computer program delineating the basic methodology shall be included in the submittal. The program output shall be annotated and supplemented with sketches to make it easier for an engineer unfamiliar with the program to verify the input and output. Critical load conditions used in the final sizing of the members shall be emphasized. The design analysis shall include the name and office phone number of the designer and checker who function as a point of contact to answer questions during the detail-drawing review.

Instruction Manuals; GA

Manufacturer's literature for individual building component systems.

Erection; GA

Manufacturer's erection instruction and erection drawings describing the preparation requirements, assembly sequence, temporary bracing, shoring, and related information necessary for erection of the metal building including its structural framework and components.

Qualifications; GA

Qualifications of the manufacturer, the manufacturer's Representative when one is used, and qualifications and experience of the building erector. A brief list of locations where buildings of similar design have been used shall be included with the detail drawings and shall also include information regarding date of completion, name and address of owner, and how the structure is used.

SD-04 Samples

Accessories; FIO

One sample of each type of flashing, trim, closure, cap and similar items. Size shall be sufficient to show construction and configuration.

Roofing and Siding; FIO

One piece of each type and finish (exterior and interior) to be used, 9 inches long, full width. The sample for factory color finished covering shall be accompanied by certified laboratory test reports showing that the sheets to be furnished are produced under a continuing quality control program and that a representative sample consisting of not less than 5 pieces has been tested and has met the quality standards specified for factory color finish.

Fasteners; FIO

Two samples of each type to be used, with statement regarding intended use. If so requested, random samples of bolts, nuts, and washers as delivered to the job site shall be taken in the presence of the Contracting Officer and provided to the Contracting Officer for testing to establish compliance with specified requirements.

Insulation; FIO

One piece of each type to be used, and descriptive data covering installation.

Gaskets and Insulating Compounds; FIO

Two samples of each type to be used and descriptive data.

Sealant; FIO

One sample, approximately 1 pound, and descriptive data.

Wall Liners; FIO

One piece, 9 inches long, full width.

SD-07 Certificates

Metal Building Systems; GA

a. A Certificate from the metal building manufacturer stating that the metal building was designed from a complete set of the contract drawings and specifications and approved design submittals, and that the building furnished complies with the specified requirements.

b. Certificates of Compliance for structural bolts, framing steel, roofing and siding, and steel wall liner panels.

c. Warranty certificate. At the completion of the project the Contractor shall furnish signed copies of the 5-year Warranty for Metal Building System, a sample copy of which is attached to this section, the 20-year Manufacturer's Material Warranties, and the Manufacturer's 20-year System Weathertightness Warranty.

1.3 GENERAL REQUIREMENTS

The metal building system covered under this specification shall be provided by a single manufacturer and shall include all components and assemblies that form a building. Structural Standing Seam Metal Roofing System, when specified, shall be furnished as part of a single manufacturer's system.

1.3.1 Building Configuration

Buildings shall have vertical walls and gable roof. Roof slope shall be 1/2:12. Building shall be single-span structure, rigid frame (tapered beam or plate girder). Building dimensions shall be as standard with the manufacturer and not less than those indicated, but exceeding the indicated dimensions only by the amount of the closest standard size thereto. Eave height shall be measured from the top of the finished floor to the intersection of the insides of the roof and sidewall sheets. The clear opening between the finished floor and the bottom of the roof steel shall be as indicated on the drawings.

1.3.2 Qualifications

1.3.2.1 Manufacturer

Metal building shall be the product of a recognized steel building systems manufacturer who has been in the practice of manufacturing steel building systems for a period of not less than 5 years. The manufacturer shall be chiefly engaged in the practice of designing and fabricating steel building systems. The manufacturer shall be certified under the Metal Building Systems (MB) Certification Program, AISC FCD. Structural framing and covering shall be designed by a Professional Engineer licensed in the State of Massachusetts experienced in design of this work.

1.3.2.2 Installer

Erector shall have specialized experience in the erection of steel building systems for a period of at least 3 years. Framing shall be erected in accordance with MBMA Low Rise Manual, common industry practices and erection instructions describing the basic sequence of assembly, temporary bracing, shoring, and related information necessary for erection of the metal building including its structural framework and components. The erector shall furnish temporary guys and bracing where needed for squaring, plumbing, and securing the structural framing against loads acting on the exposed framing, such as wind loads and seismic forces, as well as loads due to erection equipment and erection operation. Bracing furnished by the manufacturer for the metal building system shall not be assumed to be adequate during erection. Structural members shall not be field cut or altered without approval of the metal building manufacturer. Welds, abrasions, and surfaces not shop primed shall be primed after erection.

1.3.2.3 Manufacturer's Representative

A representative designated by the building manufacturer, who is familiar

with the design of the building supplied and experienced in the erection of metal buildings similar in size to the one required under this contract, shall be present at the job site during construction, from the start of the structural framing erection until completion of the installation of the exterior covering, to assure that the building is erected properly.

1.4 DESIGN REQUIREMENTS

Criteria and definitions shall be in accordance with MBMA Low Rise Manual, except criteria for seismic loads which shall be in accordance with TI 809-04 and all other loads and load combinations in accordance with ASCE 7 and 780 CMR.

1.4.1 Dead Loads

The dead load shall consist of the weight of all permanent construction such as roof, framing, covering members and all other materials of the building system.

1.4.2 Collateral Loads

Collateral load of 15 pounds per square foot shall be applied to the entire structure to account for the weight of additional permanent materials other than the building system, such as sprinklers, mechanical systems, electrical systems, hung partitions, and ceilings. This allowance does not include the weight of hung equipment weighing 50 pounds or more. Equipment loads of 50 pounds or more shall be shown on the shop (detail) drawings and the structure (frame, purlins, girts) shall be strengthened as required. The Contractor is responsible for providing the building manufacturer the magnitude and approximate location of all concentrated loads greater than 50 pounds before design of the building commences.

1.4.3 Roof Live Loads

1.4.3.1 Uniform Loads

Uniform roof live loads, including maintenance traffic and construction loads, shall be determined and applied in accordance with ASCE 7 and 780 CMR.

1.4.3.2 Concentrated Loads

In addition to ASCE 7 and 780 CMR roof live loads, a minimum design concentrated load of 300 pounds shall be used to simulate a construction load on roof panels. The concentrated load shall be applied at the panel midspan and shall be resisted by a single standing seam metal roof panel, or a 24 inches wide corrugated metal panel, assumed to be acting as a beam. The undeformed shape of the panel shall be used to determine the section properties.

1.4.4 Roof Snow Loads

The design roof snow loads, including effects of drifting, shall be determined and applied in accordance with ASCE 7 and 780 CMR.

1.4.5 Wind Loads

Wind pressures shall be computed and applied in accordance with ASCE 7 and 780 CMR.

1.4.6 Seismic Loads

Seismic loads shall be computed in accordance with TI 809-04 and 780 CMR.

1.4.7 Foundations

Foundations shall be designed for an allowable soil bearing pressure on the order of 2000 psf, a minimum bottom of footing depth of 4 feet as measured from the finished grade, finished floor or bottom of any recessed area(s) or crawl space, whichever is lowest. A factor of safety of 1.5 for overturning, sliding and uplift, and a concrete compressive strength as specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. The resistance to lateral foundation loads by the use of hairpins shall be prohibited. The foundation design shall be performed by a Professional Engineer registered in the State of Massachusetts and submitted as part of the design analysis. The design shall be based on the building and loads calculated in accordance with the requirements specified and shown. All data including column reactions, collateral loads, and any other loads to be supported by the foundations shall be tabulated by the metal building supplier and furnished by the foundation engineer. The subsurface soil conditions in the vicinity of the existing building as well as the existing foundation design will be provided by the Contracting Officer for use by the engineer performing the foundation design.

1.4.8 Framing and Structural Members

Structural steel members and their connections shall be designed in accordance with AISC ASD Spec S335 or AISC Pub No. S342 L. Structural cold-formed steel framing members and their connections shall be designed in accordance with TI 809-07 and 780 CMR. Maximum deflection under applied live load, snow, or wind load shall not exceed 1/180th of the span length. Members with openings in their webs shall be designed with consideration of the additional stresses which will result due to the openings. Deflections of the steel framing above and along the side of commercially framed door openings shall be limited to a maximum allowable deflection of 1/360 of the opening width to ensure proper operation of the doors. The Contractor shall include the loads that the door transfers to the building frame in the design. Framed openings shall be designed to structurally replace the covering and framing displaced. The subpurlin and/or purlin spacing shall not exceed 30 inches on centers at the corner, edge and ridge zones, and 5 foot maximum on centers for the remainder of the roof. The maximum deflection of steel framing that provides lateral support for masonry veneer panels shall be 1/600 of the height of framing span.

1.4.9 Roofing and Siding

Except as otherwise specified, steel roofing and siding shall be designed in accordance with AISI Cold-Formed Mnl. Maximum deflection for wall and roof panels under applied live load, snow or wind loads shall not exceed 1/180th of the span length. The design analysis shall establish that the roof, when deflected under loading combinations, shall not result in ponding. Maximum deflections shall be based on sheets continuous across two or more supports with sheets unfastened and fully free to deflect. The calculated deflection from the concentrated load shall not exceed 1/180 of the span length. The methods for resisting lateral loads shall be cross-bracing, rigid frames, or wind columns.

1.4.10 Provisions for Gutters And Downspouts

Gutters and downspouts shall be designed according to the requirements of SMACNA Arch. Manual for storms which should be exceeded only once in 5 years and with adequate provisions for thermal expansion and contraction. Supports for gutters and downspouts shall be designed for the anticipated loads.

1.4.11 Provisions for Louvers

Louvers shall be adjustable type designed for a minimum net open area of 60%, to be rainproof, and to resist vibration when air is passed at the rate of 700 cubic feet per minute. In calculating free area, consideration shall be given to the blocking effect of louvers or screens protective openings. Screens used shall not be smaller than 1/4 inch mesh and shall be readily accessible for cleaning.

1.4.12 Ventilators

1.4.12.1 Continuous Ventilators

Continuous roof ventilators shall be ridge mounted gravity type, with dampers, designed for a minimum capacity of 3000 cubic feet of air per minute based on a wind velocity of 5 miles per hour and an exterior-interior temperature differential of 10 degrees F and without screens in place. Ventilators shall match roof slope. Steel parts shall match roof type and color finish.

1.5 DESIGN ANALYSIS

The design analysis shall be the design of a Professional Engineer licensed in the State of Massachusetts who is experienced in design of this type of work. The design shall include complete calculations for the building, its components, and the foundations and shall be submitted to the Contracting Officer. Conceptual level foundations shown on the drawings are based on loads derived from a representative set of similar building types. The Contractor shall obtain the services of a licensed Professional Engineer to provide a final design of the foundations. Formulas, design load cases, and references shall be identified. Assumptions and conclusions shall be explained, and cross-referencing shall be clear. Wind forces on various parts of the structure, both positive and negative, shall be calculated and shown in the design calculations. The controlling load case shall be indicated. Lateral forces due to seismic loading shall be calculated and tabulated for the various parts and portions of the building. Computer program based designs shall be accompanied by stress values and a letter of certification, signed by a Professional Engineer licensed in the State of Massachusetts, stating the design criteria and procedures used and attesting to the adequacy and accuracy of the design. A narrative of the computer program delineating the basic methodology shall be included. Computer program output shall be annotated and supplemented with sketches to verify the input and output. Critical load conditions used in the final sizing of the members shall be defined. The design analysis shall include the name and office phone number of the designer, who shall function as a point of contact to answer questions during the detail drawing review.

1.6 DELIVERY AND STORAGE

Materials shall be delivered to the site in a dry and undamaged condition and stored out of contact with the ground. Materials other than framing and structural members shall be covered with weathertight coverings and kept dry. Storage accommodations for roofing and siding shall provide good

air circulation and protection from surface staining.

1.7 WARRANTIES

The Metal Building System, composed of framing and structural members, roofing and siding, gutters and downspouts, accessories, fasteners, trim, and miscellaneous building closure items such as doors and windows (when furnished by the manufacturer) shall be warranted as described below against material and workmanship deficiencies, system deterioration caused by exposure to the elements and service design loads, leaks and wind uplift damage. Any emergency temporary repairs conducted by the owner shall not negate the warranties.

1.7.1 Prime Contractor's Weathertightness Warranty

The Metal Building System shall be warranted by the Contractor on a no penal sum basis for a period of five years against materials and workmanship deficiencies; system deterioration caused by exposure to the elements and/or inadequate resistance to specified service design loads, water leaks, and wind uplift damage. The Metal Building System covered under this warranty shall include but is not limited to the following: framing and structural members, roofing and siding panels and seams, interior or exterior gutters and downspouts, accessories, fasteners, trim, flashings and miscellaneous building closure items such as doors and windows (when furnished by the manufacturer), connectors, components, and fasteners, and other system components and assemblies installed to provide a weathertight system; and items specified in other sections of these specifications that become part of the metal building system. All material and workmanship deficiencies, system deterioration caused by exposure to the elements and/or inadequate resistance to specified service design loads, water leaks and wind uplift damage shall be repaired as approved by the Contracting Officer. See the attached Contractor's written warranty for issue resolution of warrantable defects. This warranty shall warrant and cover the entire cost of repair or replacement, including all material, labor, and related markups. The Contractor shall supplement this warranty with written warranties from the installer and/or system manufacturer, which shall be submitted along with Contractor's warranty. However, the Contractor is ultimately responsible for this warranty. The Contractor's written warranty shall be as outlined in attached **WARRANTY FOR METAL BUILDING SYSTEMS**, and start upon final acceptance of the facility. The Contractor shall provide a separate bond in an amount equal to the installed total metal building system cost in favor of the owner (Government) covering the Contractor's warranty responsibilities effective throughout the five year Contractor's warranty period for the entire metal building system as outlined above.

1.7.2 Manufacturer's Material and/or System Weathertightness Warranties

The Contractor shall furnish, in writing, the following manufacturer's material warranties to the Contracting Officer which cover all Metal Building System components:

a. A manufacturer's 20 year material warranty warranting that the specified aluminum, zinc-coated steel, aluminum-zinc alloy coated steel or aluminum-coated steel will not rupture, structurally fail, fracture, deteriorate, or become perforated under normal design atmospheric conditions and service design loads. Liability under this warranty shall be limited exclusively to the cost of either repairing or replacing nonconforming, ruptured, perforated,

or structurally failed securement system including fasteners and coil material.

b. A manufacturer's 20 year exterior material finish warranty on the factory colored finish warranting that the finish, under normal atmospheric conditions at the site, will not crack, peel, or delaminate; chalk in excess of a numerical rating of eight, as determined by ASTM D 4214 test procedures; or change colors in excess of five CIE or Hunter Lab color difference (delta E) units in accordance with ASTM D 2244. Liability under this warranty is exclusively limited to replacing the defective coated material.

1.8 COORDINATION MEETING

A coordination meeting shall be held within 45 days after contract award for mutual understanding of the metal building system contract requirements. This meeting shall take place at the building site and shall include representatives from the Contractor, the roofing/metal building system manufacturer, the roofing/metal building supplier, the erector, the designer, and the Contracting Officer. All items required by paragraph SUBMITTALS shall be discussed, including applicable standard manufacturer shop drawings, and the approval process. The Contractor shall coordinate time and arrangements for the meeting.

PART 2 PRODUCTS

2.1 BUILDING COMPONENTS

Each piece or part of the assembly shall be clearly and legibly marked to correspond with the drawings.

2.2 FRAMING AND STRUCTURAL MEMBERS

Steel 1/8 inch or more in thickness shall conform to ASTM A 36/A 36M, ASTM A 529/A 529M, ASTM A 572/A 572M, or ASTM A 588/A 588M. Uncoated steel less than 1/8 inch in thickness shall conform to ASTM A 570/A 570M, ASTM A 606, or ASTM A 607. Galvanized steel shall conform to ASTM A 653/A 653M, G 90 coating designation, 0.045 inch minimum thickness. Aluminum-zinc coated steel shall conform to ASTM A 792/A 792M, AZ 55 coating designation, 0.045 inch minimum thickness. Structural pipe shall conform to ASTM A 53/A 53M, ASTM A 252, ASTM A 500, ASTM A 501, or ASTM A 618. Holes for structural connections shall be made in the shop.

2.3 ROOFING AND SIDING

Roofing and siding shall be either steel or aluminum and shall have a factory color finish.

2.3.1 Roofing

Length of sheets shall be sufficient to cover the entire length of any unbroken roof slope unless otherwise approved. Width of sheets with interlocking ribs shall provide not less than 12 inches of coverage in place. Provisions shall be made for thermal expansion and contraction consistent with the type of system to be used. Panel shall have configurations for overlapping sheets. Roof deck assemblies shall be Class 90 as defined in UL 580. Exposed, penetrating fastener may be used. Height of corrugation at overlap of adjacent roof sheets shall be the building manufacturer's standard for the indicated roof slope.

2.3.2 Siding

Length of sheet shall be sufficient to cover the entire height of any unbroken height of wall surface unless otherwise approved. Width of sheets with interlocking ribs shall provide not less than 12 inches of coverage in place. Provisions shall be made for thermal expansion and contraction consistent with the type of system to be used. Siding shall have configurations for overlapping adjacent sheets or interlocking ribs for securing adjacent sheets. Siding shall be fastened to framework using concealed fasteners.

2.3.3 Steel Panels

Roofing and Siding shall be zinc-coated steel conforming to ASTM A 653/A 653M, G 90 coating designation; aluminum-zinc alloy coated steel conforming to ASTM A 792/A 792M, AZ 55 coating; or aluminum-coated steel conforming to ASTM A 463/A 463M, Type 2, coating designation T2 E5. Panels shall be 0.024 inch thick minimum, except that when the mid field of the roof is subject to design wind uplift pressures of 60 psf or greater or the steel covering is used as a diaphragm, the entire roof system shall have a minimum thickness of 0.030 inch. Prior to shipment, mill finish panels shall be treated to inhibit the formation of oxide corrosion. Panels that have become wet during shipment but have not started to oxidize shall be dried, and retreated in accordance with manufacturer's standard practice.

2.3.4 Factory Insulated Panels

Insulated wall and roof panels shall be factory-fabricated units with insulating core between metal face sheets, securely fastened together and uniformly separated with rigid spacers, facing of steel of composition and gauge specified for covering, constructed in a manner that will eliminate condensation on interior of panel. Panels shall have a factory color finish. Insulation shall be compatible with adjoining materials; nonrunning and nonsettling; capable of retaining its R-value for the life of the metal facing sheets; and unaffected by extremes of temperature and humidity. The assembly shall have a flame spread rating not higher than 25, and smoke developed rating not higher than 450 when tested in accordance with ASTM E 84. The insulation shall remain odorless, free from mold, and shall not become a source of food and shelter for insects. Panels shall be not less than 8 inches wide and shall be in one piece for unbroken wall heights.

2.3.5 Factory Color Finish

Panels shall have a factory applied finish on the exposed side. The exterior finish shall consist of a baked-on topcoat with an appropriate prime coat. The exterior coating shall be a nominal 1 mil thickness consisting of a topcoat of not less than 0.7 mil dry film thickness and the paint manufacturer's recommended primer of not less than 0.2 mil thickness. The interior color finish shall consist of a 0.2 mil thick prime coat. The exterior color finish shall meet the test requirements specified below.

2.3.5.1 Salt Spray Test

A sample of the sheets shall withstand a cyclic corrosion test for a minimum of 2016 hours in accordance with ASTM D 5894, including the scribe requirement in the test. Immediately upon removal of the panel from the test, the coating shall receive a rating of not less than 10, no

blistering, as determined by ASTM D 714; 10, no rusting, as determined by ASTM D 610; and a rating of 6, over 1/16 to 1/8 inch failure at scribe, as determined by ASTM D 1654.

2.3.5.2 Formability Test

When subjected to testing in accordance with ASTM D 522 Method B, 1/8 inch diameter mandrel, the coating film shall show no evidence of cracking to the naked eye.

2.3.5.3 Accelerated Weathering, Chalking Resistance and Color Change

A sample of the sheets shall be tested in accordance with ASTM D 4587, for 2000 total hours. The coating shall withstand the weathering test without cracking, peeling, blistering, loss of adhesion of the protective coating, or corrosion of the base metal. Protective coating that can be readily removed from the base metal with tape in accordance with ASTM D 3359, Test Method B, shall be considered as an area indicating loss of adhesion. Following the accelerated weathering test, the coating shall have a chalk rating not less than No. 8 in accordance with ASTM D 4214 test procedures, and the color change shall not exceed 5 CIE or Hunter Lab color difference (delta E) units in accordance with ASTM D 2244. For sheets required to have a low gloss finish, the chalk rating shall be not less than No. 6 and the color difference shall not be greater than 7 units.

2.3.5.4 Humidity Test

When subjected to a humidity cabinet test in accordance with ASTM D 2247 for 1000 hours, a scored panel shall show no signs of blistering, cracking, creepage or corrosion.

2.3.5.5 Impact Resistance

Factory-painted sheet shall withstand direct and reverse impact in accordance with ASTM D 2794 0.500 inch diameter hemispherical head indenter, equal to 1.5 times the metal thickness in mils, expressed in inch-pounds, with no loss of adhesion.

2.3.5.6 Abrasion Resistance Test

When subjected to the falling sand test in accordance with ASTM D 968, Method A, the coating system shall withstand a minimum of 100 liters of sand before the appearance of the base metal. The term "appearance of base metal" refers to the metallic coating on steel or the aluminum base metal.

