TEST FI.
Region

New York State Department of Environmental Conservation

Region 9

Note: This is a reference cited in *AP 42, Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources.* AP42 is located on the EPA web site at www.epa.gov/ttn/chief/ap42/

The file name refers to the reference number, the AP42 chapter and section. The file name "ref02_c01s02.pdf" would mean the reference is from AP42 chapter 1 section 2. The reference may be from a previous version of the section and no longer cited. The primary source should always be checked.

GRAY
IRON FOUNDRIES 12.10
AP-42 Section ~~7.10~~
Reference Number
15

S750057

STACK TEST REPORT

Dunkirk Radiator Corp.
Cupola Scrubber

November 6, 7, 10, 11, and 12, 1975

Middle Road
Dunkirk (C)
Chautauqua County

Roger McCabe, Principal Engineering Technician
Gary Foersch, Senior Engineering Technician
Dominic Buccilli, Senior Engineering Technician

Certified by JMCGarry P.E. License No. 047232

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ABSTRACT

Stack tests were performed on the Dunkirk Radiator Corp. cupola scrubber stack. Dunkirk Radiator Corp. complex is located on Middle Road in Dunkirk, New York. The tests were performed on November 5, 6, 7, 10, 11, and 12, 1975, to determine compliance with 6 NYCRR 212 Process, Exhaust and Ventilation Systems.

The testing was performed at the request of the Region 9 Office of the Department of Environmental Conservation by the Region 9 Stack Test Team. The personnel performing the tests were: Roger McCabe, Principal Engineering Technician; Domonic Buccilli and Gary Foersch, Senior Engineering Technicians. Frank Shattuck Senior Sanitary Engineer was also present to document opacity and gather charging data during the testing.

The results of the testing show that the cupola is in compliance with 6 NYCRR 212.3 Emissions from Existing Emission Points and 212.7 Opacity of Emissions Limited.

SOURCE DESCRIPTION

The foundry cupola exhaust system at the Dunkirk Radiator Corp. Plant is located on Middle Road in Dunkirk, New York.

The cupola is prepared with a 2,600 pound bed of coke over a sand base. Combustion air is forced into the cupola to burn the coke melting the charged iron which then flows out a tap hole and into pouring ladles. Each charge into the cupola is composed of 700 lbs of pig iron; 700 lbs of scrap; 600 lbs of remelt; 260 lbs of coke; 20 lbs of silicon carbide; 2 lbs of ferric manganese; and 75 lbs of limestone.

The gases given off by the cupola are precleaned by a quenching station where water sprays remove large particles from the exhaust gas stream. The gas stream is then drawn into a National Dust Collection Corp. high energy wet scrubber. The scrubber gas is drawn through a demister where the free water is removed from the gas stream. The gas is then drawn into an induced draft fan with an operating capacity of 24,900 CFM and then exit the system through the stack.

The particulate-laden water from the precleaning quenching water and the scrubber water is washed through a hydro-filter and down into a sludge tank.

Figure 1 on the next page shows the flow diagram for this cupola exhaust system. The wet scrubber exhaust system was issued a Permit to Construct on November 12, 1970.

This cupola is governed under the production foundry process regulation 6 NYCRR 212 since the average melt time exceeds 4 hours.

New York State Department of Environmental Conservation
584 Delaware Avenue, Buffalo, N.Y. 14202

Ogden Reid
Commissioner

Acting Regional Director
W.M. Friedman, P.E.