2.3.5.7 Specular Gloss

Finished surfaces shall have a specular gloss value of greater than 70 at an angle of 20 degrees when measured in accordance with ASTM D 523.

2.3.5.8 Pollution Resistance

Coating shall show no visual effects when covered spot tested in a 10 percent hydrochloric acid solution for 24 hours in accordance with ASTM D 1308.

2.3.6 Accessories

Flashing, trim, metal closure strips and curbs, fascia, caps, diverters,

and similar metal accessories shall be the manufacturer's standard products. Exposed metal accessories shall be finished to match the building finish. Molded closure strips shall be bituminous-saturated fiber, closed-cell or solid-cell synthetic rubber or neoprene, or polyvinyl chloride premolded to match configuration of the roofing or siding and shall not absorb or retain water.

2.4 FASTENERS

Fasteners for steel wall and roof panels shall be zinc-coated steel, aluminum, corrosion resisting steel, or nylon capped steel, type and size specified below or as otherwise approved for the applicable requirements. Fasteners for attaching wall panels to supports shall provide both tensile and shear strength of not less than 750 lbs per fastener. Fasteners for accessories shall be the manufacturer's standard. Aluminum or corrosion resisting steel fasteners shall be used only with aluminum sheets. Exposed roof fasteners shall be gasketed or have gasketed washers on the exterior side of the covering to waterproof the fastener penetration. Washer material shall be compatible with the covering and have a minimum diameter of 3/8 inch for structural connections; and gasketed portion of the fasteners or washers shall be neoprene or other equally durable elastomeric material approximately 1/8 inch thick. Exposed wall fasteners shall be color finished or provided with plastic color caps to match the covering. Nonpenetrating fastener system for wall panels using concealed clips shall be manufacturer's standard for the system provided.

2.4.1 Screws

Screws shall be as recommended by the manufacturer to meet the design strength requirements.

2.4.2 End-Welded Studs

Automatic end-welded studs shall be shouldered type with a shank diameter of not less than 3/16 inch and cap or nut for holding covering against the shoulder.

2.4.3 Explosive Actuated Fasteners

Fasteners for use with explosive actuated tools shall have a shank of not less than 0.145 inch with a shank length of not less than 1/2 inch for fastening panels to steel and not less than 1 inch for fastening panels to concrete.

2.4.4 Blind Rivets

Blind rivets shall be aluminum with 3/16 inch nominal diameter shank or stainless steel with 1/8 inch nominal diameter shank. Rivets shall be threaded stem type if used for other than the fastening of trim. Rivets with hollow stems shall have closed ends.

2.4.5 Bolts

Bolts shall be not less than 1/4 inch diameter, shouldered or plain shank as required, with proper nuts.

2.5 GUTTERS AND DOWNSPOUTS

Gutters and downspouts shall be fabricated of aluminum, zinc-coated steel

or aluminum-zinc alloy coated steel and shall have manufacturer's standard finish. Minimum uncoated thickness of materials shall be 0.018 inch for steel and 0.032 inch for aluminum. All accessories necessary for the complete installation of the gutters and downspouts shall be furnished. Accessories shall include gutter straps, downspout elbows, downspout straps and fasteners fabricated from metal compatible with the gutters and downspouts.

2.6 LOUVERS

Louvers shall be fabricated of aluminum, zinc-coated steel, or aluminum-zinc alloy coated steel; shall have manufacturer's standard finish; and shall be furnished with insect screens. Minimum uncoated thickness of materials shall be 0.048 inch for steel and 0.064 inch for aluminum. Manually operated louvers shall be designed to be opened and closed from the operating floor.

2.7 CONTINUOUS ROOF VENTILATORS

Continuous roof ventilators shall be fabricated of aluminum, zinc-coated steel, or aluminum-zinc alloy coated steel, shall have manufacturer's standard finish, and shall be furnished with insect screens and chain or cable operated dampers. Minimum uncoated thickness of materials shall be 0.018 inch for steel and 0.032 inch for aluminum. Ventilators shall be furnished in 8 to 10 feet long sections braced at midlength.

2.8 DOORS

2.8.1 Hinged Doors

Hinged doors and frames shall receive a galvanic coating and factory primer and shall conform to the requirements of Section 08110 STEEL DOORS AND FRAMES. Exterior doors shall have top edges closed flush and sealed against water penetration. Hardware shall be as specified in Section 08700 BUILDERS' HARDWARE.

2.8.2 Overhead Doors Rolling Doors

Overhead rolling doors shall conform to the requirements of Section 08330 OVERHEAD ROLLING DOORS. Hardware shall be as specified in Section 08700 BUILDERS' HARDWARE.

2.9 WINDOWS

Windows shall conform to the requirements of Section 08510 STEEL WINDOWS.

2.10 INSULATION

Thermal resistance of insulation shall be not less than the following R-values:

Roof R-Value	19
Walls R-Value	11

R-values shall be determined at a mean temperature of 75 degrees F in accordance with ASTM C 518. Insulation shall be a standard product with the insulation manufacturer, factory marked or identified with insulation manufacturer's name or trademark and R-value. Identification shall be on individual pieces or individual packages. Insulation shall have a facing providing a permeability of 0.02 perm or less when tested in accordance

with ASTM E 96.

Facing and finishes shall be factory applied. Provide roof system insulation blocks to thermally separate roof from purlins. Facing shall consist of aluminum foil (0.0005 inch), fiberglass scrim reinforced 4/in x 3/in with tab reinforcement, 8/in. x 3/in., and 0.002 inch rigid vinyl film.

2.10.1 Rigid Board Insulation

2.10.1.1 Polyisocyanurate

Polyisocyanurate insulation shall conform to ASTM C 1289, Type I, Class 2 (having a minimum recovered material content of 9 percent by weight of core material in the polyisocyanurate portion). For impermeable faced polyisocyanurate (Ex: aluminum foil) the maximum design R-value per 1 inch of insulation used shall be 7.2 inch.

2.10.1.2 Polystyrene

Insulation shall conform to ASTM C 578, Type IV.

2.10.1.3 Mineral Fiber

Insulation shall conform to ASTM C 612.

2.10.1.4 Insulation Retainers

Retainers shall be type, size and design necessary to adequately hold the insulation and to provide a neat appearance. Metallic retaining members shall be nonferrous or have a nonferrous coating. Nonmetallic retaining members, including adhesives used in conjunction with mechanical retainers or at insulation seams, shall have a fire resistance classification not less than that permitted for the insulation.

2.11 SEALANT

Sealant shall be an elastomeric type containing no oil or asphalt. Exposed sealant shall be colored to match the applicable building color and shall cure to a rubber like consistency.

2.12 GASKETS AND INSULATING COMPOUNDS

Gaskets and insulating compounds shall be nonabsorptive and suitable for insulating contact points of incompatible materials. Insulating compounds shall be nonrunning after drying.

2.13 SHOP PRIMING

Ferrous surfaces shall be cleaned of oil, grease, loose rust, loose mill scale, and other foreign substances and shop primed. Primer coating shall be in accordance with the manufacturer's standard system.

2.14 SNOW GUARDS

Snow guards shall be provided to prevent a mass quantity of snow or ice from avalanching all at once off the roof. Snow guards shall be manufactured of case aluminum and shall adhere to the pan surface of the prefinished metal roof system using a high strength construction adhesive.

PART 3 EXECUTION

3.1 EARTHWORK AND FOUNDATION

Surfaces to receive concrete shall be clean, damp, and free from debris, frost, ice, and standing or running water. Prior to placement of concrete, the foundation shall be well drained and shall be satisfactorily graded and meet the compaction requirements of Section 02315 EXCAVATION, FILLING, AND BACKFILLING FOR STRUCTURES. Forms shall be in place, cleaned, coated, and adequately supported in accordance with Section 03100 STRUCTURAL CONCRETE FORMWORK. Reinforcing steel shall be in place, cleaned, tied, and adequately supported in accordance with Section 03200 CONCRETE REINFORCEMENT. Concrete materials shall meet the requirements of Section 03330 CAST-IN-PLACE STRUCTURAL CONCRETE. Upon approval from the Contracting Officer, the Contractor shall commence concrete placement in accordance with Section 03330 CAST-IN-PLACE STRUCTURAL CONCRETE.

3.2 ERECTION

Dissimilar materials which are not compatible when contacting each other shall be insulated from each other by means of gaskets or insulating compounds. Improper or mislocated drill holes in panels shall be plugged with an oversize screw fastener and gasketed washer; however, panels with an excess of such holes or with such holes in critical locations shall not be used. Exposed surfaces shall be kept clean and free from sealant, metal cuttings, excess material from thermal cutting, and other foreign materials. Exposed surfaces which have been thermally cut shall be finished smooth within a tolerance of 1/8 inch. Stained, discolored or damaged sheets shall be removed from the site. Welding of steel shall conform to AWS D1.1.

3.2.1 Framing Members and Anchor Bolts

Erection shall be in accordance with the approved erection instructions and drawings and with applicable provision of AISC ASD Spec S335. Framing members fabricated or modified on site shall be saw or abrasive cut; bolt holes shall be drilled. Onsite flame cutting of framing members, with the exception of small access holes in structural beam or column webs, will not be permitted. High-strength bolting shall conform to AISC Pub No. S329 using ASTM A 325 or ASTM A 490, ASTM A 490M bolts. Improper or mislocated bolt holes in structural members or other misfits caused by improper fabrication or erection, shall be repaired in accordance with AISC Pub No. S303. Concrete work is specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. Anchor bolts shall be accurately set by template while the concrete is in a plastic state. Uniform bearing under base plates and sill members shall be provided using a nonshrinking grout. Separate leveling plates under column base plates shall not be used. Members shall be accurately spaced to assure proper fitting of panels. As erection progresses, the work shall be securely fastened to resist the dead load and wind and erection stresses.

3.2.2 Roofing and Siding Installation

Siding shall be applied with the longitudinal configurations in the vertical position. Roofing shall be applied with the longitudinal configurations in the direction of the roof slope. Accessories shall be fastened into framing members, except as otherwise approved. Closure strips shall be provided as indicated and where necessary to provide weathertight construction. Fastener and fastener spacing shall be in

accordance with manufacture design.

3.2.3 Installation of Gutters and Downspouts

Gutters and downspouts shall be rigidly attached to the building. Spacing of cleats for gutters shall be 16 inches maximum. Spacing of brackets and spacers for gutters shall be 36 inches maximum. Supports for downspouts shall be spaced according to manufacturer's recommendations.

3.2.4 Louvers and Ventilators

The Contractor shall coordinate with the Contracting Officer prior to installing wall and roof penetrations for louvers and ventilators. Louvers and ventilators shall be rigidly attached to the supporting construction to assure a weather tight installation.

3.2.5 Doors and Windows

Doors and windows, including frames and hardware, shall be securely anchored to the supporting construction, shall be installed plumb and true, and shall be adjusted as necessary to provide proper operation. Joints at doors and windows shall be sealed according to manufacturer's recommendations to provide weathertight construction.

3.2.6 Insulation Installation

Insulation shall be installed as indicated and in accordance with manufacturer's instructions. Joints shall be tight and sealed as required by the manufacturer. Final appearance or installed insulation shall be free of unsightly sags and wrinkles.

3.2.7 Installation of Snow Guards

Recommended placement of snow guards consists of two groups of three staggered rows on 24-inch centers with one group at the eave and one group midway on roof slope. On long slopes, multiple groups with a maximum of 6 to 8 feet space separation is recommended. The Contractor shall determine final placement of snow guards in accordance with SMACNA Arch. Manual.

Before installing, all contact surfaces should be wiped with isopropyl alcohol only. Adhesive should then be applied to completely coat the underside of the unit before positioning it on the roof surface. After positioning, exert uniform pressure until adhesive is squeezed out around the entire perimeter of the snow guard pointing up joint to create a bead which is free of gaps or air pockets. Surebond's SB-190 sealant-adhesive is recommended.

3.3 FIELD PAINTING

Immediately upon detection, abraded or corroded spots on shop-painted surfaces shall be wire brushed and touched up with the same material used for the shop coat. Shop-primed ferrous surfaces exposed on the outside of the building and all shop-primed surfaces of doors and windows shall be painted with two coats of an approved exterior enamel. Factory color finished surfaces shall be touched up as necessary with the manufacturer's recommended touch-up paint.

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY
FOR
METAL BUILDING SYSTEM

FACILITY
DESCRIPTION: _____

BUILDING
NUMBER: _____

CORPS OF ENGINEERS CONTRACT
NUMBER: _____

CONTRACTOR

CONTRACTOR: _____

ADDRESS: _____

POINT OF
CONTACT: _____

TELEPHONE
NUMBER: _____

OWNER

OWNER: _____

ADDRESS: _____

POINT OF
CONTACT: _____

TELEPHONE
NUMBER: _____

CONSTRUCTION AGENT

CONSTRUCTION
AGENT: _____

ADDRESS: _____

POINT OF CONTACT: _____

TELEPHONE
NUMBER: _____

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY
FOR
METAL BUILDING SYSTEM
(continued)

THE METAL BUILDING SYSTEM INSTALLED ON THE ABOVE NAMED BUILDING IS WARRANTED BY [_____] FOR A PERIOD OF FIVE (5) YEARS AGAINST WORKMANSHIP AND MATERIAL DEFICIENCIES, WIND DAMAGE AND STRUCTURAL FAILURE WITHIN PROJECT SPECIFIED DESIGN LOADS, AND LEAKAGE. THE METAL BUILDING SYSTEM COVERED UNDER THIS WARRANTY SHALL INCLUDE, BUT SHALL NOT BE LIMITED TO, THE FOLLOWING: FRAMING AND STRUCTURAL MEMBERS, ROOFING AND SIDING PANELS AND SEAMS, INTERIOR OR EXTERIOR GUTTERS AND DOWNSPOUTS, ACCESSORIES, TRIM, FLASHINGS AND MISCELLANEOUS BUILDING CLOSURE ITEMS SUCH AS DOORS AND WINDOWS (WHEN FURNISHED BY THE MANUFACTURER), CONNECTORS, COMPONENTS, AND FASTENERS, AND OTHER SYSTEM COMPONENTS AND ASSEMBLIES INSTALLED TO PROVIDE A WEATHERTIGHT SYSTEM; AND ITEMS SPECIFIED IN OTHER SECTIONS OF THESE SPECIFICATIONS THAT BECOME PART OF THE METAL BUILDING SYSTEM. ALL MATERIAL AND WORKMANSHIP DEFICIENCIES, SYSTEM DETERIORATION CAUSED BY EXPOSURE TO THE ELEMENTS AND/OR INADEQUATE RESISTANCE TO SPECIFIED SERVICE DESIGN LOADS, WATER LEAKS AND WIND UPLIFT DAMAGE SHALL BE REPAIRED AS APPROVED BY THE CONTRACTING OFFICER

ALL MATERIAL DEFICIENCIES, WIND DAMAGE, STRUCTURAL FAILURE AND LEAKAGE ASSOCIATED WITH THE METAL BUILDING SYSTEM COVERED UNDER THIS WARRANTY SHALL BE REPAIRED AS APPROVED BY THE CONTRACTING OFFICER. THIS WARRANTY SHALL COVER THE ENTIRE COST OF REPAIR OR REPLACEMENT, INCLUDING ALL MATERIAL, LABOR, AND RELATED MARKUPS. THE ABOVE REFERENCED WARRANTY COMMENCED ON THE DATE OF FINAL ACCEPTANCE ON [_____] AND WILL REMAIN IN EFFECT FOR STATED DURATION FROM THIS DATE.

SIGNED, DATED, AND NOTARIZED (BY COMPANY PRESIDENT)

_____

(Company President) (Date)

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY
FOR
METAL BUILDING SYSTEM
(continued)

THE CONTRACTOR SHALL SUPPLEMENT THIS WARRANTY WITH WRITTEN WARRANTIES FROM THE MANUFACTURER AND/OR INSTALLER OF THE METAL BUILDING SYSTEM, WHICH SHALL BE SUBMITTED ALONG WITH THE CONTRACTOR'S WARRANTY. HOWEVER, THE CONTRACTOR WILL BE ULTIMATELY RESPONSIBLE FOR THIS WARRANTY AS OUTLINED IN THE SPECIFICATIONS AND AS INDICATED IN THIS WARRANTY.

EXCLUSIONS FROM COVERAGE

1. NATURAL DISASTERS, ACTS OF GOD (LIGHTNING, FIRE, EXPLOSIONS, SUSTAINED WIND FORCES IN EXCESS OF THE DESIGN CRITERIA, EARTHQUAKES, AND HAIL).

2. ACTS OF NEGLIGENCE OR ABUSE OR MISUSE BY GOVERNMENT OR OTHER PERSONNEL, INCLUDING ACCIDENTS, VANDALISM, CIVIL DISOBEDIENCE, WAR, OR DAMAGE CAUSED BY FALLING OBJECTS.

3. DAMAGE BY STRUCTURAL FAILURE, SETTLEMENT, MOVEMENT, DISTORTION, WARPAGE, OR DISPLACEMENT OF THE BUILDING STRUCTURE OR ALTERATIONS MADE TO THE BUILDING.

4. CORROSION CAUSED BY EXPOSURE TO CORROSIVE CHEMICALS, ASH OR FUMES GENERATED OR RELEASED INSIDE OR OUTSIDE THE BUILDING FROM CHEMICAL PLANTS, FOUNDRIES, PLATING WORKS, KILNS, FERTILIZER FACTORIES, PAPER PLANTS, AND THE LIKE.

5. FAILURE OF ANY PART OF THE BUILDING SYSTEM DUE TO ACTIONS BY THE OWNER WHICH INHIBIT FREE DRAINAGE FROM THE ROOF, AND GUTTERS AND DOWNSPOUTS; OR CONDITIONS WHICH CREATE PONDING WATER ON THE ROOF OR AGAINST THE BUILDING SIDING.

6. THIS WARRANTY APPLIES TO THE METAL BUILDING SYSTEM. IT DOES NOT INCLUDE ANY CONSEQUENTIAL DAMAGE TO THE BUILDING INTERIOR OR CONTENTS WHICH IS COVERED BY THE WARRANTY OF CONSTRUCTION CLAUSE INCLUDED IN THIS CONTRACT.

7. THIS WARRANTY CANNOT BE TRANSFERRED TO ANOTHER OWNER WITHOUT WRITTEN CONSENT OF THE CONTRACTOR AND THIS WARRANTY AND THE CONTRACT PROVISIONS WILL TAKE PRECEDENCE OVER ANY CONFLICTS WITH STATE STATUTES. REPORTS OF LEAKS AND BUILDING SYSTEM DEFICIENCIES SHALL BE RESPONDED TO WITHIN 48 HOURS OF RECEIPT OF NOTICE BY TELEPHONE OR IN WRITING FROM EITHER THE OWNER, OR CONTRACTING OFFICER. EMERGENCY REPAIRS, TO PREVENT FURTHER ROOF LEAKS, SHALL BE INITIATED IMMEDIATELY; A WRITTEN PLAN SHALL BE SUBMITTED FOR APPROVAL TO REPAIR OR REPLACE THIS SSSMR SYSTEM WITHIN SEVEN CALENDAR DAYS. ACTUAL WORK FOR PERMANENT REPAIRS OR REPLACEMENT SHALL BE STARTED WITHIN 30 DAYS AFTER RECEIPT OF NOTICE, AND COMPLETED WITHIN A REASONABLE TIME FRAME. IF THE CONTRACTOR FAILS TO ADEQUATELY RESPOND TO THE WARRANTY PROVISIONS, AS STATED

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY
FOR
METAL BUILDING SYSTEM
(Exclusions from Coverage Continued)

IN THE CONTRACT AND AS CONTAINED HEREIN, THE CONTRACTING OFFICER MAY HAVE THE METAL BUILDING SYSTEM REPLACED OR REPAIRED BY OTHERS AND CHARGE THE COST TO THE CONTRACTOR. IN THE EVENT THE CONTRACTOR DISPUTES THE EXISTENCE OF A WARRANTABLE DEFECT, THE CONTRACTOR MAY CHALLENGE THE OWNER'S DEMAND FOR REPAIRS AND/OR REPLACEMENT DIRECTED BY THE OWNER OR CONTRACTING OFFICER EITHER BY REQUESTING A CONTRACTING OFFICER'S DECISION, UNDER THE CONTRACT DISPUTES ACT, OR BY REQUESTING THAT AN ARBITRATOR RESOLVE THE ISSUE. THE REQUEST FOR AN ARBITRATOR MUST BE MADE WITHIN 48 HOURS OF BEING NOTIFIED OF THE DISPUTED DEFECTS. UPON BEING INVOKED THE PARTIES SHALL, WITHIN 10 DAYS JOINTLY REQUEST A LIST OF FIVE (5) ARBITRATORS FROM THE FEDERAL MEDIATION AND CONCILIATION SERVICE. THE PARTIES SHALL CONFER WITHIN 10 DAYS AFTER RECEIPT OF THE LIST TO SEEK AGREEMENT ON AN ARBITRATOR. IF THE PARTIES CANNOT AGREE ON AN ARBITRATOR, THE CONTRACTING OFFICER AND THE PRESIDENT OF THE CONTRACTOR'S COMPANY WILL STRIKE ONE (1) NAME FROM THE LIST ALTERNATIVELY UNTIL ONE NAME REMAINS. THE REMAINING PERSON SHALL BE THE DULY SELECTED ARBITRATOR. THE COSTS OF THE ARBITRATION, INCLUDING THE ARBITRATOR'S FEE AND EXPENSES, COURT REPORTER, COURTROOM OR SITE SELECTED ETC., SHALL BE BORNE EQUALLY BETWEEN THE PARTIES. EITHER PARTY DESIRING A COPY OF THE TRANSCRIPT SHALL PAY FOR THE TRANSCRIPT. A HEARING WILL BE HELD AS SOON AS THE PARTIES CAN MUTUALLY AGREE. A WRITTEN ARBITRATOR'S DECISION WILL BE REQUESTED NOT LATER THAN 30 DAYS FOLLOWING THE HEARING. THE DECISION OF THE ARBITRATOR WILL NOT BE BINDING; HOWEVER, IT WILL BE ADMISSIBLE IN ANY SUBSEQUENT APPEAL UNDER THE CONTRACT DISPUTES ACT. A FRAMED COPY OF THIS WARRANTY SHALL BE POSTED IN THE MECHANICAL ROOM OR OTHER APPROVED LOCATION DURING THE ENTIRE WARRANTY PERIOD.

-- End of Section --

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DIVISION 13 - SPECIAL CONSTRUCTION

SECTION 13405

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SECTION 13405

PROCESS CONTROL

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced and are referred to in the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(1995) Code for Electricity Metering
ANSI X3.64	(1979; R 1990) Additional Controls for Use with American National Standard Code for Information Interchange
ANSI X3.154	(1988; R 1994) Office Machines and Supplies - Alphanumeric Machines-Keyboard Arrangement

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 88	(1996) Seamless Copper Water Tube
ASTM D 635	(1997) Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position
ASTM D 638	(1997) Tensile Properties of Plastics
ASTM D 792	(1991) Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D 1238	(1995) Flow Rates of Thermoplastics by Extrusion Plastometer
ASTM D 1693	(1997a) Environmental Stress - Cracking of Ethylene Plastics

AMERICAL SOCIETY OF HEATING, REFRIGERATION AND AIR CONDITIONING ENGINEERS (ASHRAE)

ASHRAE Hdbk-IP	(1997) Handbook, Fundamentals I-P Edition

ASME INTERNATIONAL (ASME)

ASME-18	(1971; Int Supple 19.5, 1972; Errata) Fluid Meters, Their Theory and Application
ASME B31.8	(1995) Gas Transmission and Distribution Piping Systems

ASME BPV VIII Div 1	(1998) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division I - Basic Coverage

CODE OF FEDERAL REGULATIONS (CFR)

47 CFR 15	Radio Frequency Devices
47 CFR 68	Connection of Terminal Equipment to the Telephone Network

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

EIA ANSI/EIA/TIA-232-F	(1997) Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.90	(1989; R 1994) Relays and Relay Systems Associated with Electric Power Apparatus
IEEE C37.90.1	(1989; R 1994) Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems
IEEE C62.41	(1991; R 1995) Surge Voltages in Low-Voltage AC Power Circuits
IEEE Std 100	(1996) IEEE Standard Dictionary of Electrical and Electronic Terms
IEEE Std 142	(1991) IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems

INTERNATIONAL ELECTROMECHANICAL COMMISSION (IEC)

IEC 1131-3	Programmable Controllers - Part 3: Programming Language

INTERNATIONAL TELECOMMUNICATIONS UNION (ITU)

ITU V.42 bis	(1990) Data Compression Procedures for Data Circuit Terminating Equipment (DCE) Using Error-Correction Procedures

INSTRUMENTATION, SYSTEMS, AND AUTOMATION SOCIETY (ISA)

ISA S7.0.01	(1996) Quality Standards for Instrument Air

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(1993) Industrial Control and Systems
NEMA ICS 2	(1993) Industrial Control and Systems Controllers, Contactors, and Overload

	Relays Rated Not More Than 2,000 Volts AC or 750 Volts DC
NEMA ICS 3	(1993) Industrial Control and Systems Factory Built Assemblies
NEMA ICS 4	(1993) Industrial Control and Systems Terminal Blocks
NEMA 250	(1991) Enclosures for Electrical Equipment (100 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2002) National Electrical Code

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST SP 250	(1991) Calibration Service Users Guide

UNDERWRITERS LABORATORIES (UL)

UL 94	(1996; Rev thru Jul 1998) Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 508	(1993; Rev thru Oct 1997) Industrial Control Equipment
UL 1059	(1993; 3rd Edition) Standard for Terminal Blocks

1.2 CONTROL SYSTEM DESCRIPTION

The process instrumentation and control system shall be used to monitor and control the operation of process equipment as specified and in accordance with the sequence of control and control schematics shown on the drawings. The control system shall provide for operator interaction, overall control system supervision, and process equipment control and monitoring. The Contractor shall provide hardware configured and sized to support expansion as specified and shown on the drawings.

1.2.1 Control System General Requirements

The control system shall consist of a microprocessor based, Personal Computer (PC). The PC combined with a "Human Machine Interface" (HMI), which includes video display, key board and printer will provide the plant operator with complete control of all vital plant operation functions. The system video display graphics indicate a real time and continuously updated set of all parameters, possibly requiring operator intervention. The control system personal computer also serves as a data acquisition system for all system parameters thereby allowing plant operator or maintenance personnel a facility for equipment historical record keeping.

1.2.2 Control System Operation

The control system provided under this specification shall operate using direct digital control (DDC) algorithms or ladder logic type and supervisory control to provide the required sequences of operation. Input

data to the controller shall be obtained by using instruments and controls interfaced to mechanical, electrical, utility systems and other systems as shown and specified. All required setpoints, settings, alarm limits, and sequences of operation shall be as identified in the specifications. The number and location of control panels shown on drawings shall be provided as a minimum.

1.2.3 Control System Points

Inputs to and outputs from the control system shall be in accordance with the attached Input/Output (I/O) Summary. Each connected analog output (AO), analog input (AI), digital output (DO), digital input (DI), pulse accumulator (PA) input and other input or output device connected to the control system shall represent a "point" where referred to in this specification.

1.2.4 Symbols, Definitions, and Abbreviations

Symbols, definitions, and engineering unit abbreviations shall conform to IEEE Std 100, as applicable.

1.3 ENVIRONMENTAL CONDITIONS

The Main Control (I/O) Cabinet, HMI, and peripherals will be located in an air-conditioned control room environment. However, the equipment shall be able to operate safely and continuously within the specified accuracy and reliability's with the air conditioning/heating system out of service for a short duration (8 to 16 hours) with the approximate extreme conditions indicated below.

	Normal Conditions	Extreme Conditions
Temperature	70 to 78 degrees F	5 to 100 degrees F
Humidity (non-condensing)	60% RH	5 to 100% RH

1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation; GA
Wiring; GA

Detail drawings containing wiring, schematic, flow diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall include, as appropriate: product specific catalog cuts; a drawing index; a list of symbols; a series of drawings for each control system using abbreviations, symbols, nomenclature and identifiers as shown.

SD-03 Product Data

Instrumentation and Control System; GA

Manufacturer's descriptive and technical literature, performance charts and installation instructions. Product specific catalog cuts shall be in booklet form, indexed to the unique identifiers, and shall consist of data sheets that document compliance with the specification. Where multiple components are shown on a catalog cut, the application specific component shall be marked.

Meters and Sensors; GA

Manufacturer's descriptive and technical literature, catalog cuts, performance charts and installation instructions.

Training Manual; GA

Instruction manual within 60 days of Notice to Proceed.

Performance Verification Test (PVT); GA

The performance verification test procedure; it shall refer to the actions and expected results to demonstrate that the control system performs in accordance with the sequence of control. A list of the equipment to be used during the testing shall be included. The list shall also include manufacturer's name, model number, equipment function, the date of the latest calibration and the results of the latest calibration.

SD-06 Test Reports

Testing, Adjusting and Commissioning; GA
Performance Verification Test(PVT); GA

SD-07 Certificates

Sensor and Control Wiring; GA

SD-10 Operation and Maintenance Data

Instrumentation and Control System; GA

Six (6) complete copies of operating instructions outlining the step-by-step procedures required for system startup, operation and shutdown. The instructions shall include layout, wiring and control diagrams of the system as installed. The instructions shall include the manufacturer's name, model number, service manual, parts list and a brief description of all equipment and their basic operating features.

Six (6) complete copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs and trouble shooting guides.

1.5 EQUIPMENT REQUIREMENTS

1.5.1 Materials and Equipment

Materials and equipment shall be standard unmodified products of a manufacturer regularly engaged in the manufacturing of such products. Units of the same type of equipment shall be products of a single

manufacturer. Items of the same type and purpose shall be identical and supplied by the same manufacturer, unless replaced by a new version approved by the Contracting Officer.

1.5.2 Nameplates

Each major component of equipment shall have the manufacturer's name and address, and the model and serial number in a conspicuous place. Laminated plastic nameplates shall be provided for equipment devices and panels furnished. Each nameplate shall identify the device, such as pump "P-1" or valve "VLV-402". Labels shall be coordinate with the schedules and the process and instrumentation drawings. Laminated plastic shall be 1/8 inch thick, white with black center core. Nameplates shall be a minimum of 1 by 3 inches with minimum 1/4 inch high engraved block lettering. Nameplates for devices smaller than 1 by 3 inches shall be attached by a nonferrous metal chain. All other nameplates shall be attached to the device.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

Electrical equipment will conform to Section 16415 ELECTRICAL WORK, INTERIOR. Equipment and wiring must be in accordance with NFPA 70, with proper consideration given to environmental conditions such as moisture, dirt, corrosive agents, and hazardous area classification.

2.2 MONITORING AND CONTROL PARAMETERS

The control system shall be complete including sensors, field preamplifiers, signal conditioners, offset and span adjustments, amplifiers, transducers, transmitters, control devices, engineering units conversions and algorithms for the applications; and shall maintain the specified end-to-end process control loop accuracy from sensor to display and final control element. Control equipment shall be powered by a 120 vAc, single phase, 60 Hz power source, with local transformers included as needed for signal transmission and subsystem operation. Connecting conductors shall be suitable for installed service. Enclosures shall be rated for NEMA 12.

2.2.1 Transmitter

Unless indicated otherwise, each sensor shall be provided with a transmitter, selected to match the sensor. Except where specifically indicated otherwise on the drawings, the transmitter shall be provided with a four digit or analog visual display of the measured parameter and shall provide a 4 to 20 mAdc output signal proportional to the level of the measured parameter. Accuracy shall be plus or minus 1 percent of full scale reading with output error not exceeding plus or minus 0.5 percent of full scale. Transmitter shall be located where indicated, mounted integrally with the sensor, pipe mounted, wall mounted or installed in the control panel. The distance between the sensor and transmitter shall not exceed the manufacturer's recommendation. Field preamplifiers and signal conditioners shall be included when necessary to maintain the accuracy from sensor to the programmable logic controller or recorder.

2.2.2 Liquid Service

Sensors and meters in liquid service shall be rated for continuous duty service at fluid approach velocities from 2.5 ft/s to 10 ft/s with

correspondingly higher constriction velocities over a fluid temperature range from 32 degrees F to 120 degrees F at pressures up to 150 psi gage.

2.2.3 Flow Sensor

Liquid flow indication shall be provided in gallons per minute (gpm). Vapor flow indication shall be provided in cubic feet per minute. Pressure taps shall incorporate appropriate snubbers. Unless indicated otherwise, the flow transmitter shall produce a signal that is proportional to the volumetric flow rate, compensated for fluid temperature, and shall have an accuracy of plus or minus 1 percent of full flow. Flow transmitter shall be located within 15 feet of the flow element. The flow transmitter shall include a digital readout of the volumetric flow rate to 3 significant figures. The transmitter shall provide a 4-20 mAdc output signal to the programmable logic controller, proportional to the measured parameter.

2.2.3.1 Flow Nozzle

Flow nozzle shall be made of austenitic stainless steel. The inlet nozzle form shall be elliptical and the nozzle throat shall be the quadrant of an ellipse. The thickness of the nozzle wall and flange shall be such that the accuracy will not be degraded by distortion of the nozzle throat from strains caused by the pipeline temperature and pressure, flange bolting, or other methods of installing the nozzle in the pipeline. The outside diameter of the nozzle flange or the design of the flange facing shall be such that the nozzle throat shall be centered accurately in the pipe.

2.2.3.2 Flow Switch

Flow switch shall have a repetitive accuracy of plus or minus 10 percent of actual flow setting. Switch actuation shall be adjustable over the operating flow range. Flow switch for use in contaminated water system shall be rated for use and constructed of suitable materials for installation in the environment encountered. The flow switch shall have non flexible paddle with Form C snap action contacts, rated in accordance with NEMA ICS 1.

2.2.3.3 Magnetic Flowmeter

Magnetic flowmeter shall be non-intrusive and shall measure fluid flow through the use of a self generated magnetic field. The magnetic flow element shall be encapsulated in type 300 stainless steel. Flowmeter shall be capable of measuring clean or dirty flow up to a maximum flow velocity of 10 fps. The metering tube shall be constructed of 316 stainless steel. The maximum pressure drop across the meter and appurtenances shall be 5 psi at the maximum flow rate.

2.2.3.4 Positive Displacement Flowmeter

Output accuracy shall be plus or minus 2 percent of the flow range. The flow meter shall be a direct reading, gerotor, nutating disk or vane type displacement device rated for liquid service. A counter shall be mounted on top of the meter, and shall consist of a non-resettable mechanical totalizer for local reading, and a pulse transmitter for remote reading. The totalizer shall have a six digit register to indicate the volume passed through the meter in gallons. A sweep-hand dial will indicate down to 1 gallon. The pulse transmitter shall have a hermetically sealed reed switch which is activated by magnets fixed on gears of the counter. The meter shall have a bronze body with threaded or flanged connections as required

for the application. The maximum pressure drop at full flow shall be 5 psi gage.

2.2.4 Level Instrumentation

Pressure taps shall incorporate appropriate snubbers. Relays and housing shall be intrinsically safe or explosion proof as required by the NFPA hazard rating for compatibility with the contents of the tank or sump. The transmitter shall provide a 4-20 mAdc output signal to the programmable logic controller, proportional to the measured parameter.

2.2.4.1 Capacitance Type Level Sensor

Liquid level sensor shall produce a signal that is proportional to the measured level. Sensor shall be capacitance type. The transmitter shall have non-interacting zero and span adjustments, and shall have an accuracy of plus or minus 0.1 percent of calibrated span. Assemblies shall include wall bracket or mounting plate, austenitic stainless steel rods, stainless steel bolts and corrosion resistant housing.

2.2.4.2 Conductivity Switch

The switch shall detect the presence of a fluid by measuring the electrical resistance between a sensor and a ground electrode. Electrodes shall be constructed of 316 stainless steel. Electrodes shall be fully clad using polytetrafluoroethylene (PTFE). The conductivity switch shall be capable of 4 separate level set points. The switch shall be provided with a ground electrode. Electrode lengths shall be as necessary, based on the application and to meet the requirements of the control sequence. A relay switching point shall be provided for each sensor. Contacts shall be rated for a maximum of 240 vAc, 5 A. Switch shall have a maximum response time of 2 seconds. Assembly shall be flange mounted and suitable for the indicated environment.

2.2.4.3 Displacement Type Level Switch

Liquid level switch shall be displacement type, having a minimum of two tandem floats with each float independently activating a set of Form C contacts at two different level settings. Each switch shall have a narrow differential band. The mounting connections shall be threaded, flanged or surface mounted to suit the application. All surfaces in contact with the tank contents shall be austenitic stainless steel. The switch enclosure shall be explosion proof for use in a hazardous environment, complete with a sealed water tight junction box, terminal block, and mounting plate. Each set of contacts shall be snap action, dry contact type with one normally open and one normally closed, contact rated in accordance with NEMA ICS 1. The switch shall be actuated by a magnetically equipped stainless steel displacer. Repetitive accuracy shall be plus or minus 1/4 inch of actual displacer setting.

2.2.4.4 Mercury Float Switch

Float switch assemblies for use in liquid systems shall consist of wall bracket or mounting plate, galvanized steel rods, stainless steel bolts, explosion proof and corrosion resistant housing, and intrinsically safe relays. Each switch shall consist of two normally open mercury switches, encapsulated in epoxy resin. The float casing shall be polypropylene. The switch cable shall be oil resistant thermoplastic cable with 4 No. 18 gauge stranded copper conductors, rated for 600 Volt application.

2.2.4.5 Ultrasonic Sensor

The sensor shall be microprocessor based and shall provide continuous, non-contact level measurement of liquids and solids utilizing microwave pulsed time of flight measurement method. The sensor shall operate in a frequency band approved for industrial use. The sensor shall be capable of measuring in a range of 0 to 20 feet with an accuracy of plus or minus 1 percent of full scale. The sensor shall be capable of distinguishing between real echoes, reflections and background noise. The sensor shall automatically compensate for temperature changes. The sensor shall be capable of operating in a temperature range from minus 15 degrees F to 105 degrees F. Assembly shall be flange mounted of sufficient size to eliminate echoing and suitable for the installed environment indicated. Mounting assembly shall be suitable for service without requiring entry or drainage of the vessel where level is being measured.

2.2.5 Pressure Instrumentation

Pressure taps shall incorporate appropriate snubbers. The controller shall provide a 4-20 mAdc output signal to the programmable logic controller, proportional to the measured parameter. The controller shall be provided with an internal battery to maintain operation for a minimum of 12 hours if power is lost. Pressures shall be controlled to within plus or minus 5 percent of design pressures.

2.2.5.1 Pressure Sensor

The sensing element shall be either capsule, diaphragm, bellows, Bourdon tube, or solid state as applicable for the installation. The pressure transducer shall withstand up to 300 percent of rated pressure, with an accuracy of plus or minus 1.0 percent of full scale selected to put the design range of the measured pressure in the middle third of the transducer's range. Pressure shall be measured in pounds per square inch (psi) gage with a range, plus or minus 10 percent of design range. The transmitter output error shall not exceed 0.1 percent of calibrated span.

2.2.5.2 Pressure Switch

Sensors shall be diaphragm or Bourdon tube and shall be constructed of 316 stainless steel. Pressure switch shall have a repetitive accuracy of plus or minus 5.0 percent of the operating range and shall withstand up to 150 percent of rated pressure. Switch actuation set point shall be adjustable over the operating pressure range with a differential adjustment span of 20 to 40 percent of the range of the switch. The switch shall have Form C snap-action contacts rated in accordance with NEMA ICS 1.

2.2.5.3 Differential Pressure

The sensor/transmitter assembly accuracy shall be plus or minus 2 percent of full scale. The over pressure rating shall be a minimum of 300 percent of the operating pressure. Transmitter shall be suitable for installation with the low pressure connection removed.

2.2.5.4 Differential Pressure Switch

Each switch shall be an adjustable diaphragm, or bellows operated device, with taps for sensing lines for connection of pressure fittings designed to sense fluid pressure. The adjustable differential range shall be a maximum

of 0.5 inches water at the low end to a minimum of 6.0 inches water at the high end. Two Form C contacts rated in accordance with NEMA ICS 1 shall be provided.

2.2.6 Process Analytical Instrumentation

Probes shall be easily removable without interrupting service. Sampling pumps shall be included where necessary or applicable to the sensing device. For sensors integral to the electronic controller the sample may be drawn directly into the sensor or may be drawn through a sample tube. For sensors remotely located the sample may be drawn through a sample tube. Outdoor sample tubes shall be heat traced. Sensor and controller construction shall be suitable for operation in the monitored medium. The controller shall be provided with a minimum of two alarm lights. The first alarm light shall indicate when the lower (warning) detection level has been exceeded. The second alarm light hall indicate when the upper (alarm) detection level has been exceeded. The alarm levels shall be individually adjustable. The controller shall be provided with an audible warning horn that sounds when the upper detection level has been exceeded, and a warning horn silence button. The controller shall provide a 4-20 mAdc output signal to the programmable logic controller, proportional to the measured parameter. The controller shall be provided with an internal battery to maintain operation for a minimum of 12 hours if power is lost.

2.2.6.1 Water Turbidity

System shall be complete and include indicating meter, sensing element and a transmitter. System shall be industrial grade and suitable for measurement of turbidity by insertion of the sensing element into the pipeline, using a hot tap assembly. Sensor assembly shall be suitable for periodic removal for adjustment and cleaning without requiring shutdown of the process. Sensor shall be suitable for range from 0 to 200 Nephelometric turbidity units (NTU). The accuracy shall be plus or minus 2 percent of full scale reading. Range shall be field verified for the application and adjusted as required. Sensing element shall be constructed of 316 stainless steel and glass. Sensing element shall be unaffected by color in the fluid, pressure, temperature and rate of flow. Sensor shall have automatic zeroing and shall require no normal maintenance or periodic recalibration.

2.3 COMPRESSED AIR STATIONS

2.3.1 Air Compressor Assembly

The air compressor shall be a high-pressure compressing unit with electric motor. The compressor shall be equipped with a motor with totally enclosed belt guard, an operating-pressure switch, safety relief valves, gauges, intake filter and intake silencer and combination type magnetic starter with under voltage protection and thermal overload protection for each phase, and shall be supported by a steel base mounted on an air storage tank. The air compressor shall provide the compressed air required for control operation while operating not more than one-third of the time. The tank shall be of sufficient volume so that no more than six compressor starts per hour are required with the starting pressure switch differential set at 20 psi gage. The air storage tank shall be fabricated for a working pressure of not less than 200 psi gage and constructed and certified in accordance with ASME BPV VIII Div 1. The tank shall be provided with an automatic condensate drain trap with manual override feature.

2.3.2 Compressed Air Station Specialties

2.3.2.1 Refrigerated Dryer, Filters and Pressure Regulator

A refrigerated dryer shall be provided in the air outlet line of the air storage tank. The dryer shall be of the size required for the full delivery capacity of the compressor. The air shall be dried at a pressure of not less than 70 psi gage to a temperature not greater than 35 degrees F. The dryer shall be provided with an automatic condensate drain trap with manual override feature. The refrigerant used in the dryer shall be one of the fluorocarbon gases and have an ozone depletion potential of not more than 0.05. A 5 micron prefilter and coalescing-type oil removal filter with shut-off valves shall be provided in the dryer discharge. Each filter bowl shall be rated for 150 psi gage maximum working pressure. A pressure regulator with high side and low side pressure gauges and a safety valve shall be provided downstream of the filter. Pressure regulators of the relieving type shall not be used.

2.3.2.2 Coalescing Filter

A coalescing prefilter, together with an automatic drain valve, shall be provided for removal of liquids. The flow through the prefilter shall be from inside to outside and reduce an entrained quantity of 50 ppmv oil to 0.0013 ppmv effluent liquid oil and water and remove all particulates greater than 0.6 micron absolute. The prefilter housing (bowl) shall be fitted with a drain port to eliminate collected liquids and provide sufficient sump volume to prevent liquid re-entrainment, and an automatic drain valve with adjustable cycle and drain times. Prefilter pressure drop shall be less than 3 psi saturated. A particulate after filter, outside to inside flow, designed to remove desiccant fines shall be provided. The after filter cartridge shall have a particulate removal rating of 0.5 micron absolute. Both prefilter and after filter housings shall allow for service of elements without removing the entire assembly from the system. Filter life shall be stated and guaranteed by the vendor.

2.3.2.3 Flexible Pipe Connections

The flexible pipe connectors shall be designed for 150 psi gage and 250 degrees F service and shall be constructed of rubber, polytetrafluoroethylene (PTFE) resin or braided corrosion-resistant steel, bronze, monel or galvanized steel. The connectors shall be suitable for the service intended and may have threaded or soldered ends. The length of the connectors shall be as recommended by the manufacturer for the service intended.

2.3.2.4 Vibration Isolation Units

The vibration isolation units shall be standard products with published loading ratings and shall be single rubber-in-shear, double rubber-in-shear or spring type.

2.3.2.5 Compressed Air Piping

Control air delivered to the system shall conform to ISA S7.0.01. Air lines for pneumatic controls shall be seamless copper tubing or nonmetallic tubing. Nonmetallic tubing shall be compounded from polyethylene. Air lines concealed in walls shall be hard-drawn copper tubing or nonmetallic tubing in rigid conduit. Terminal single lines shall be hard-drawn copper tubing except when the run is less than 12 inches in length, flexible

polyethylene may be used. Nonmetallic tubing will not be used for applications where the tubing could be subjected to a temperature exceeding 130 degrees F. Fittings for nonmetallic tubing shall be for instrument service and may be brass or acetyl resin of the compression or barbed push-on type. Tubing shall be as follows:

a. Copper tubing shall conform to ASTM B 88 and shall have sweat fittings and valves. Exposed tubing shall be hard drawn in exposed areas and hard-drawn or annealed in concealed areas. Only tool made bends shall be used. Fittings for copper tubing shall be brass or copper solder joint type except at connections to the apparatus, where fittings shall be brass compression type. Tubing shall be rack mounted where multiple tubes run in parallel. Multiple tubes may be bundled when concealed.

b. Tubing shall be flame resistant, multiple polyethylene tubing in an extruded PVC protective sheath, or unsheathed polyethylene tubing in rigid metal, intermediate metal, or electrical metallic tubing conduit for areas where tubing is exposed. Tubing shall have barbed fittings and valves, and shall conform to the following: Burst pressure shall be 550 psi gage at 75 degrees F to 175 psi gage at 150 degrees F, mini mum. Stress crack resistance in accordance with ASTM D 1693 shall be 200 hours, minimum. Tensile strength in accordance with ASTM D 638 shall be 2000 psi, minimum. Average density in accordance with ASTM D 792 shall be 57 pounds per cubic foot. Average flow rate in accordance with ASTM D 1238 shall be 0.30 decigram per minute.

c. Plastic tubing shall have the burning characteristics of linear low density polyethylene tubing, shall be self extinguishing when tested in accordance with ASTM D 635, shall have UL 94 V-2 flammability classification, and shall withstand stress cracking when tested in accordance with ASTM D 1693. Polyethylene tubing shall not be used for smoke removal systems.

2.3.3 Barrier Jacket

Plastic tubing bundles shall be provided with mylar barrier and flame retardant polyethylene jacket. Each tube shall be numbered.

2.4 PROGRAMMABLE LOGIC CONTROLLER (PLC)

2.4.1 PLC General Requirements

PLCs shall be micro-processor based, capable of receiving discrete and analog inputs and, through programming, shall be able to control discrete and analog output functions, perform data handling operations and communicate with external devices. PLCs shall meet the requirements of Class A computing devices, and shall be labeled as set forth in 47 CFR 15 and shall be able to withstand conducted susceptibility test as outlined in NEMA ICS 1, NEMA ICS 2, NEMA ICS 3, and IEEE C37.90.1. PLCs shall function properly at temperatures between 32 and 122 degrees F at 5 to 95 percent relative humidity non-condensing and shall tolerate storage temperatures between minus 40 and plus 140 degrees F at 5 to 95 percent relative humidity non-condensing.

2.4.2 Modular PLC

PLCs shall be based on a modular, field expandable design allowing the

system to be tailored to the process control application. The system shall be expandable through the use of additional hardware and/or user software. As a minimum, the PLC shall include a mounting backplane, power supply module, central processing unit (CPU) module, communications module, and input/output (I/O) module. The modules shall be grouped together in a mounting rack or cabinet. The mounting rack backplane shall provide the communications mechanism to fully integrate the individual modules located within the rack. Modules shall plug directly into the backplane. The use of wire connectors between modules will not be allowed. The rack size shall be as needed to hold the equipment necessary while performing the required control functions. The system configuration shall allow for the removal and/or installation of modules under power.

2.4.2.1 Central Processing Unit (CPU) Module

The CPU module shall be a self contained, microprocessor based unit that provides time of day, scanning, application (ladder rung logic) program execution, storage of application programs, storage of numerical values related to the application process and logic, I/O bus traffic control, peripheral and external device communications and self diagnostics.

2.4.2.2 Communications Module

The communications module shall allow peer-to-peer communication with other PLCs and shall allow the PLC to communicate with the central station, or workstation. The communication module shall utilize the manufacturer's standard communication architecture and protocol, ethernet architecture and protocol or a combination of these. The communication module shall allow programming of the PLC to be done locally through the use of a laptop computer or from the central station or remote workstation.

2.4.2.3 Power Supply Module

One or more power supply modules shall be provided as necessary to power other modules installed in the same cabinet. Power supply modules shall plug directly into the backplane. Auxiliary power supplies may be used to supply power to remote cabinets or modules.

a. Power supply modules shall use AC power with a nominal voltage of 120 vAc plus or minus 5 percent. The power supply module shall monitor the incoming line voltage level and shall provide over current and over voltage protection. If the voltage level is detected as being out of range the power supply module shall continue to provide power for an adequate amount of time to allow for a safe and orderly shutdown. Power supply modules shall be capable of withstanding a power loss for a minimum of 20 milliseconds while still remaining in operation and providing adequate power to all connected modules.

b. Each power supply module shall be provided with an on-off switch integral to the module. If the manufacturer's standard power supply module is not provided with an on-off switch, a miniature toggle type switch shall be installed near the PLC and shall be clearly labeled as to its function.

c. Power supply modules shall be provided with an indicating light which shall be lit when the module is operating properly.

2.4.2.4 Input/Output (I/O) Modules

Modules shall be self contained, microprocessor based units that provide an interface to field devices. The module shall be located in the same mounting rack as the other PLC components. The unit shall plug directly into the backplane of the mounting rack. Each module shall contain visual indication to display the on-off status of individual inputs or outputs.

2.4.3 Program Storage/Memory Requirements

The CPU shall utilize the manufacturer's standard non-volatile memory for the operating system. The controller shall have electronically erasable, programmable, read only memory (EEPROM) for storage of user programs and battery backed RAM for application memory. The EEPROM shall be loaded through the controller keypad, central station or through the use of a laptop computer. The CPU memory capacity shall be based on the system's control requirements. The memory capacity shall be sized such that, when the system is completely programmed and functional, no more than 50 percent of the memory allocated for these purposes is used.

2.4.4 Input/Output Characteristics

Each controller shall allow for analog input, analog output, discrete input and discrete output. The number and type of inputs and outputs for the system shall be as shown on the drawings and shall comply with the sequence of control. The system capacity shall include a minimum of 20 percent spare input and output points (no less than two points) for each point type provided. During normal operation, a malfunction in any input/output channel shall affect the operation of that channel only and shall not affect the operation of the CPU or any other channel. Analog input circuits shall be available in 4-20 mA. Discrete input circuits shall be available in 79-132 vAc. All input circuits shall have a minimum optical isolation of 1500 VRMS and shall be filtered to guard against high voltage transients from the externally connected devices. Analog output circuits shall be available in 4-20 mA. Discrete output circuits shall be available in 79-132 vAc. All output circuits shall have a minimum optical isolation of 1500 VRMS and shall be filtered to guard against high voltage transients from the externally connected devices.

2.4.5 Wiring Connections

Wiring connections shall be heavy duty, self lifting, pressure type screw terminals to provide easy wire insertion and secure connections. The terminals shall accept two #14 AWG wires. A hinged protective cover shall be provided over the wiring connections. The cover shall have write-on areas for identification of the external circuits.

2.4.6 On-Off Switch

Each controller shall be provided with an integral on-off power switch. If the controller is not provided with a manufacturer's standard on-off switch, a miniature toggle type switch shall be installed in the control panel near the controller and shall be clearly labeled as to its function.

2.4.7 Diagnostics

Each PLC shall have diagnostic routines implemented in firmware. The CPU shall continuously perform self-diagnostic routines that will provide information on the configuration and status of the CPU, memory, communications and input/output. The diagnostic routines shall be

regularly performed during normal system operation. A portion of the scan time of the controller shall be dedicated to performing these housekeeping functions. In addition, a more extensive diagnostic routine shall be performed at power up and during normal system shutdown. The CPU shall log input/output and system faults in fault tables which shall be accessible for display. When a fault affects input/output or communications modules the CPU shall shut down only the hardware affected and continue operation by utilizing the healthy system components. All faults shall be annunciated at the PLC. Diagnostic software shall be useable in conjunction with the portable tester.

2.4.8 Accuracy

Controllers shall have an accuracy of plus or minus 0.25 percent of input span.

2.5 PLC SOFTWARE

All PLC software described in this specification shall be furnished as part of the complete control system.

2.5.1 Operating System

Each PLC shall be provided with the manufacturer's standard operating system software package. The PLC shall maintain a point database in its memory that includes all parameters, constraints and the latest value or status of all points connected to the PLC. Execution of the PLC application programs shall use the data in memory resident files. The operating system shall support a full compliment of process control functions. It shall be possible to define these functions using a mix of function blocks, ladder logic diagrams, sequential function charts and text programming. Programming methods and interactions shall be based on IEC 1131-3. A combination of the programming methods shall be possible within a single controller. The operating system shall allow loading of software locally or from the central station and data files from the portable tester. It shall also support data entry and diagnostics using an operator interface panel attached directly to the PLC. Each PLC shall be capable of operating in stand alone mode.

2.5.1.1 Startup

The PLC shall have startup software that causes automatic commencement of operation without human intervention, including startup of all connected I/O functions. A PLC restart program based on detection of power failure at the PLC shall be included in the PLC software. The restart program shall include start time delays between successive commands to prevent demand surges or overload trips.

2.5.1.2 Failure Mode

Upon failure for any reason, each PLC shall perform an orderly shutdown and force all PLC outputs to a predetermined (failure mode) state, consistent with the failure modes shown and the associated control device.

2.5.2 Functions

The controller operating system shall be able to scan inputs, control outputs, and read and write to its internal memory in order to perform the required control as indicated in the sequence of control on the drawings.

The controller shall periodically perform self diagnostics to verify that it is functioning properly.

2.5.2.1 Analog Monitoring

The system shall measure and transmit all analog values including calculated analog points.

2.5.2.2 Logic (Virtual)

Logic (virtual) points shall be software points entered in the point database which are not directly associated with a physical I/O function. Logic (virtual) points shall be analog or digital points created by calculation from any combination of digital and analog points, or other data having all the properties of real points, including alarms, without the associated hardware. Logic (virtual) points shall be defined or calculated and entered into the database by the Contractor. The calculated analog point shall have point identification in the same format as any other analog point.

2.5.2.3 State Variables

If an analog point represents more than two (up to 8) specific states, each state shall be nameable. For example, a level sensor shall be displayed at its measured engineering units plus a state variable with named states usable in programs or for display such as low alarm/low/normal/high/high alarm.

2.5.2.4 Analog Totalization

Any analog point shall be operator assignable to the totalization program. Up to eight analog values shall be totalized within a selectable time period.

2.5.2.5 Trending

Any analog or calculated point shall be operator assignable to the trend program. Up to eight points shall be sampled at individually assigned intervals, selectable between 1 minute and 2 hours. A minimum of the most recent 128 samples of each trended point shall be stored. The sample intervals shall be able to be defined, modified, or deleted online.

2.5.3 Alarm Processing

Each PLC shall have alarm processing software for AI, DI, and PA alarms for all real and virtual points connected to that PLC.

2.5.3.1 Digital Alarms

Digital alarms are those abnormal conditions indicated by DIs as specified and shown. The system shall automatically suppress analog alarm reporting associated with a digital point when that point is turned off.

2.5.3.2 Analog Alarms

Analog alarms are those conditions higher or lower than a defined value, as measured by an AI. Analog readings shall be compared to predefined high and low limits, and alarmed each time a value enters or returns from a limit condition. Unique high and low limits shall be assigned to each

analog point in the system. In control point adjustment (CPA) applications, key the limit to a finite deviation traveling with the setpoint. The system shall automatically suppress analog alarm reporting associated with an analog point when that analog point is turned off.

2.5.3.3 Pulse Accumulator (PA) Alarms

Pulse accumulator alarms are those conditions calculated from totalized values of accumulator inputs or PA input rates that are outside defined limits as specified and shown. PA totalized values shall be compared to predefined limits and alarmed each time a value enters a limit condition. Unique limits shall be assigned to each PA point in the system.

2.5.4 Constraints

2.5.4.1 Equipment Constraints Definitions

Each control point in the database shall have PLC resident constraints defined and entered by the Contractor, including as applicable: maximum starts (cycles) per hour; minimum off time; minimum on time; high limit (value in engineering units); and low limit (value in engineering units).

2.5.4.2 Constraints Checks

All control devices connected to the system shall have the PLC constraints checked and passed before each command is issued. Each command point shall have unique constraints assigned. High and low "reasonableness" values or one differential "rate-of-change" value shall be assigned to each AI. Each individual point shall be capable of being selectively disabled by the operator from the central station.

2.5.5 Control Sequences and Control Loops

Specific functions to be implemented are defined in individual system control sequences and database tables shown on the drawings, and shall include, as applicable, the following functions: PI control shall provide proportional control and proportional plus integral control; two position control shall provide control for a two state device by comparing a set point against a process variable and an established dead band; floating point control shall exercise control when an error signal exceeds a selected dead band, and shall maintain control until the error is within the dead band limits; signal selection shall allow the selection of the highest or lowest analog value from a group of analog values as the basis of control and shall include the ability to cascade analog values so that large numbers of inputs can be reduced to one or two outputs; signal averaging shall allow the mathematical calculation of the average analog value from a group of analog values as the basis of control and shall include the ability to "weight" the individual analog values so that the function output can be biased as necessary to achieve proper control; reset function shall develop an AO based on up to two AIs and one operator specified reset schedule.

2.5.6 Plant Control Logic

A description of the control logic for the water treatment system is provided in Attachment #1.

2.5.7 Command Priorities

A scheme of priority levels shall be provided to prevent interaction of a command of low priority with a command of higher priority. Override commands entered by the operator shall have higher priority than those emanating from applications programs.

2.5.8 Resident Application Software

The Contractor shall provide resident applications programs developed in accordance with paragraph Graphical Object Oriented Programming to achieve the sequences of operation, parameters, constraints, and interlocks necessary to provide control of the process systems connected to the control system. All application programs shall be resident in the PLC and shall execute in the PLC, and shall coordinate with each other, to insure that no conflicts or contentions remain unresolved.

2.5.8.1 Program Inputs and Outputs

The Contractor shall use program inputs listed for each application program to calculate the required program outputs. Where specific program inputs are not available, a "default" value or virtual point appropriate for the equipment being controlled and the proposed sequence of operation shall be provided to replace the missing input, thus allowing the application program to operate.

2.5.8.2 Failure Mode

In the event of a PLC failure, the controlled equipment shall continue to function in the failure mode shown on the drawings.

2.6 CONTROL PANELS

2.6.1 Components

2.6.1.1 Enclosures

The enclosure for each control panel shall conform to the requirements of NEMA 250 for the types specified. Finish color shall be the manufacturer's standard, unless otherwise indicated. Damaged surfaces shall be repaired and refinished using original type finish. Enclosures for installation in mechanical equipment rooms shall be Type NEMA 12; other locations shall be as otherwise specified or shown. Enclosures for equipment installed outdoors shall be Type 4 or as shown. Enclosure shall be provided with a single, continuously hinged exterior door with print pocket, 3-point latching mechanism and key lock and a single, continuously hinged interior door.

2.6.1.2 Controllers

Controllers shall be in accordance with paragraph Programmable Logic Controller (PLC).

2.6.1.3 Standard Indicator Light

Indicator lights shall comply with NEMA ICS 1, NEMA ICS 2 and UL 508. Lights shall be heavy duty, round and shall mount in a 0.875 inch mounting hole. Indicator lights shall be LED type and shall operate at 120 vAc or 24 vDc. Long life bulbs shall be used. Indicator light shall be provided with a legend plate labeled as shown on the drawings. Lens color shall be as indicated on the drawings. Lights shall be push to test (lamp) type.

2.6.1.4 Selector Switches

Selector switches shall comply with NEMA ICS 1, NEMA ICS 2 and UL 508. Selector switches shall be heavy duty, round and shall mount in a 0.875 inch mounting hole. The number of positions shall be as indicated on the drawings. Switches shall be illuminated. Switches shall be rated for 600 volts, 10 amperes continuous. Selector switches shall be provided with a legend plate labeled as shown on the drawings. Where indicated or required, dual auxiliary contacts shall be provided for the automatic position to provide position sensing at the central station or workstation. Auxiliary contacts shall be rated for 120 vAc, 1A as a minimum. Where indicated on the drawings, switches shall be key operated. All keys shall be identical.

2.6.1.5 Push Buttons

Push buttons shall comply with NEMA ICS 1, NEMA ICS 2 and UL 508. Push buttons shall be heavy duty, round and shall mount in a 0.875 inch mounting hole. The number and type of contacts shall be as indicated on the drawings or required by the Sequence of Control. Push buttons shall be rated for 600 volts, 10 amperes continuous. Push buttons shall be provided with a legend plate labeled as shown on the drawings.

2.6.1.6 Relays

Relays shall comply with IEEE C37.90. Relays shall be as required by the Sequence of Control. Relay coil shall be 120 vAc and shall be provided with matching mounting socket. Power consumption shall not be greater than 3 watts.

2.6.1.7 Terminal Blocks

Terminal blocks shall comply with NEMA ICS 4 and UL 1059. Terminal blocks for conductors exiting control panels shall be two-way type with double terminals, one for internal wiring connections and the other for external wiring connections. Terminal blocks shall be made of bakelite or other suitable insulating material with full deep barriers between each pair of terminals. A terminal identification strip shall form part of the terminal block and each terminal shall be identified by a number in accordance with the numbering scheme on the approved wiring diagrams.

2.6.1.8 Autodialer

Autodialer shall be a self contained, programmable device capable of automatic operation. The unit shall automatically dial preprogrammed number(s) to report alarm(s) or other specified conditions. The autodialer shall automatically redial upon receipt of a busy signal. The number of redials shall be an operator definable parameter. The unit shall be capable of dialing a minimum of three phone numbers. The unit shall communicate over voice grade phone lines.

2.6.1.9 Alarm Horns

Alarm horns shall be provided where indicated on the drawings. Horns shall be vibrating type and shall comply with UL 508. Horns shall provide 100 dB at 10 feet. Exterior mounted horns shall be weather proof by design or shall be mounted in a weather proof enclosure that does not reduce the effectiveness of the horn.

2.6.2 Panel Assembly

Control panels shall be factory assembled and shipped to the jobsite as a single unit. Panels shall be fabricated as indicated and devices shall be mounted as shown or required. Each panel shall be fabricated as a bottom-entry connection point for control system electrical power, control system wiring, communications system wiring to other control panels, and operators workstation.

2.6.3 Electrical Requirements

Each panel shall be powered by a dedicated 120 volts ac circuit, with a fuse, sized as recommended by the equipment manufacturer, and a disconnect switch located inside the panel. Wiring shall terminate inside the panel on terminal blocks. Electrical work shall be as specified in Section 16415 ELECTRICAL WORK, INTERIOR and as shown on the drawings.

2.6.4 Power Line Conditioner

Each control panel shall be provided with a power line conditioner to provide both voltage regulation and noise rejection. The power line conditioner shall be of the ferro-resonant design, with no moving parts and no tap switching, while electrically isolating the secondary from the power line side. The power line conditioner shall be sized for 125 percent of the actual connected kva load. Characteristics of the power line conditioner shall be as follows:

2.6.4.1 85 Percent Load

At 85 percent load, the output voltage shall not deviate by more than plus or minus 1 percent of nominal voltage when the input voltage fluctuates between minus 20 percent to plus 10 percent of nominal voltage.

2.6.4.2 Load Changes

During load changes of zero to full load, the output voltage shall not deviate by more than plus or minus 3 percent of nominal voltage. Full correction of load switching disturbances shall be accomplished within 5 cycles, and 95 percent correction shall be accomplished within 2 cycles of the onset of the disturbance.

2.6.5 Grounding

Control panel enclosures shall be equipped with a solid copper ground bus or equivalent. The ground bus shall be securely anchored to the enclosure so as to effectively ground the entire structure. Clamp-type terminals sized large enough to carry the maximum expected current shall be provided on the ground bus for grounding cables. Where a definite circuit ground is required, a single wire not less than #10 AWG shall run independently to the panel ground bus and shall be fastened to the ground bus with a bolted terminal lug. Cases of instruments, relays and other devices shall be effectively grounded through the enclosures steel structure unless otherwise indicated. Insulated wiring having a continuous rated current of not less than the circuit fuse rating shall be used for grounding. Grounding terminals of power receptacles shall be solidly grounded to the panel enclosure.

2.6.6 Convenience Outlet

A 120 volt ac, 20 amp, ground fault interruption (GFI) type duplex convenience outlet shall be provided inside the panel. The outlet circuit shall be separate from the panel power circuit.

2.6.7 Panel Interior Light

Eachcontrol panel shall be provided with a 60 watt incandescent light. The light shall be operated by a manual on-off switch mounted on the interior door of the enclosure. The light shall be powered by the same circuit as the convenience outlet.

2.7 CENTRAL STATION AND OPERATORS WORKSTATION EQUIPMENT

2.7.1 Central Station and Operators Workstation Computer

Computer shall be a standard desk top configuration, unmodified digital computer of modular design. Computing devices, as defined in 47 CFR 15, supplied as part of the control system shall be certified to comply with the requirements of Class B computing devices and shall be labeled as set forth in 47 CFR 15.

2.7.1.1 Minimum Processor Operating Speed

Minimum processor operating speed shall be 1 GHz.

2.7.1.2 RAM Memory

Ram memory shall be 128 MB, expandable to a minimum of 512 MB.

2.7.1.3 Minimum Power Supply

Minimum power supply shall have a capacity of 250 watts.

2.7.1.4 Real Time Clock (RTC)

Real time clock accurate to within plus or minus one minute per month. Battery backed for a minimum of 3 months.

2.7.1.5 Serial Ports

Two EIA ANSI/EIA/TIA-232-F ports. Data transmission rate shall be software adjustable between 9600 and 57,600 bps.

2.7.1.6 Parallel Port

One enhanced parallel port.

2.7.1.7 SVGA Color Monitor

SVGA color monitor shall be no less than 17 inches, with a minimum resolution of 1280 by 1024 pixels, noninterlaced, and a maximum dot pitch of 0.28 millimeters. The video output card shall support at least 256 colors at a resolution of 1280 by 1024 at a minimum refresh rate of 70 Hz.

2.7.1.8 Keyboard

A 101 key, 64 character standard ASCII character set based on ANSI X3.64 and ANSI X3.154.

2.7.1.9 Hard Disk

Hard disk with a minimum of 10 gigabytes of formatted storage.

2.7.1.10 Floppy Disk Drives

One high density floppy disk drive and controller in 3-1/2 inch diameter size shall be provided.

2.7.1.11 Zip Drive

One zip drive and controller with 100 megabyte of formatted storage shall be provided.

2.7.1.12 Modem

Modem shall operate on analog telephone lines 56K kbps, full duplex using asynchronous communications. It shall have an error detection, auto answer/autodial, and call progress detection. The modem shall meet the requirements of ITU V.42 bis for error correction and ITU V.42 bis for data compression standards. Model shall be suitable for operating on ISDN circuits in conformance with 47 CFR 68.

2.7.1.13 Mouse

Mouse: minimum resolution of 400 dots per inch.

2.7.1.14 CD Drive

CD drive: ROM with storage capacity of 650 megabytes of formatted storage, 40X speed.

2.7.1.15 Network Interface Card

Network interface card shall be provided for LAN equipment functions and for serving devices as shown on the drawings. The network interface card shall use a 16 bit interface to the data bus; it shall be supplied with an on-board RJ45 connector and transceiver for direct connection to the LAN. It shall also have an auxiliary unit input port for performing diagnostics. On-board buffer of at least 16K bytes shall be included to prevent the loss of data packages.

2.7.2 Printer

A laser printer shall installed at the central station computer. The printer shall meet the following requirements: The input interface shall be a parallel port connection. Resolution shall be a minimum of 600 by 600 dots per inch. Printing speed shall be a minimum of 4 pages per minute. The data buffer size shall be a minimum of 10 megabytes. The size for paper and other media shall be 8.5 X 11 inches. The paper cassette shall have a 250 sheet minimum capacity.

2.7.3 Uninterruptible Power Supply (UPS)

A self contained UPS suitable for installation and operation at the central station shall be provided. The unit shall be sized to provide a minimum of 10 minutes of operation of the central station computer. The UPS shall incorporate surge suppression, noise filtering (normal and common mode)

short circuit protection and voltage regulation (brownout and overvoltage protection). UPS shall be complete with all necessary power supplies, transformers, batteries, and accessories and shall include visual indication of normal power operation, UPS operation, abnormal operation and visual and audible indication of low battery power. The UPS shall comply with the Federal Communications Commission Standard 15J part A for radio noise emissions.

2.7.4 Portable Tester/Programmable Device

A portable tester/programmable device shall be provided and shall be connectable to any PLC. The portable tester/workstation shall consist of a portable computer with a nominal 10 inch active color matrix liquid crystal display, capable of displaying up to 256 colors at a minimum resolution of 640 x 480 pixels, 64 bit microprocessor operating at a minimum of 700 MHz. The portable tester/workstation shall have, as a minimum, 6 GB hard drive, 32 megabytes of memory, integral pointing device, serial and parallel ports, color VGA video port for an external color monitor, 3.5 inch floppy disk drive, modem, PCMCIA type 3 slot, rechargeable battery, battery charger and a compatible network adapter. The portable tester/workstation shall be provided with the proper cables, connectors, adapters and software required to connect to and be compatible with the PLCs. Connection may be made directly to the PLCs or to the communications network. The tester/work station shall be capable of performing all workstation functions contingent on proper password level. The communication and programmable device shall connect to the PLC directly for readout of variables, override, control, servicing, troubleshooting and adjustment of control parameters. The device shall communicate in English language for inquiry, reporting and programming purposes.

2.8 CENTRAL STATION SOFTWARE

The central station software shall provide the communication, programming and control capabilities necessary to support all specified points and functions, plus a minimum expansion of 50 percent of the current number of points, complete with their point database. The central station shall be online at all times and shall perform all required functions as specified. The central station software shall be one or more standard software modules. Where multiple modules are used the modules shall be capable of sharing data and operating together seamlessly. Software shall be windowing type using icons and pull down menus. The system shall support multiple user operation with multiple tasks for each user and shall support operation and management of all peripheral devices.

2.8.1 Graphical Operations

2.8.1.1 Graphical User Interface

The central station shall be provided with an object-oriented, mouse driven, graphical user interface. The graphical user interface shall include a set of desktop utilities including the following: file management; shell tool; calculator; text editor; and icon editor.

2.8.1.2 Display Information

The central station shall display information necessary to support all requirements specified, including: operator commands; alarm notification; reports; system graphics as specified and as shown, incorporating dynamic data; and curve plotting.

2.8.1.3 System Graphics Implementation

System graphics displays shall be hierarchical displays which integrate dynamic data into the display. System graphics shall reflect actual system configuration. Each system schematic shall be included as a separate display. Different colors, textures, and use of inverted video shall be used for various components and dynamic data. The displays shall include standard and/or custom symbols. A library of callable display symbols containing symbols for all necessary equipment and control devices shall be furnished. Symbols shall conform to ASHRAE Hdbk-IP where applicable. Data associated with a display shall be updated within 5 seconds of the digital status change or the analog change in excess of the analog change differential. Any dynamic data which is not current, due to PLC communications failure, PLC failure, or point out of service, shall be highlighted or flagged.

2.8.1.4 Display Editor

The display editor shall enable the user to create, modify, save and delete displays and symbols. Within the display shall be dynamic fields. The function of linking the dynamic fields with the database shall be handled by a separate software module which shall be executed automatically as the last step of the database generation and modification procedure.

2.8.1.5 Graphical Object Oriented Programming

The system shall include a graphical object oriented programming function which shall be used to create all control sequences utilized in the control panels. This function shall reside in the central station to create, modify, and test software for control panel resident programs. The graphical object oriented programming function shall provide programming elements to be connected together to create a logic diagram. The diagram shall be compilable to produce executable code for the control panel. The graphical object oriented programming function shall include elements necessary to create logic diagrams that represent sequences of operation. Program elements shall be able to be combined into a custom template which can then be used as a standard function. Program checkout and debug facilities shall include display of dynamic and/or simulated system variables and points on the programming screens. The user shall be able to fix or force values of variables to enable program checkout during debugging. The programming shall allow for the use of the portable tester for loading files directly into the control panel, uploading of existing control panel programming and database information and downloading of control panel programming and database information.

2.8.1.6 Charting

The user shall be able to display data in chart formats, and the system shall support the presentation of data: 1) with time on the X-axis (horizontal) and amplitude on the Y-axis (vertical) for trend charts; and 2) in bar chart form with a minimum of 360 15-minute divisions and 31 1-day divisions to be displayed on the X-axis.

2.8.1.7 System Menus and Displays

The user shall be able to call up the following displays by dedicated function key, pull down menu or by icon and shall be able to page forward and backward on linked multiple page displays. The system menu and index

displays shall also contain icons which can be used to call up subsequent displays.

a. System Menu (list of all graphics and menus).

b. Index (list of all PLCs).

c. Alarm Summary (list of all uncleared alarms).

d. Abnormal Summary (list of all devices not in normal state; keeps track of alarm conditions which have been cleared).

e. Data Communications Summary (listing of availability for each communication channel, by statistically processing the number of transmission errors, outages, and other abnormal conditions for each channel).

2.8.1.8 Hard-Copy Screen Request

The central station shall be able to obtain a hard copy of the monitor display being viewed. This shall be an exact "snapshot" of the data and device symbols shown on the selected monitor.

2.8.2 Command Software

The software shall provide for defining and selecting points, parameters, graphics, report generation, and all other functions associated with operation. The operator commands shall be usable from central station computer and workstation keyboards with individual operator passwords as specified.

2.8.2.1 Command Input

Command menus shall utilize full words and acronyms selected to allow operators to use the system without extensive training or data processing backgrounds. The system shall prompt the operator.

2.8.2.2 Command Input Errors

The system shall supervise operator inputs to ensure they are correct for proper execution. Operator input assistance shall be provided whenever a command cannot be executed because of operator input errors.

2.8.2.3 Special Functions

The system shall support the following special functions by using a mouse, in addition to all other commands specified:

a. Help shall produce a display of all commands available to the operator. The help command, followed by a specific command, shall produce context sensitive listing with a short explanation of the purpose, use, and system reaction to that command.

b. Start/Enable shall manually start equipment and enable monitoring and control of points.

c. Stop/Disable shall manually stop equipment and disable monitoring and control components.

d. Display Diagram shall display diagrams of specific utility systems or other systems.

e. Diagram Development shall facilitate development of diagrams of specific utility systems or other systems.

f. Auto/Override shall override automatic operation of a point or return a point to automatic operation.

g. Print Report shall allow the operator to print reports.

h. Confirm Action shall allow the operator to confirm that the desired command sequence has been correctly entered and is to be executed.

i. Cancel Action shall perform the opposite function of the confirm action, at any time prior to executing confirm action.

j. Memo Pad shall allow the operator to create, store and retrieve pop-up notes.

2.8.2.4 Operator's Commands

The operator's commands shall provide the means for entry of control and monitoring commands, and for retrieval of information. The operator's commands shall perform such tasks as requesting a display of any digital, analog, or accumulator point, or any group of related points, startup and shutdown selected systems or devices, modifying, adjusting, enabling or defining a point or point parameters.

2.8.2.5 Level of Addressing

Four levels of addressing for identification shall be provided as follows:

a. Point. The individual sensor or control device within a unit.

b. Unit. The unit that a point is associated with, such as a blower.

c. Sub-system. The sub-system that a point is located in or near.

d. System. The system that a sub-system is located in or near.

2.8.2.6 System Access Control

A minimum of 4 passwords shall be usable with the control system software. The system shall maintain an ASCII disk file logging all operators logged onto the system, alarm acknowledgments, commands issued and all database modifications for each password. Each password shall be definable as to the functions that the operator can perform.

2.8.3 Alarms

The software shall notify an operator of the occurrence of an alarm condition. The control system alarm history shall be stored in an ASCII file and shall be recallable by the operator using the report generator. Alarm messages shall take precedence over other functions. A minimum of the most recent 25 system alarms shall be directly available at the central station computer. Operator acknowledgment of one alarm shall not be considered as acknowledgment of any other alarm nor shall it inhibit

reporting of subsequent alarms. Alarm data to be displayed and stored shall include: identification of the alarm; date and time to the nearest second of occurrence; device or sensor type; limit exceeded (if analog); engineering units; current value or status; alarm class; and alarm messages.

2.8.3.1 Digital Alarms

Digital alarms shall be subject to immediate reporting, within the alarm response time, at the central station.

2.8.3.2 Analog Alarms

These alarms shall be subject to immediate reporting, within the alarm response time, at the central station. The control panel analog readings shall be compared to predefined high and low limits, and alarmed to the central station each time a value enters or returns from a limit condition. The program shall automatically change the high or low limits, or both, of any analog point, based on time scheduled operations as specified, allowing for a time interval before the new alarm limit becomes effective. For those applications where setpoint adjustments are made, the alarm limit shall be keyed to a finite deviation traveling with the setpoint.

2.8.3.3 Alarm Messages

A unique message with a field of 60 characters shall be provided for each alarm. Assignment of messages to a point shall be an operator editable function. Secondary messages shall be assignable by the operator for printing to provide further information, such as telephone lists or maintenance functions, and shall be editable by the operator.

2.8.3.4 Alarm Classes

Classes of alarms, which will be identified for each item, include class 1 and class 2 alarm conditions. Class 1 (Critical) shall include display, print, and audible alarm at occurrence and at return-to-normal. Acknowledgment of class 1 alarms by the operator shall be required at occurrence and at return-to-normal. Class 2 (Informational) shall include display, print, and audible alarm at occurrence and at return-to-normal. No acknowledgment of class 2 alarms is required unless otherwise shown.

2.8.4 Pop-up Note Function

A pop-up note function shall be included with the central station, providing the operator a capability of noting any data which may be associated with alarms or with any other event. A note created by an operator shall be automatically called up when any other workstation calls up the associated point, alarm, or alarm summary. The pop-up note function shall also support free form entry of data which can be used by any workstation operators as general reminders or instructions.

2.8.5 Real Time Clock Synchronization

The system shall synchronize each central station computer, real time clock, within one second and at least once per day automatically, without operator intervention and without requiring system shutdown. The central station computer shall automatically initiate a call once per day to the NIST clock to obtain the correct time and date and update the real time clock. The central station computer shall generate a report showing the time difference.

2.8.6 System Reaction

Under system normal heavy load, no more than 10 seconds shall lapse from the time a digital status alarm or analog alarm occurs at a PLC until the change is displayed at the central station and operator's workstation. The total system response time from initiation of a control action command to display of the resulting status change shall not exceed 20 seconds under system normal heavy load conditions, assuming a zero response time for operation of the PLC's control device. The alarm printer shall continue to print out all occurrences, including time of occurrence, to the nearest second. All system normal heavy load conditions shall be introduced to the system via AIs and DIs.

2.8.6.1 Occurrence

System normal heavy load conditions are defined as the occurrence throughout the system of a total of three status changes, three digital alarms, three analog high or low limit alarms, and three analog quantity changes within the high and low limits during a single 1-second interval. This number of similar occurrences shall repeat on a continuous basis during successive 1-second intervals for a period of 2 minutes.

2.8.6.2 Location

System normal heavy load conditions, as specified, shall have 50% of the changes and alarms, including no less than one of each type, occurring at a single PLC with the remaining changes and alarms distributed among the remaining PLCs.

2.8.7 Report Generator

Software shall be provided to generate and format standard and custom reports for displaying, printing, and storing on disk. Reports shall use database values and parameters, values calculated using the real time static database or historical data base; with the reports subsequently stored on hard disk or zip drive. Dynamic operation of the system shall not be interrupted to generate a report. The report shall contain the time and date when the sample was taken, and the time and date when the report was printed.

2.8.7.1 Periodic Automatic Report

The system shall allow for specifying, modifying, or inhibiting the report to be generated, the time the initial report is to be generated, the time interval between reports, end of period, and the output peripheral.

2.8.7.2 Request Report Mode

The system shall allow for the operator to request, at any time, an immediate printout of any report.

2.8.8 Data Interchange

Software shall be provided to format and store on a removable diskette the data, trends, profiles, reports and logs as specified in a defined, standard format such as ASCII text or DIF for export and further processing by other software and/or computer systems.

2.8.9 Control Panel and DTS Circuit Alarms

The system shall supervise each control panel, I/O function and DTS circuit for alarm reporting, including: control panel not responding; control panel responding (return to normal); control panel to central station DTS circuit high error rate; control panel to control panel DTS circuit high error rate; control panel/central station real time clock error more than 15 seconds (adjustable); control panel intrusion alarm; control panel offline; control panel online (return to normal); control panel failure (self-diagnostics); point not responding to command; and point change of state without command.

2.8.10 Central Station Database

The central station database shall be stored on disk and in memory. The static database shall be downloadable as required to control panels in the system.

2.8.10.1 Database Definition Process

Software shall be provided to define and modify each point in the database using operator commands. The definition shall include all physical parameters and constraints associated with each point. Each database item shall be callable for display or printing, including EEPROM, ROM and RAM resident data. Each point shall be defined and entered into central station database by the Contractor.

2.8.10.2 Dynamic Database

The dynamic database includes those variables which change with time or conditions including all DIs, AIs, PAs, and virtual (logic) points.

2.8.10.3 Dynamic Database Update

The dynamic database shall be updated from the field, allowing the operator to select update times from 0.1 seconds to 2.0 seconds.

2.8.10.4 Static Database

The static database includes those fixed parameters and constraints from all PLCs which define the characteristics of the system and I/O functions such as alarm limits, start/stop times, point names, PLC channel addresses, and sensor spans.

2.8.10.5 Central Station Static Database Update

A copy of each control panels static database shall be updated automatically once per day, each time an authorized change is submitted or upon demand from the central station database.

2.8.10.6 Workstation Access to Dynamic Data

Any workstation with proper access password and connected to the central station via the DTS, or via a dial-up telephone circuit, shall have access to the central station's dynamic data. Display of data shall commence within 5 seconds.

2.8.11 Historical Data Storage and Retrieval

A historical data storage and retrieval function shall be provided at the central station to collect and store dynamic data. This function shall be in addition to other data storage requirements. The function shall have the capability to collect and store alarm status changes, point values, events and operator commands, and system responses. The storage function shall also have the capability to collect and store multiple sets of analog data at pre-specified sampling rates. This function shall have the capability to retain historical data on hard disk for pre-specified time periods, up to forty five days using last day roll over, for short-term analysis, and then output the data to the zip drive for long-term retention. The operator shall also be able to selectively recall short-term data stored on hard disk. Retrieval and printing of the contents of any selected historical data file shall be available using the data retrieval and report generation program. The output of the report generation program shall be capable of being viewed on the screen, printed in a report, or stored.

2.8.12 Trending

Any analog or calculated point shall be operator assignable to the trend program. Points shall be sampled at individually assigned intervals, selectable between one minute and 24 hours. The system shall automatically store the accumulated trend data to an ASCII disk file. The size of the trend data file shall be limited only by available disk space. The program shall print portions of the file as selected by the operator.

2.8.13 Analog Monitoring

The system shall measure, transmit, and display analog values, including calculated analog points. Differential measurements shall be displayed as positive or negative values with respect to their reference points shown. An analog change in value is defined as a change exceeding a preset differential value as specified. Each analog change in value shall be operator selectable and settable to provide for a minimum reporting change in value of one-half the specified end-to-end accuracy of the measured variable. Displays and reports shall express analog values in proper engineering units with sign. The Contractor shall provide 128 different sets of engineering unit conversions. Each engineering conversion unit shall include range, span, and conversion equation.

2.8.14 Analog Totalization

Any analog or calculated point shall be operator assignable to the totalization program. The analog totalization time period shall be defined uniquely for each point. At the end of the period, totals shall be stored on disk for future reference. Totalization shall then restart from zero for the next time period. The program shall keep track of the peak and total value measured during the current period and for the previous period. The operator shall be able to initiate a summary of totalization information on a point, unit, sub-system or system. The operator shall be able to set or reset each totalized value individually. The operator shall be able to define, modify, or delete the time period online.

2.8.15 LAN Software

A network operating system shall be supplied as part of the LAN software. The network operating system shall support network device access to the central station. The system shall provide workstation access to the central station as a virtual terminal. The network shall provide network

access to shared peripherals. The LAN software shall provide for transparent communication with any node on the system. The LAN software shall support the following:

2.8.15.1 Access Control

Access control to the central station computer and workstations. Operators shall be able to perform all specified functions, given the proper passwords, including database definition/modification, graphic creation/modification, and trending.

2.8.15.2 Multiple Sessions

Support operation in multiple sessions.

2.8.15.3 Other Functions and Configurations

Other functions and configurations shown.

2.9 DATA COMMUNICATION REQUIREMENTS

Control system data communications shall support the specified functions and control system configuration shown on the drawings.

2.9.1 Central Station/Workstation

Each workstation shall be able to communicate with the central station as a virtual terminal. The workstation shall be able to initiate uploads or downloads of programs and resident data, including parameters of connected systems PLCs and devices, constraints and programs in the central station.

2.9.2 Central Station/PLC

The central station shall be able to initiate an upload or download of PLC data programs.

2.9.3 Modem Communication

Communication with other computer systems shall be accomplished using a modem and dialup circuit. The central station or workstation shall be able to initiate upload or download of data files, however, answering incoming calls shall not be possible (for system security reasons).

2.9.4 Error Detection and Retransmission

Asynchronous transmission system shall use cyclic code error detection methods. The predicted undetected error rate shall not exceed 1 bit in 1 billion. A message shall be in error if one bit is received incorrectly. The system shall retransmit messages with detected errors. Where a LAN is not utilized for data transmission, a 2-digit decimal number shall be operator assignable to each communication link representing the number of retransmission attempts. When the number of consecutive retransmission attempts equals the assigned quantity, the central station shall close down transmission to that particular device, and print an alarm message. The operator shall manually reopen any communications line after automatic closedown, subject to the same error checking and automatic closedown procedures in effect before the first automatic closedown. The system shall monitor the frequency of data transmission errors for display and logging.

2.10 CONSUMABLE SUPPLIES

The Contractor shall provide the following consumable supplies, after the endurance test, to the Contracting Officer. These extraordinary supplies shall not be used during system installation or testing.

CONSUMABLE SUPPLIES

blank zip cartridges	10 each
diskettes 3-1/2 inch	2 boxes of 10 each
laser printer toner cartridges	2 each
color printer ink cartridges	2 per color
dot matrix printer ribbons	2 each
color printer paper	2 boxes
alarm printer fanfold paper	1 box

2.11 FACTORY TEST

The control system shall be tested at the factory prior to shipment. Certification of a comprehensive Y2K compliance testing program is required. Written notification of planned testing shall be given to the Contracting Officer at least 21 days prior to testing, and in no case shall notice be given until after the Contractor has received written approval from the Contracting Officer of the test procedures.

2.11.1 Factory Test Setup

The Contractor shall assemble and integrate the factory test setup as specified to prove that performance of the system satisfies all requirements of this project, including system communications requirements in accordance with the approved test procedures. The factory test shall take place during regular daytime working hours on weekdays. Equipment used shall be the same equipment that is to be delivered to the site. The factory test setup shall include the following:

	Factory Test
central station equipment	one each of the components
workstation	one of each type
control panel	not less than two control panels: at least one of each type used in the system plus at least one per DTS type
test set	one of each type
portable tester	one of each type
communications circuits	one of each type and speed to be utilized in the proposed system including bridges, modems, encoder/decoders, transceivers and

	Factory Test
	repeaters.
surge protection equipment	for power, communications, I/O functions and networks
I/O functions	sufficient to demonstrate the I/O capability and system normal operation
software	software required for proper operation of the proposed system including application programs and sequences of operation

2.11.2 Factory Test Procedure

Test procedures shall define the tests required to ensure that the system meets technical, operational, and performance requirements. The test procedures shall define location of tests, milestones for the tests, and identify simulation programs, equipment, personnel, facilities, and supplies required. The test procedures shall provide for testing all control system capabilities and functions specified and shown. The procedures shall cover actual equipment and sequences to be used by the Contractor for the specified project and shall consist of detailed instructions for test setup, execution, and evaluation of test results. The test reports shall document results of the tests. Reports shall be delivered to the Contracting Officer within 7 days after completion of each test. Surge testing need not be conducted if the Contractor can provide acceptable documented proof that such testing has been satisfactorily demonstrated to the Contracting Officer with identical surge protection applied. The procedures shall include the following:

	Test Procedure
equipment	block diagram
hardware and software	descriptions
commands	operator commands
I/O functions	test database points with failure modes
passwords	required for each operator access level
each type of digital and analog point in the test database	description
test equipment	list
surge protection	circuit diagrams
inputs required (I/O point values and status) and corresponding expected results of each set of input values	for each application program
default values	for the application program inputs not implemented or provided for in the contract

Test Procedure

documents for the application programs to be tested.

2.11.3 Factory Test Report

Original copies of data produced during the factory test, including results of each demonstration procedure, shall be delivered to the Contracting Officer at the conclusion of the test, prior to Government approval of the factory test. The report shall be arranged so that commands, responses, and data acquired are correlated to allow logical interpretation of the data.

PART 3 EXECUTION

3.1 EQUIPMENT INSTALLATION REQUIREMENTS

3.1.1 Installation

The Contractor shall install system components and appurtenances in accordance with the manufacturer's instructions and shall provide necessary interconnections, services, and adjustments required for a complete and operable system. Instrumentation and communication equipment and cable grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation. The Contractor shall adjust or replace devices not conforming to the required accuracies. Factory sealed devices shall be replaced (rather than adjusted). Wiring in exposed areas, including low voltage wiring, shall be installed in metallic raceways or EMT conduit as specified in Section 16415 ELECTRICAL WORK, INTERIOR. Wiring in air plenum areas installed without conduit shall be plenum-rated per NFPA 70.

3.1.1.1 Isolation, Penetrations of Buildings and Clearance from Equipment

Dielectric isolation shall be provided where dissimilar metals are used for connection and support. Penetrations through and mounting holes in the building exteriors shall be made watertight. Holes in concrete, brick, steel and wood walls shall be drilled or core drilled with proper equipment; conduits installed through openings shall be sealed with materials which are compatible with existing materials. Openings shall be sealed with materials which meet the requirements of NFPA 70. Installation shall provide clearance for control-system maintenance. Control system installation shall not interfere with the clearance requirements for mechanical and electrical system maintenance.

3.1.1.2 Device Mounting

Devices shall be installed in accordance with manufacturers' recommendations and as shown. Control devices to be installed in piping shall be provided with required gaskets, flanges, thermal compounds, insulation, piping, fittings, and manual valves for shutoff, equalization, purging, and calibration. Any deviations shall be documented by the Contractor and submitted to the Contracting Officer for approval prior to mounting. Damaged insulation shall be replaced or repaired after devices are installed to match existing work. Damaged galvanized surfaces shall be repaired by touching up with zinc paint.

3.1.1.3 Pneumatic Tubing

Tubing shall be concealed in finished areas. Tubing may be run exposed in unfinished areas, such as mechanical equipment rooms. For tubing to be enclosed in concrete, rigid metal or intermediate metal conduit shall be provided. Tubing shall be installed parallel or perpendicular to building walls throughout. Maximum spacing between tubing supports shall be 5 feet. Each tubing system shall be tested pneumatically at 1.5 times the working pressure for 24 hours, with a maximum pressure drop of 1.0 psig with compressed air supply turned off. Joint leaks shall be corrected by remaking the joint. Caulking of joints will not be permitted. Tubing and two insulated copper phone wires for installation checkout may be run in the same conduit. Tubing and electrical power conductors shall not be run in the same conduit; however, control circuit conductors may be run in the same conduit as polyethylene tubing.

3.1.2 Sequences of Operation

The Contractor shall study the operation and sequence of local equipment controls, as a part of the conditions report, and note any deviations from the described sequences of operation on the contract drawings. The Contractor shall make necessary adjustments to make the equipment operate in an optimum manner and shall fully document changes made.

3.2 INSTALLATION OF EQUIPMENT

The Contractor shall install equipment as specified, as shown and as required in the manufacturer's instructions for a complete and fully operational control system.

3.2.1 Control Panels

Control panels shall be located as indicated on the drawings. Devices located in the control panels shall be as shown on the drawings or as needed to provide the indicated control sequences.

3.2.2 Flow Measuring Device

Fluid flow instruments shall be installed in accordance with ASME-18, unless otherwise indicated in the specification. The minimum straight unobstructed piping for the flowmeter installation shall be 10.0 pipe diameters upstream and 5.0 pipe diameters downstream. Meters for gases and vapors shall be installed in vertical piping, and meters for liquids shall be installed in horizontal piping, unless otherwise recommended by the manufacturer or indicated in the specifications.

3.2.2.1 Flow Nozzle

Flow nozzles flanges shall be installed so that the pressure taps are in a horizontal plane with the centerline of the pipe. Flow nozzles shall be installed for ease of accessibility for periodic maintenance. Differential pressure sensors shall be installed as close to the flow nozzle as possible.

3.2.2.2 Flow Switch

Flow switches shall be installed in such a manner as to minimize disturbance of the flow of fluid while maintaining reliable operation of the switch.

3.2.2.3 Magnetic Flowmeter

Meter shall be installed in vertical piping so that the flow tube remains full of the process fluid under all operating conditions. A minimum of five pipe diameters straight run upstream of the flowmeter and two pipe diameters straight run downstream of the flowmeter shall be provided.

3.2.2.4 Positive Displacement Flow Meters

Flow meters shall be installed horizontally, and aligned correctly in the direction of flow.

3.2.3 Level Instruments

3.2.3.1 Capacitance Liquid Level Sensors

The sensing probes shall be located close to, and parallel with, the tank or sump wall.

3.2.3.2 Conductivity Switch

Level switches shall be installed vertically and in accordance with the manufacturer's instructions. Switches shall be accessible for maintenance and calibration. In applications where switches cannot be directly mounted to a tank by the threaded or flanged connection, a mounting bracket shall be provided for connection to the inside tank wall, maintaining the minimum recommended distance from the tank fill opening.

3.2.3.3 Displacement Type Liquid Level Switch

Level switches shall be installed in accordance with the manufacturer's instructions. Switches shall be accessible for maintenance and calibration. In applications where switches cannot be directly mounted to a tank by the threaded or flanged connection, a mounting bracket shall be provided for connection to the inside tank wall.

3.2.3.4 Mercury Float Switches

Switches shall be mounted in accordance with manufacturer's published instructions. Procedures shall be those used for equipment in hazardous locations.

3.2.3.5 Ultrasonic Sensor

Sensor shall be installed vertically in the top of the tank and in accordance with the manufacturer's instructions. Switches shall be accessible for maintenance and calibration. In applications where switches cannot be directly mounted to a tank by the threaded or flanged connection, a mounting bracket shall be provided for connection to the inside tank wall. Sensor shall be positioned to maximize the return echo signal and minimize vessel obstructions in the sensors line of sight. The minimum recommended distance from the tank fill opening and from the side of the tank shall be maintained.

3.2.4 Pressure Instruments

Pressure sensors and pressure transducers shall be verified by calibration. All pressure taps shall incorporate appropriate snubbers. Pressure sensors and pressure switches shall have valves for isolation, venting, and taps for calibration. Pressure switches and pressure transducers installed

on liquid or steam lines shall have drains. Pressure transducers, differential pressure sensors and differential pressure switches shall have nulling valves. Pressure switches shall be adjusted to the proper setpoint and shall be verified by calibration. Switch contact ratings and duty shall be selected for the application.

3.2.5 Process Analytical Instrumentation

3.2.5.1 PH and ORP Sensor

Pipe mounted flow sensor shall be located in a threaded tee or fitting to allow removal from the pipe. Submersible sensor shall be completely immersed in the fluid being monitored using an ensemble that will allow for removal of the sensor from the fluid for replacement. The sensor shall be located in an area of continuous flow. The transmitter shall be located at the sensor. The transmitter shall be mounted to allow the digital readout to be easily viewed.

3.2.6 Instrument Shelters

Instrument shelters shall be installed in the location shown with the bottom 4.0 feet above the supporting surface using legs and secured rigidly to minimize vibrations from winds. Instrument shelters shall be oriented with door facing North. Instruments located in shelters shall be mounted in the 3-dimensional center of the open space of the shelter.

3.2.7 Output Devices

Output devices (transducers, relays, contactors, or other devices) which are not an integral part of the control panel, shall be mounted in an enclosure mounted adjacent to the control panel, unless otherwise shown. Where H-O-A and/or override switches on the drawings or required by the control sequence, the switches shall be installed so that the control system controls the function through the automatic position and other controls work through the hand position.

3.2.8 Enclosures

All enclosure penetrations shall be from the bottom of the enclosure, and shall be sealed to preclude entry of water using a silicone rubber sealant.

3.2.9 Transformers

Transformers for control voltages below 120 vAc shall be fed from the nearest power panel or motor control center, using circuits provided for the purpose. The Contractor shall provide a disconnect switch on the primary side and a fuse on the secondary side. Transformers shall be enclosed in a steel cabinet with conduit connections.

3.3 WIRE, CABLE AND CONNECTING HARDWARE

3.3.1 LAN Cables and Connecting Hardware

LAN cables and connecting hardware shall be installed as specified.

3.3.2 Metering and Sensor Wiring

Metering and sensor wiring shall be installed in accordance with the requirements of ANSI C12.1, NFPA 70, and Section 16415 ELECTRICAL WORK,

INTERIOR.

3.3.2.1 Power Line Surge Protection

Control panels shall be protected from power line surges. Protection shall meet the requirements of IEEE C62.41. Fuses shall not be used for surge protection.

3.3.2.2 Sensor and Control Wiring Surge Protection

Digital and analog inputs shall be protected against surges induced on control and sensor wiring. Digital and analog outputs shall be protected against surges induced on control and sensor wiring installed outdoors and as shown. Fuses shall not be used for surge protection. The inputs and outputs shall be tested in both the normal and common mode using the following two waveforms: The first waveform shall be 10 microseconds by 1000 microseconds with a peak voltage of 1500 volts and a peak current of 60 amperes. The second waveform shall be 8 microseconds by 20 microseconds with a peak voltage of 1000 volts and a peak current of 500 amperes.

3.4 SOFTWARE INSTALLATION

The Contractor shall load software required for an operational control system, including databases (for points specified and shown), operational parameters, and system, command, and application programs. The Contractor shall adjust, tune, debug, and commission all software and parameters for controlled systems to assure proper operation in accordance with the sequences of operation and database tables.

3.5 FIELD TESTING AND ADJUSTING EQUIPMENT

The Contractor shall provide personnel, equipment, instrumentation, and supplies necessary to perform site testing. The Contracting Officer will witness the PVT, and written permission shall be obtained from the Contracting Officer before proceeding with the testing. Original copies of data produced, including results of each test procedure, during PVT shall be turned over to the Contracting Officer at the conclusion of each phase of testing prior to Government approval of the test. The test procedures shall cover actual equipment and functions specified for the project.

3.5.1 Testing, Adjusting and Commissioning

After successful completion of the factory test as specified, the Contractor will be authorized to proceed with the installation of the system equipment, hardware, and software. Once the installation has been completed, the Contractor shall test, adjust, and commission each control loop and system in accordance with NIST SP 250 and shall verify proper operation of each item in the sequences of operation, including hardware and software. The Contractor shall calibrate field equipment, including control devices, adjust control parameters and logic (virtual) points including control loop setpoints, gain constants, constraints, and verify data communications before the system is placed online. Ground rods installed by the Contractor shall be tested as specified in IEEE Std 142. The Contractor shall calibrate each instrumentation device connected to the control system control network by making a comparison between the reading at the device and the display at the workstation, using a standard at least twice as accurate as the device to be calibrated. The Contractor shall check each control point within the control system control network by making a comparison between the control command at the central station and

field-controlled device. The Contractor shall deliver trend logs/graphs of all points showing to the Contracting Officer that stable control has been achieved. Points on common systems shall be trended simultaneously. One log shall be provided showing concurrent samples taken once a minute for a total of 4 hours. One log shall be provided showing concurrent samples taken once every 30 minutes, for a total of 24 hours. The Contractor shall verify operation of systems in the specified failure modes upon Control system network failure or loss of power, and verify that systems return to control system control automatically upon a resumption of control system network operation or return of power. The Contractor shall deliver a report describing results of functional tests, diagnostics, calibrations and commissioning procedures including written certification to the Contracting Officer that the installed complete system has been calibrated, tested, adjusted and commissioned and is ready to begin the PVT. The report shall also include a copy of the approved PVT procedure.

3.5.2 Performance Verification Test (PVT)

The Contractor shall prepare test procedures for the PVT. The test procedure shall describe all tests to be performed and other pertinent information such as specialized test equipment required and the length of the PVT. The test procedures shall explain, in detail, step-by-step actions and the expected results, to demonstrate compliance with all the requirements of the drawings and this specification. The test procedure shall be site specific and based on the inputs and outputs, required calculated points and the sequence of control. The Contractor shall demonstrate that the completed Control system complies with the contract requirements. All physical and functional requirements of the project including communication requirements shall be demonstrated and shown. The Contractor shall demonstrate that each system operates as required in the sequence of operation. The PVT as specified shall not be started until after receipt by the Contractor of written permission by the Contracting Officer, based on the Contractor's written report including certification of successful completion of testing, adjusting and commissioning as specified, and upon successful completion of training as specified. Upon successful completion of the PVT, the Contractor shall deliver test reports and other documentation as specified to the Contracting Officer.

3.5.3 Endurance Test

The Contractor shall use the endurance test to demonstrate the overall system reliability of the completed system. The endurance test shall be conducted in phases. The endurance test shall not be started until the Contracting Officer notifies the Contractor in writing that the PVT is satisfactorily completed, training as specified has been completed, outstanding deficiencies have been satisfactorily corrected, and that the Contractor has permission to start the endurance test. The Contractor shall provide an operator to man the system 8 hours per day during daytime operations, including weekends and holidays, during Phase I endurance testing, in addition to any Contracting Officer personnel that may be made available. The Contracting Officer may terminate testing at any time when the system fails to perform as specified. Upon termination of testing by the Contracting Officer or by the Contractor, the Contractor shall commence an assessment period as described for Phase II. Upon successful completion of the endurance test, the Contractor shall deliver test reports and other documentation, as specified, to the Contracting Officer prior to acceptance of the system.

3.5.3.1 Phase I (Testing)

The test shall be conducted 24 hours per day, 7 days per week, for 7 consecutive calendar days, including holidays, and the system shall operate as specified. The Contractor shall make no repairs during this phase of testing unless authorized by the Contracting Officer in writing.

3.5.3.2 Phase II (Assessment)

After the conclusion of Phase I, the Contractor shall identify failures, determine causes of failures, repair failures, and deliver a written report to the Contracting Officer. The report shall explain in detail the nature of each failure, corrective action taken, results of tests performed, and shall recommend the point at which testing should be resumed. After delivering the written report, the Contractor shall convene a test review meeting at the job site to present the results and recommendations to the Contracting Officer. The meeting shall not be scheduled earlier than 5 business days after receipt of the report by the Contracting Officer. As a part of this test review meeting, the Contractor shall demonstrate that failures have been corrected by performing appropriate portions of the performance verification test. The Contracting Officer reserves the right to cancel the test review meeting if no failures or deficiencies occur during the Phase I testing. If the Contracting Officer chooses to do so, the Contractor will be notified in writing. Based on the Contractor's report and the test review meeting, the Contracting Officer will determine if retesting is necessary and the restart point. The Contracting Officer reserves the right to require that the Phase I test be totally or partially rerun. The Contractor shall not commence any required retesting until after receipt of written notification by the Contracting Officer. After the conclusion of any retesting which the Contracting Officer may require, the Phase II assessment shall be repeated as if Phase I had just been completed.

3.5.3.3 Exclusions

The Contractor will not be held responsible for failures resulting from the following: Outage of the main power supply in excess of the capability of any backup power source, provided that the automatic initiation of all backup sources was accomplished and that automatic shutdown and restart of the control system performed as specified. Failure of a Contracting Officer furnished communications link, provided that the PLC automatically and correctly operates in the stand-alone mode as specified, and that the failure was not due to Contractor furnished equipment, installation, or software. Failure of existing equipment, provided that the failure was not due to Contractor furnished equipment, installation, or software.

3.6 MANUFACTURER'S FIELD SERVICES

The Contractor shall obtain the services of a manufacturer's representative experienced in the installation, adjustment, and operation of the equipment specified. The representative shall supervise the installing, adjusting, and testing of the equipment.

3.7 INSTRUMENTATION AND CONTROL SYSTEM

Control drawings shall be provided for equipment furnished and for interfaces to equipment at each respective equipment location. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation and procedures for safely starting and stopping the system manually shall be prepared in typed

form, and posted beside the diagrams. Diagrams and instructions shall be submitted prior to posting.

3.8 FIELD TRAINING

Field training oriented to the specific system shall be provided for designated personnel. A copy of the training manual for each trainee plus two additional copies shall be delivered to the Contracting Officer. Manuals shall include an agenda, the defined objectives for each lesson, and a detailed description of the subject matter for each lesson. The Contractor shall furnish audiovisual equipment and other training supplies and materials. Copies of the audiovisuals shall be delivered with the printed training manuals. The Contracting Officer reserves the right to videotape training sessions for later use. A training day is defined as 8 hours of classroom instruction, excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility. Approval of the Contractor's training schedule shall be obtained from the Contracting Officer at least 30 days before the training.

3.8.1 Preliminary Operator Training

Prior to the start of field testing, preliminary operator training shall be taught at the project site for 2 consecutive training days. Upon completion of this course, each student, using appropriate documentation, should be able to perform elementary operations with guidance and describe the general hardware architecture and functionality of the system. This course shall include: general system architecture; functional operation of the system, including workstations; operator commands; application programs, control sequences, and control loops; database entry and modification; reports generation; alarm reporting; diagnostics; and historical files.

3.8.2 Maintenance Training

A minimum period of two training days shall be provided by a factory representative or a qualified Contractor trainer for designated personnel on maintenance of the equipment. The training shall include: physical layout of each piece of hardware, calibration procedures, preventive maintenance procedures, schedules, troubleshooting, diagnostic procedures and repair instructions.

-- End of Section --

ATTACHMENT #1

LIST OF EQUIPMENT, INSTRUMENTATION AND CONTROLS

List of Equipment, Instrumentation and Controls
New Bedford Harbor (OU#1) Water Treatment Plant

CLARIFIER SYSTEM (100 Series)

Equipment

P-101A /B/C	Clarifier Feed Pumps
SM-101	Static Mixer
CL-101	Inclined Plate Clarifier System
MX-101	Flash Mix Tank Mixer
MX-102	Flocculation Tank Mixer
DP-101	Clarifier Slurry Transfer Pump
DP-102	Slurry Recycle Pump
DP-103	Slurry Transfer Pump
TK-101	Slurry Holding Tank

Instrumentation and Controls

LE-101	Equalization Basin (CDF Cell #2) Level Element
LSLL-101	Low-Low Level Switch within CDF Cell 2. Shuts down Clarifier Feed Pumps (P-101 A/B/C) and sends an alarm (LALL-101)
LSL-101	Low Level Switch within CDF Cell #2. Stops Clarifier Feed Pumps (P-101 A/B/C)
LSH-101	High Level Switch within CDF Cell #2. Starts Clarifier Feed Pumps (P-101 A/B/C)
LSHH-101	High-High Level Switch within CDF Cell #2. Sends alarm (LAHH-101)
LALL-101	Low-Low Level Alarm and shut off switch (LSLL-101)
LAHH-101	High-High Level Alarm
FE-101	Clarifier Feed Flow Element
FIT-101	Clarifier Feed Flow Transmitter
FQIR-101	Clarifier Feed Flow Totalizer/Recorder
FIC-101	Clarifier Feed Indicating Controller
PI-101	Clarifier Feed Pump (P-101 A) Effluent Line Pressure
PI-102	Clarifier Feed Pump (P-101 B) Effluent Line Pressure
PI-103	Clarifier Feed Pump (P-101 C) Effluent Line Pressure
PIT-101	Pressure Indicating Transmitter for Clarifier Effluent Line
PSH-101	Clarifier Feed Pump Effluent Line High Pressure Switch
PAH-101	High Pressure Alarm for Clarifier Feed Pump Effluent Line and Shutoff Switch (PSH-101).

LSL-102	Low Level Switch within Slurry Holding Tank (TK-101). Stops the Slurry Transfer Pump (DP-103).
LSH-102	High Level Switch within TK-101. Starts Slurry Transfer Pump (DP-103)
LSHH-102	High-High Level Switch within TK-101. Stops Clarifier Sludge Pump (DP-101)
LAHH-102	High-High Level Alarm
PI-104	Pressure Indicator Clarifier Slurry Pump (DP-101) Effluent line
PI-105	Pressure Indicator Slurry Recycle Pump (DP-102) Effluent Line
PI-106	Pressure Indicator Slurry Transfer Pump (DP-103) Effluent Line
PCV-101	Pressure Control Valve for Clarifier Slurry Pump (DP-101)
SV-101	Solenoid Valve for Clarifier Slurry Pump (DP-101)
PCV-102	Pressure Control Valve for Slurry Recycle Pump (DP-102)
SV-102	Solenoid Valve for Slurry Recycle Pump (DP-102)
PCV-103	Pressure Control Valve for Slurry Transfer Pump (DP-103)
SV-103	Solenoid Valve for Slurry Transfer Pump (DP-103)

CHEMICAL FEED SYSTEM (200 Series)

Equipment

TK-201	Alum Storage Tank
TK-202	Alum Feed Tank
CF-201	Polymer Addition System
MP-201A	Alum Metering Pump
MP-201B	Alum Metering Pump
MP-202A	Polymer Metering Pump
MP-202B	Polymer Metering Pump
MP-203	Algaecide Metering Pump
DP-201	Alum Transfer Pump
DP-202	Alum Recycle Pump

Instrumentation and Controls

PCV-201/202	Pressure Control Valves for Alum Metering Pump (MP-201 A/B)
PCV-203/204	Pressure Control Valves for Polymer Metering Pump (MP-202 A/B)
PCV-205	Pressure Control Valve for Algaecide Metering Pump (MP-203)
PCV-206	Pressure Control Valve for Alum Recirculation Pump (DP-202)
PCV-207	Pressure Control Valve for Alum Transfer Pump (DP-201)

LSHH-201	High-High Level Switch with TK-201. Send alarm (LAHH-201) and shuts down DP-201
LAHH-201	High-High Level Alarm
LSL-201	Low Level Switch within Alum Feed Tank (TK-201). Starts alum transfer pump (DP-201)
LSH-201	High Level Switch within Alum Feed Tank (TK-101). Stops alum transfer pump (DP-201)
LSLL-201	Low-Low Level Switch within Alum Feed Tank (TK-201). Send alarm (LALL-201).
LALL-201	Low-Low Level Alarm within TK-201

SAND FILTRATION SYSTEM (300)

Equipment

P-301A/B/C	Sand Filtration System Feed Pumps
SF-301/302	Sand Filtration Systems

Instrumentation and Controls

LE-301	Filtration Feed Basin (CDF Cell #2) Level Element
LSLL-301	Low-Low Level Switch within CDF Cell #3. Shuts down Filtration Feed Pumps (P-301) and sends an alarm (LALL-301)
LSL-301	Low Level Switch within CDF Cell #3. Stops Filtration Feed Pumps (P-301)
LSH-301	High Level Switch within CDF Cell #3. Starts Filtration Feed Pumps (P-301)
LSHH-301	High-High Level switch within CDF Cell #3. Sends alarm (LAHH-301) and stops Clarifier Feed pumps (P-101)
LALL-301	Low-Low Level Alarm for CDF Cell #3 and shut off switch (LSLL-301) for Filtration Feed Pumps (P-301)
LAHH-301	High-High Level Alarm for CDF Cell #3
FE-301	Filtration Feed Flow element. Measures flow to sand filtration system
FIT-301	Filtration Feed Flow Transmitter
FQIR-301	Filtration Feed Totalizer/Recorder
FIC-301	Filtration Feed Flow Controller
PI-301	Pressure Indicator Filtration Feed Pump (P-301 A) Effluent Line
PI-302	Pressure Indicator Filtration Feed Pump (P-301 B) Effluent Line
PI-303	Pressure Indicator Filtration Feed Pump (P-301 C) Effluent Line
PIT-301	Pressure Indicating Tranmitter Filtration Effluent Line
PSH-301	High Pressure Switch for Filtration Feed Pump (P-301) Effluent Line
PAH-301	High Pressure Alarm for Filtration Feed Pump (P-301) effluent line
PI-3xx	Pressure Indicators Sand Filtration Vessels Influent SF-301/302
PI-3xx	Pressure Indicators Sand Filtration Vessels Effluent SF-301/302

DPSH-3xx	High Differential Pressure Switches Sand Filtration Vessels SF-301/302
DPAH-3xx	High Differential Pressure Alarms SF-301/302
AE-301	Sand Filtration System Influent Turbidity Element
AIT-301	Sand Filtration System Influent Turbidity Transmitter
AR-301	Sand Filtration System Turbidity Recorder

POLISHING FILTER SYSTEM (Series 400)

Equipment

PF-401	Polishing Filtration System (Two vessels)
PF-402	Polishing Filtration System (Three vessels)

Instrumentation and Controls

PI-401	Pressure Indicator Polishing Filtration System Influent
PIT-401	Pressure Indicating Transmitter
PSH-401	High Pressure Switch Polishing Filtration System Influent
PAH-401	High pressure Alarm Polishing Filtration System Influent
PDIT-401	Pressure Differential Indicating Transmitter PF-401A
PDIT-402	Pressure Differential Indicating Transmitter PF-401B
PDIT-403	Pressure Differential Indicating Transmitter PF-402A
PDIT-404	Pressure Differential Indicating Transmitter PF-402B
PDIT-405	Pressure Differential Indicating Transmitter PF-402C
PDSH-401	High Pressure Differential Switch PF-401A
PDSH-402	High Pressure Differential Switch PF-401B
PDSH-403	High Pressure Differential Switch PF-402A
PDSH-404	High Pressure Differential Switch PF-402B
PDSH-405	High Pressure Differential Switch PF-402C
PDAH-401	High Pressure Differential Alarm PF-401A
PDAH-402	High Pressure Differential Alarm PF-401B
PDAH-403	High Pressure Differential Alarm PF-402A
PDAH-404	High Pressure Differential Alarm PF-402B
PDAH-405	High Pressure Differential Alarm PF-402C
AE-401	Polishing Filtration System Influent Turbidity Element
AIT-401	Polishing Filtration System Influent Turbidity Transmitter
AR-401	Polishing Filtration System Turbidity Recorder
FCV-401	Flow Control Valve

LIQUID PHASE CARBON ADSORPTION SYSTEM (Series 500)

Equipment

L-501A	Liquid Phase Carbon Adsorption System 501, Primary Vessel
L-501B	Liquid Phase Carbon Adsorption System 501, Secondary Vessel
LC-502A	Liquid Phase Carbon Adsorption System 502, Primary Vessel
LC-502B	Liquid Phase Carbon Adsorption System 502, Secondary Vessel
LC-503A	Liquid Phase Carbon Adsorption System 503, Primary Vessel
LC-503B	Liquid Phase Carbon Adsorption System 503, Secondary Vessel

Instrumentation And Controls

PIT-501	Pressure Indicating Transmitter Influent to LC-501
PIT-502	Pressure Indicating Transmitter Influent to LC-502
PIT-503	Pressure Indicating Transmitter Influent to LC-503
PI-501	Pressure Indicator Effluent to LC-501A
PI-502	Pressure Indicator Effluent to LC-501B
PI-503	Pressure Indicator Effluent to LC-502A
PI-504	Pressure Indicator Effluent to LC-502B
PI-505	Pressure Indicator Effluent to LC-503A
PI-506	Pressure Indicator Effluent to LC-503B
PSH-501	High Pressure Switch for influent to LC-501
PSH-502	High Pressure Switch for influent to LC-502
PSH-503	High Pressure Switch for influent to LC-503
PSHH-501	High-High Pressure Switch for influent to LC-501
PSHH-502	High-High Pressure Switch for influent to LC-502
PSHH-503	High-High Pressure Switch for influent to LC-503
PAH-501	High Pressure Alarm for influent to LC-501
PAH-502	High Pressure Alarm for influent to LC-502
PAH-503	High Pressure Alarm for influent to LC-503
PAHH-501	High-High Pressure Alarm for influent to LC-501
PAHH-502	High-High Pressure Alarm for influent to LC-502
PAHH-503	High-High Pressure Alarm for influent to LC-503
PDSH-501	High Pressure Differential Switch for LC-501A
PDSH-502	High Pressure Differential Switch for LC-501B
PDSH-503	High Pressure Differential Switch for LC-502A
PDSH-504	High Pressure Differential Switch for LC-502B
PDSH-505	High Pressure Differential Switch for LC-503A
PDSH-506	High Pressure Differential Switch for LC-503B
PDAH-501	High Pressure Differential Alarm for LC-501A

PDAH-502	High Pressure Differential Alarm for LC-501B
PDAH-503	High Pressure Differential Alarm for LC-502A
PDAH-504	High Pressure Differential Alarm for LC-502B
PDAH-505	High Pressure Differential Alarm for LC-503A
PDAH-506	High Pressure Differential Alarm for LC-503B
FE-501	WTP Effluent flow element
FIT-501	WTP Effluent flow transmitter
FQIR-501	WTP Effluent Flow Totalizer/Recorder

SUMP PUMPS (Series 600)

Equipment

P-601A	Sump Pump #1
P-601B	Sump Pump #2

Instrumentation and Controls

LSL-601	Low Level Switch. Starts P-601 A/B
LSH-601	High Level Switch. Stops P-601 A/B
LSHH-601	High-High Level Switch
LAHH-601	High-High Level Alarm.

AIR COMPRESSOR SYSTEM (Series 700)

Equipment

AC-701	Air Compressor

Instrumentation and Controls

PI-701	Pressure Indicator for Air Compressor Effluent Line
PSL-701	Low Pressure Switch for Air Compressor Vessel (AC-701)
PSH-701	High Pressure Switch for Air Compressor Vessel (AC-701)
PAH-701	High Pressure Alarm for Air Compressor Vessel (AC-701)
PAH-701	High Pressure Alarm for air compressor system
PALL	Low-Low Pressure Alarm for air compressor system

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DIVISION 13 - SPECIAL CONSTRUCTION

SECTION 13850

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SECTION 13850

FIRE DETECTION AND ALARM SYSTEM

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI S3.41	(1990; R 1996) Audible Emergency Evacuation Signal

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991; R 1995) Surge Voltages in Low-Voltage AC Power Circuits

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1999) National Electrical Code
NFPA 72	(1996; Errata Oct 96, Dec 96; TIA 96-1, 96-2, 96-3) National Fire Alarm Code
NFPA 90A	(1996) Installation of Air Conditioning and Ventilating Systems

UNDERWRITERS LABORATORIES (UL)

UL 6	(1997) Rigid Metal Conduit
UL 38	(1994; Rev Nov 1994)) Manually Actuated Signaling Boxes for Use with Fire-Protective Signaling Systems
UL 228	(1997) Door Closers-Holders, With or Without Integral Smoke Detectors
UL 268	(1996; Rev thru Jun 1998) Smoke Detectors for Fire Protective Signaling Systems
UL 268A	(1998) Smoke Detectors for Duct Applications
UL 464	(1996; Rev May 1997) Audible Signal Appliances
UL 521	(1993; Rev Oct 1994) Heat Detectors for Fire Protective Signaling Systems

UL 797	(1993; Rev thru Mar 1997) Electrical Metallic Tubing
UL 864	(1996) Control Units for Fire-Protective Signaling Systems
UL 1242	(1996; Rev Mar 1998) Intermediate Metal Conduit
UL 1971	(1995; Rev thru May 1997) Signaling Devices for the Hearing Impaired

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fire Alarm Reporting System; GA

Detail drawings, prepared and signed by a Registered Professional Engineer or a NICET Level 3 Fire Alarm Technician, consisting of a complete list of equipment and material, including manufacturer's descriptive and technical literature, catalog cuts, and installation instructions. Note that the contract drawings show layouts based on typical detectors. The Contractor shall check the layout based on the actual detectors to be installed and make any necessary revisions in the detail drawings. The detail drawings shall also contain complete wiring and schematic diagrams for the equipment furnished, equipment layout, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Detailed point-to-point wiring diagram shall be prepared and signed by a Registered Professional Engineer or a NICET Level 3 Fire Alarm Technician showing points of connection. Diagram shall include connections between system devices, appliances, control panels, supervised devices, and equipment that is activated or controlled by the panel.

SD-03 Product Data

Storage Batteries; GA

Substantiating battery calculations for supervisory and alarm power requirements. Ampere-hour requirements for each system component and each panel component, and the battery recharging period shall be included.

Voltage Drop; FIO

Voltage drop calculations for notification appliance circuits to indicate that sufficient voltage is available for proper appliance operation.

Spare Parts; FIO

Spare parts data for each different item of material and equipment specified, not later than 2 months prior to the date of beneficial occupancy. Data shall include a complete list of parts and supplies with the current unit prices and source of supply and a list of the parts recommended by the manufacturer to be replaced after 1 year of service.

Technical Data and Computer Software; GA

Technical data which relates to computer software.

Training; GA

Lesson plans, operating instructions, maintenance procedures, and training data, furnished in manual format, for the training courses. The operations training shall familiarize designated government personnel with proper operation of the fire alarm system. The maintenance training course shall provide the designated government personnel adequate knowledge required to diagnose, repair, maintain, and expand functions inherent to the system.

Testing; GA

Detailed test procedures, prepared and signed by a Registered Professional Engineer or a NICET Level 3 Fire Alarm Technician, for the fire detection and alarm system 60 days prior to performing system tests.

SD-06 Test Reports

Testing; GA

Test reports, in booklet form, showing field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall document readings, test results and indicate the final position of controls. The Contractor shall include the NFPA 72 Certificate of Completion and NFPA 72 Inspection and Testing Form, with the appropriate test reports.

SD-07 Certificates

Equipment; GA

Certified copies of current approvals or listings issued by an independent test lab if not listed by UL, FM or other nationally recognized testing laboratory, showing compliance with specified NFPA standards.

Qualifications; GA

Proof of qualifications for required personnel. The installer shall submit proof of experience for the Professional Engineer, fire alarm technician, and the installing company.

SD-10 Operation and Maintenance Data

Technical Data and Computer Software; GA

Six (6) copies of operating instructions outlining step-by-step procedures required for system startup, operation, and shutdown. The instructions shall include the manufacturer's name, model number, service manual, parts list, and complete description of equipment and their basic operating features. Six (6) copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The instructions shall include conduit layout, equipment layout and simplified wiring, and control diagrams of the system as installed. The instructions shall include the information provided in paragraph TECHNICAL DATA AND COMPUTER SOFTWARE. The instructions shall include complete procedures for system revision and expansion, detailing both equipment and software requirements. Original and backup copies of all software delivered for this project shall be provided, on each type of media utilized. Instructions shall be approved prior to training.

1.3 GENERAL REQUIREMENTS

1.3.1 Standard Products

Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that can provide service within 24 hours of notification.

1.3.2 Nameplates

Major components of equipment shall have the manufacturer's name, address, type or style, voltage and current rating, and catalog number on a noncorrosive and nonheat-sensitive plate which is securely attached to the equipment.

1.3.3 Keys and Locks

Locks shall be keyed alike. Four keys for the system shall be provided.

1.3.4 Tags

Tags with stamped identification number shall be furnished for keys and locks.

1.3.5 Verification of Dimensions

After becoming familiar with details of the work, the Contractor shall verify dimensions in the field and shall advise the Contracting Officer of any discrepancy before performing the work.

1.3.6 Compliance

The fire detection and alarm system and the central reporting system shall be configured in accordance with NFPA 72; exceptions are acceptable as directed by the Contracting Officer. The equipment furnished shall be compatible and be UL listed, FM approved, or approved or listed by a nationally recognized testing laboratory in accordance with the applicable NFPA standards.

1.3.7 Qualifications

1.3.7.1 Engineer and Technician

a. Registered Professional Engineer with verification of experience and at least 4 years of current experience in the design of the fire protection and detection systems.

b. National Institute for Certification in Engineering Technologies (NICET) qualifications as an engineering technician in fire alarm systems program with verification of experience and current NICET certificate.

c. The Registered Professional Engineer may perform all required items under this specification. The NICET Fire Alarm Technician shall perform only the items allowed by the specific category of certification held.

1.3.7.2 Installer

The installing Contractor shall provide the following: Fire Alarm Technicians to perform the installation of the system. A Fire Alarm Technician with a minimum of 4 years of experience shall perform/supervise the installation of the fire alarm system. Fire Alarm technicians with a minimum of 2 years of experience shall be utilized to assist in the installation and terminate fire alarm devices, cabinets and panels. An electrician shall be allowed to install wire or cable and to install conduit for the fire alarm system. The Fire Alarm technicians installing the equipment shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.3.7.3 Design Services

Installations requiring designs or modifications of fire detection, fire alarm, or fire suppression systems shall require the services and review of a qualified fire protection engineer. For the purposes of meeting this requirement, a qualified fire protection engineer is defined as an individual meeting one of the following conditions:

a. An engineer having a Bachelor of Science or Masters of Science Degree in Fire Protection Engineering from an accredited university engineering program, plus a minimum of 2 years' work experience in fire protection engineering.

b. A registered professional engineer (P.E.) in fire protection engineering.

c. A registered PE in a related engineering discipline and member grade status in the National Society of Fire Protection Engineers.

d. An engineer with a minimum of 10 years' experience in fire protection engineering and member grade status in the National Society of Fire Protection Engineers

1.4 SYSTEM DESIGN

1.4.1 Operation

The fire alarm and detection system shall be a complete, supervised fire alarm reporting system. The system shall be activated into the alarm mode

by actuation of any alarm initiating device. The system shall remain in the alarm mode until the initiating device is reset and the fire alarm control panel is reset and restored to normal. Alarm initiating devices shall be connected to initiating device circuits (IDC), Style D, in accordance with NFPA 72. Alarm notification appliances shall be connected to notification appliance circuits (NAC), Style Z in accordance with NFPA 72. A looped conduit system shall be provided so that if the conduit and all conductors within are severed at any point, all IDC, or NAC will remain functional. The conduit loop requirement is not applicable to the signal transmission link from the local panels (at the protected premises) to the Supervising Station (fire station, fire alarm central communication center). Textual, audible, and visual appliances and systems shall comply with NFPA 72. Fire alarm system components requiring power, except for the control panel power supply, shall operate on 24 Volts dc.

1.4.2 Operational Features

The system shall have the following operating features:

a. Monitor electrical supervision of alarm IDC and NAC. Smoke detectors shall have combined alarm initiating and power circuits.

b. Monitor electrical supervision of the primary power (ac) supply, battery voltage, placement of alarm zone module (card, PC board) within the control panel, and transmitter tripping circuit integrity.

c. A trouble buzzer and trouble light emitting diode (LED) to activate upon a single break, open, or ground fault condition which prevents the required normal operation of the system. The trouble signal shall also operate upon loss of primary power (ac) supply, low battery voltage, removal of alarm zone module (card, PC board), and disconnection of the circuit used for transmitting alarm signals off-premises. A trouble alarm silence switch shall be provided which will silence the trouble buzzer, but will not extinguish the trouble indicator LED. Subsequent trouble and supervisory alarms shall sound the trouble signal until silenced. After the system returns to normal operating conditions, the trouble buzzer shall again sound until the silencing switch returns to normal position, unless automatic trouble reset is provided.

d. A one person test mode. Activating an initiating device in this mode will activate an alarm for a short period of time, then automatically reset the alarm, without activating the transmitter during the entire process.

e. A transmitter disconnect switch to allow testing and maintenance of the system without activating the transmitter but providing a trouble signal when disconnected and a restoration signal when reconnected.

f. Evacuation alarm silencing switch which, when activated, will silence alarm devices, but will not affect the zone indicating LED/LCD nor the operation of the transmitter. This switch shall be over-ridden upon activation of a subsequent alarm from an unalarmed zone and the NAC devices will be activated.

g. Electrical supervision for circuits used for supervisory signal

services (i.e., sprinkler systems, valves, etc.). Supervision shall detect any open, short, or ground.

h. Confirmation or verification modules for smoke detection initiating circuits. The modules shall interrupt the transmission of an alarm signal to the system control panel for a factory preset period. This interruption period shall be adjustable from 1 to 60 seconds and be factory set at 20 seconds. Immediately following the interruption period, a confirmation period shall be in effect during which time an alarm signal, if present, will be sent immediately to the control panel. Fire alarm devices, other than smoke detectors, will be prohibited on circuits controlled by confirmation or verification modules.

i. The fire alarm control panel shall provide supervised relays for HVAC shutdown. An override at the HVAC panel shall not be provided.

j. Provide one person test mode - Activating an initiating device in this mode will activate an alarm for a short period of time, then automatically reset the alarm, without activating the transmitter during the entire process.

k. The fire alarm control panel shall provide the required modules to monitor and control the fire sprinkler system, or other fire protection extinguishing system.

1.4.3 Alarm Functions

An alarm condition on a circuit shall automatically initiate the following functions:

a. Transmission of a signal over the station telephonic fire reporting system.

b. Visual indications of the alarmed zone on the fire alarm control panel annunciator.

c. Continuous sounding or operation of alarm notification appliances throughout the building as required by ANSI S3.41.

d. Closure of doors held open by electromagnetic devices.

e. Operation of the smoke control system.

f. Deactivation of the air handling units throughout the building.

g. Shutdown of power to the data processing equipment in the alarmed zones.

1.4.4 Primary Power

Operating power shall be provided as required by paragraph Power Supply for the System. Transfer from normal to emergency power or restoration from emergency to normal power shall be fully automatic and not cause transmission of a false alarm. Loss of ac power shall not prevent transmission of a signal via the fire reporting system upon operation of any initiating circuit.

1.4.5 Battery Backup Power

Battery backup power shall be through use of rechargeable, sealed-type storage batteries and battery charger.

1.5 TECHNICAL DATA AND COMPUTER SOFTWARE

Technical data and computer software (meaning technical data which relates to computer software) which is specifically identified in this project, and which may be defined/required in other specifications, shall be delivered in accordance with the CONTRACT CLAUSES, and in accordance with the Contract Data Requirements List, DD Form 1423. Data delivered shall be identified by reference to the particular specification paragraph against which it is furnished. Data to be submitted shall include complete system, equipment, and software descriptions. Descriptions shall show how the equipment will operate as a system to meet the performance requirements of this contract. The data package shall also include the following:

(1) Identification of programmable portions of system equipment and capabilities.

(2) Description of system revision and expansion capabilities and methods of implementation detailing both equipment and software requirements.

(3) Provision of operational software data on all modes of programmable portions of the fire alarm and detection system.

(4) Description of Fire Alarm Control Panel equipment operation.

(5) Description of auxiliary and remote equipment operations.

(6) Library of application software.

(7) Operation and maintenance manuals described under SD-10 in the SUBMITTALS paragraph.

1.6 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variation, dirt, dust, and any other contaminants.

PART 2 PRODUCTS

2.1 CONTROL PANEL

Control panel shall comply with the applicable requirements of UL 864. Panel shall be modular, installed in a surface mounted steel cabinet with hinged door and cylinder lock. Control panel shall be a clean, uncluttered, and orderly assembled panel containing components and equipment required to provide the specified operating and supervisory functions of the system. The panel shall have prominent rigid plastic, phenolic or metal identification plates for LEDs, zones, controls, meters, fuses, and switches. Nameplates for fuses shall also include ampere rating. Separate alarm and trouble LEDs shall be provided for each zone alarm. These LEDs shall be located on the exterior of the cabinet door or be visible through the cabinet door. Control panel switches shall be within the locked cabinet. A suitable means (single operation) shall be provided for testing the control panel visual indicating devices (meters or

LEDs). Meters and LEDs shall be plainly visible when the cabinet door is closed. Signals and LEDs shall be provided to indicate by zone any alarm, supervisory or trouble condition on the system. Each IDC shall be powered and supervised so that a signal on one zone does not prevent the receipt of signals from other zones. Loss of power, including batteries, shall not require the reloading of a program. Upon restoration of power, startup shall be automatic, and shall not require any manual operation. The loss of primary power or the sequence of applying primary or emergency power shall not affect the transmission of alarm, supervisory or trouble signals. Visual annunciators shall be provided for each active zone and spare zone. One (1) spare zone shall be provided. Each LED shall provide specific identification of the zone by means of a permanently attached rigid plastic, phenolic, or metal sign with either raised or engraved letters. Zone identification shall consist of a word description of the zone. Cabinets shall be provided with ample gutter space to allow proper clearance between the cabinet and live parts of the panel equipment. If more than one modular unit is required to form a control panel, the units shall be installed in a single cabinet large enough to accommodate units. Cabinets shall be painted red.

2.1.1 Remote System Trouble Audible/Visual Appliance

Audible appliance shall have a minimum sound level output rating of 85 dBA at 10 feet and operate in conjunction with the panel's integral trouble signal. The audible device shall be silenced by the system trouble silence switch located at the remote location, but shall not extinguish the visual indicator. A rigid plastic, phenolic or metal identification sign which reads "Fire Alarm System Trouble" shall be provided at the audible appliance. The visual appliance located with the audible appliance shall not be extinguished until the trouble has been cleared.

2.1.2 Circuit Connections

Circuit conductors entering or leaving the panel shall be connected to screw-type terminals with each conductor and terminal marked for identification.

2.1.3 System Expansion and Modification Capabilities

Any equipment and software needed by qualified technicians to implement future changes to the fire alarm system shall be provided as part of this contract.

2.2 STORAGE BATTERIES

Storage batteries shall be provided and shall be 24 Vdc sealed, lead-calcium type requiring no additional water. The batteries shall have ample capacity, with primary power disconnected, to operate the fire alarm system for a period of 72 hours. Following this period of battery operation, the batteries shall have ample capacity to operate all components of the system, including all alarm signaling devices in the total alarm mode for a minimum period of 15 minutes. Batteries shall be located at the bottom of the panel. Batteries shall be provided with overcurrent protection in accordance with NFPA 72. Separate battery cabinets shall have a lockable, hinged cover similar to the fire alarm panel. The lock shall be keyed the same as the fire alarm control panel. Cabinets shall be painted to match the fire alarm control panel.

2.3 BATTERY CHARGER

Battery charger shall be completely automatic, 24 Vdc with high/low charging rate, capable of restoring the batteries from full discharge (18 Volts dc) to full charge within 48 hours. A pilot light indicating when batteries are manually placed on a high rate of charge shall be provided as part of the unit assembly, if a high rate switch is provided. Charger shall be located in control panel cabinet or in a separate battery cabinet.

2.4 MANUAL FIRE ALARM STATIONS

Manual fire alarm stations shall conform to the applicable requirements of UL 38. Manual stations shall be connected into signal line circuits. Stations shall be installed on surface mounted outlet boxes. Manual stations shall be mounted at 48 inches. Stations shall be double action type. Stations shall be finished in red, with raised letter operating instructions of contrasting color. Stations requiring the breaking of glass or plastic panels for operation are not acceptable. Stations employing glass rods are not acceptable. The use of a key or wrench shall be required to reset the station. Gravity or mercury switches are not acceptable. Switches and contacts shall be rated for the voltage and current upon which they operate. Stations shall have a separate screw terminal for each conductor. Surface mounted boxes shall be matched and painted the same color as the fire alarm manual stations.

2.5 FIRE DETECTING DEVICES

Fire detecting devices shall comply with the applicable requirements of NFPA 72, NFPA 90A, UL 268, UL 268A, and UL 521. The detectors shall be provided as indicated. Detector base shall have screw terminals for making connections. No solder connections will be allowed. Detectors located in concealed locations (above ceiling, raised floors, etc.) shall have a remote visible indicator LED/LCD. Installed devices shall conform to the NFPA 70 hazard classification of the area where devices are to be installed.

2.5.1 Heat Detectors

Heat detectors shall be designed for detection of fire by combination fixed temperature and rate-of-rise principle. Heat detector spacing shall be rated in accordance with UL 521. Detectors located in areas subject to moisture, exterior atmospheric conditions, or hazardous locations as defined by NFPA 70, shall be types approved for such locations. Heat detectors located in attic spaces or similar concealed spaces below the roof shall be intermediate temperature rated.

2.5.1.1 Combination Fixed-Temperature and Rate-of-Rise Detectors

Detectors shall be designed for surface outlet box mounting and supported independently of wiring connections. Contacts shall be self-resetting after response to rate-of-rise principle. Under fixed temperature actuation, the detector shall have a permanent external indication which is readily visible. Detector units located in boiler rooms, showers, or other areas subject to abnormal temperature changes shall operate on fixed temperature principle only. The UL 521 test rating for the fixed temperature portion shall be 135 degrees F. The UL 521 test rating for the Rate-of-Rise detectors shall be rated for 50 by 50 ft.

2.5.2 Smoke Detectors

Smoke detectors shall be designed for detection of abnormal smoke

densities. Smoke detectors shall be ionization or photoelectric type. Detectors shall contain a visible indicator LED that shows when the unit is in alarm condition. Detectors shall not be adversely affected by vibration or pressure. Detectors shall be the plug-in type in which the detector base contains terminals for making wiring connections. Detectors that are to be installed in concealed (above false ceilings, etc.) locations shall be provided with a remote indicator LED suitable for mounting in a finished, visible location.

2.5.2.1 Ionization Detectors

Ionization detectors with a dual chamber shall be responsive to both invisible and visible particles of combustion. One chamber shall be a reference chamber and the second a sampling chamber. Detectors containing radium shall not be provided. Detectors shall not cause an alarm condition due to anticipated fluctuations in relative humidity. The sensitivity of the detector shall be field adjustable to compensate for operating conditions. Detector shall require no replacement or readjustment to restore it to normal operation after an alarm condition. Each detector shall be capable of withstanding ambient air velocity up to 300 fpm in accordance with UL 268.

2.5.2.2 Photoelectric Detectors

Detectors shall operate on a light scattering concept using an LED light source. Failure of the LED shall not cause an alarm condition. Detectors shall be factory set for sensitivity and shall require no field adjustments of any kind. Detectors shall have an obscuration rating in accordance with UL 268.

2.6 NOTIFICATION APPLIANCES

Audible appliances shall conform to the applicable requirements of UL 464. Devices shall be connected into notification appliance circuits. Devices shall have a separate screw terminal for each conductor. Audible appliances shall generate a unique audible sound from other devices provided in the building and surrounding area. Surface mounted audible appliances shall be painted red. Recessed audible appliances shall be installed with a grill that is painted red.

2.6.1 Alarm Horns

Horns shall be surface mounted, with the matching mounting back box grille and vibrating type suitable for use in an electrically supervised circuit. Horns shall produce a sound rating of at least 85 dBA at 10 feet. Horns used in exterior locations shall be specifically listed or approved for outdoor use and be provided with metal housing and protective grilles.

2.6.2 Visual Notification Appliances

Visual notification appliances shall conform to the applicable requirements of UL 1971. Appliances shall have clear high intensity optic lens, xenon flash tubes, and output white light. Strobe flash rate shall be between 1 to 3 flashes per second and a minimum of 75 candela. Strobe shall be surface mounted.

2.6.3 Combination Audible/Visual Notification Appliances

Combination audible/visual notification appliances shall provide the same

requirements as individual units, except that they shall mount as a unit in standard backboxes. Units shall be factory assembled. Any other audible notification appliance employed in the fire alarm systems shall be approved by the Contracting Officer.

2.7 FIRE DETECTION AND ALARM SYSTEM PERIPHERAL EQUIPMENT

2.7.1 Electromagnetic Door Hold-Open Devices

Devices shall be attached to the walls unless otherwise indicated. Devices shall comply with the appropriate requirements of UL 228. Devices shall operate on 24 Volt dc power. Compatible magnetic component shall be attached to the door. Under normal conditions, the magnets shall attract and hold the doors open. When magnets are de-energized, they shall release the doors. Magnets shall have a holding force of 25 pounds. Devices shall be UL or FM approved. Housing for devices shall be brushed aluminum or stainless steel. Operation shall be fail safe with no moving parts. Electromagnetic door hold-open devices shall not be required to be held open during building power failure.

2.7.2 Conduit

Conduit and fittings shall comply with UL 6, UL 1242 and UL 797.

2.7.3 Wiring

Wiring shall conform to NFPA 70. Wiring for 120 Vac power shall be No. 12 AWG minimum. Wiring for Fire Alarm circuits shall be No. 16 AWG minimum. Voltages shall not be mixed in any junction box, housing, or device, except those containing power supplies and control relays. Wiring shall conform to NFPA 70. System field wiring shall be solid copper and installed in metallic conduit or electrical metallic tubing, except rigid plastic conduit may be used under slab-on-grade. Conductors shall be color coded. Conductors used for the same functions shall be similarly color coded. Wiring code color shall remain uniform throughout the circuit. Pigtail or T-tap connections to initiating device circuits, supervisory alarm circuits, and notification appliance circuits are prohibited.

2.7.4 Special Tools and Spare Parts

Software, connecting cables and proprietary equipment, necessary for the maintenance, testing, and reprogramming of the equipment shall be furnished to the Contracting Officer. Two spare fuses of each type and size required shall be furnished. Two percent of the total number of each different type of detector, but no less than two each, shall be furnished. Spare fuses shall be mounted in the fire alarm panel.

PART 3 EXECUTION

3.1 INSTALLATION

All work shall be installed as shown and in accordance with the manufacturer's diagrams and recommendations, unless otherwise specified. Smoke detectors shall not be installed until construction is essentially complete and the building has been thoroughly cleaned.

3.1.1 Power Supply for the System

A single dedicated circuit connection for supplying power from a branch

circuit to each building fire alarm system shall be provided. The power shall be supplied as shown on the drawings. The power supply shall be equipped with a locking mechanism and marked in red with the words "FIRE ALARM CIRCUIT CONTROL".

3.1.2 Wiring

Conduit size for wiring shall be in accordance with NFPA 70. Wiring for the fire alarm system shall not be installed in conduits, junction boxes, or outlet boxes with conductors of lighting and power systems. Not more than two conductors shall be installed under any device screw terminal. The wires under the screw terminal shall be straight when placed under the terminal then clamped in place under the screw terminal. The wires shall be broken and not twisted around the terminal. Circuit conductors entering or leaving any mounting box, outlet box enclosure, or cabinet shall be connected to screw terminals with each terminal and conductor marked in accordance with the wiring diagram. Connections and splices shall be made using screw terminal blocks. The use of wire nut type connectors in the system is prohibited. Wiring within any control equipment shall be readily accessible without removing any component parts. The fire alarm equipment manufacturer's representative shall be present for the connection of wiring to the control panel.

3.1.3 Control Panel

The control panel and its assorted components shall be mounted so that no part of the enclosing cabinet is less than 12 inches nor more than 78 inches above the finished floor. Manually operable controls shall be between 36 and 42 inches above the finished floor. Panel shall be installed to comply with the requirements of UL 864.

3.1.4 Detectors

Detectors shall be located and installed in accordance with NFPA 72. Detectors shall be connected into signal line circuits or initiating device circuits as indicated on the drawings. Detectors shall be at least 12 inches from any part of any lighting fixture. Detectors shall be located at least 3 feet from diffusers of air handling systems. Each detector shall be provided with appropriate mounting hardware as required by its mounting location. Detectors which mount in open space shall be mounted directly to the end of the stubbed down rigid conduit drop. Conduit drops shall be firmly secured to minimize detector sway. Where length of conduit drop from ceiling or wall surface exceeds 3 feet, sway bracing shall be provided. Detectors installed in concealed locations (above ceiling, raised floors, etc.) shall have a remote visible indicator LED/LCD in a finished, visible location.

3.1.5 Notification Appliances

Notification appliances shall be mounted 80 inches above the finished floor or 6 inches below the ceiling, whichever is lower.

3.2 OVERVOLTAGE AND SURGE PROTECTION

3.2.1 Power Line Surge Protection

All equipment connected to alternating current circuits shall be protected from surges per IEEE C62.41 B3 combination waveform and NFPA 70. Fuses shall not be used for surge protection. The surge protector shall be rated

for a maximum let thru voltage of 350 Volts ac (line-to-neutral) and 350 Volt ac (neutral-to-ground).

3.2.2 Low Voltage DC Circuits Surge Protection

All IDC, NAC, and communication cables/conductors, except fiber optics, shall have surge protection installed at each point where it exits or enters a building. Equipment shall be protected from surges per IEEE C62.41 B3 combination waveform and NFPA 70. The surge protector shall be rated to protect the 24 Volt dc equipment. The maximum dc clamping voltages shall be 36 V (line-to-ground) and 72 Volt dc (line-to-line).

3.3 GROUNDING

Grounding shall be provided by connecting to building ground system.

3.4 TESTING

The Contractor shall notify the Contracting Officer at least 10 days before the preliminary and acceptance tests are to be conducted. The tests shall be performed in accordance with the approved test procedures in the presence of the Contracting Officer. The control panel manufacturer's representative shall be present to supervise tests. The Contractor shall furnish instruments and personnel required for the tests.

3.4.1 Preliminary Tests

Upon completion of the installation, the system shall be subjected to functional and operational performance tests including tests of each installed initiating and notification appliance, when required. Tests shall include the meggering of system conductors to determine that the system is free from grounded, shorted, or open circuits. The megger test shall be conducted prior to the installation of fire alarm equipment. If deficiencies are found, corrections shall be made and the system shall be retested to assure that it is functional. After completing the preliminary testing the Contractor shall complete and submit the NFPA 72, Certificate of Completion.

3.4.2 Acceptance Test

Acceptance testing shall not be performed until the Contractor has completed and submitted the Certificate of Completion. Testing shall be in accordance with NFPA 72. The recommended tests in NFPA 72 shall be considered mandatory and shall verify that previous deficiencies have been corrected. The Contractor shall complete and submit the NFPA 72, Inspection and Testing Form. The test shall include all requirements of NFPA 72 and the following:

a. Test of each function of the control panel.

b. Test of each circuit in both trouble and normal modes.

c. Tests of each alarm initiating devices in both normal and trouble conditions.

d. Tests of each control circuit and device.

e. Tests of each alarm notification appliance.

f. Tests of the battery charger and batteries.

g. Complete operational tests under emergency power supply.

h. Visual inspection of wiring connections.

i. Opening the circuit at each alarm initiating device and notification appliance to test the wiring supervisory feature.

j. Ground fault.

k. Short circuit faults.

l. Stray voltage.

m. Loop resistance.

3.5 TRAINING

Training course shall be provided for the operations and maintenance staff. The course shall be conducted in the building where the system is installed or as designated by the Contracting Officer. The training period for systems operation shall consist of 1 training days (8 hours per day) and shall start after the system is functionally completed but prior to final acceptance tests. The instructions shall cover items contained in the operating and maintenance instructions.

-- End of Section --