Flow Diagram
Dunkirk Radiator Corp.
Cupola Exhaust

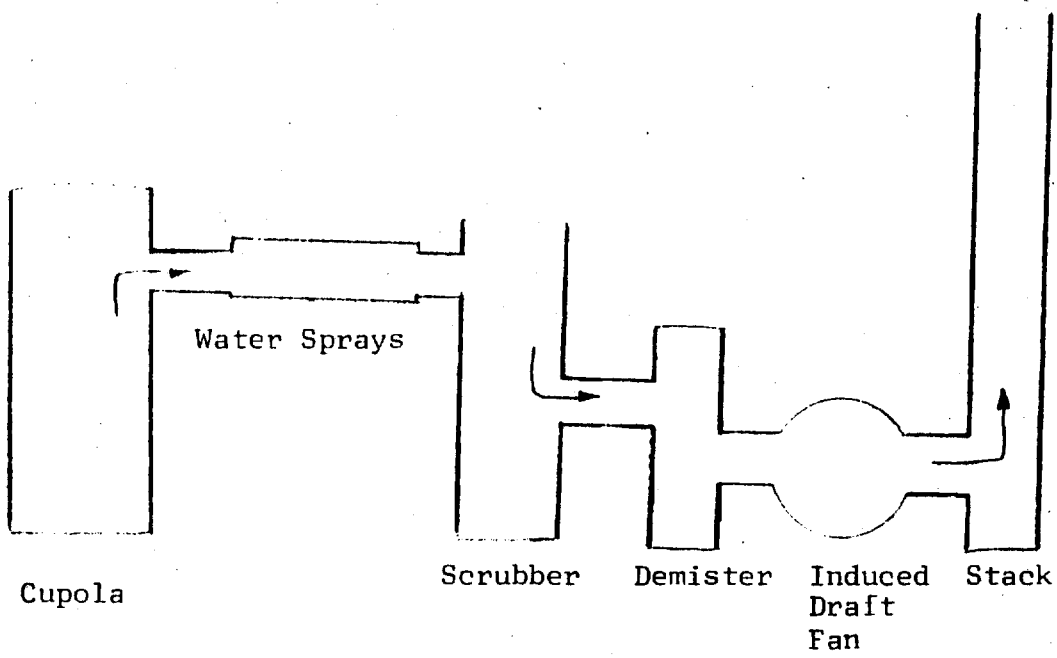

Figure 1

TEST PROCEDURES

The procedures used for testing this incinerator were those set forth in the Federal Register, Volume 36, No. 247, December 23, 1971, and New York State Department of Environmental Conservation publications, 9AIR 100.81 (11/75), AIR 200 (3/73), AIR 200.1 (3/73), AIR 200.3 (3/73), and AIR 201 (12/73).

The sampling train was of the configuration shown in Figure 2 of this section. The filter used was a MSA 1106 BH. A glass-lined heated three feet long probe was used for all of the sampling.

The cupola scrubber stack was measured to determine the inside diameter of 42". The ports in the stack are located above the roof of the foundry. Two sampling ports 90° apart are located eight straight stack diameters downstream from any flow disturbance, and two straight diameters upstream from the exit point of the stack. Figure 3 in this section shows the sampling port location for the scrubber stack. Figure 4 shows the location of the 12 sampling points in relation to the inside stack wall. Table 1 gives the actual distance from the inside stack wall to each sampling point.

The analytical procedures used on each of the samples were according to the methods specified in the AIR 201 (12/73), Section 5, Sample Analysis. The only modification of the procedure is to the contents of container 3, the condensate collected in the impingers, was first filtered in the lab through a tare weighed millipore filter to remove the suspended solids. This filter is then dried and reweighed. The weight gain is reported as the suspended solids of the condensate. The condensate is then further analyzed as required by the AIR 201 (12/73).

The wet catch (particulate from the condensate plus impinger wash) is given for information only and is not included in the emission rate calculations. The wet catch data may be found on the 9AIR 224.1 included in the Appendix of this report with the test data for each of the individual runs. The analysis results for the Dunkirk Radiator cupola scrubber stack tests submitted by Mr. Hanson of NYSHD Central New York Laboratory to Mr. Armbrust, NYSDEC Region 9 has been included in the Appendix of this report.

The molecular weight of the stack gas was determined by using a Burrel Orsat Analyzer. The composite gas samples were taken in an evacuated mylar sample bag during the particulate testing at the stack site. The gas samples were analyzed at the stack test shop. Orsat analyses can be more accurately performed at the shop than in the field.

The allowable emission rate for the cupola scrubber stack is based on the cupola process weight (lb/hr). The process weight, as described in the Cupola Testing Procedure (9AIR 100.81 11/75) is all that material introduced into the cupola prior to and during the melt cycle.

The charging and melt cycle data is included in the Appendix of this report. The firm submitted the charging data and cupola operations to Mr. Shattuck upon his request. The number of charges to the cupola varied each day that tests were performed. The charges all had identical amounts of raw materials. The melt cycle is identified by the "tap out" to the "wind off" on the submitted data sheets. A summary of the process weight and the allowable emissions is tabulated in Table 3 and is included in this section.

Test runs 1 and 2 which were performed on November 5, 1975 have not been submitted in this report. The existing gas stream from the cupola scurbber stack was assumed to have a 14% moisture content when in reality it was found to be 30%. This inaccurate moisture content resulted in sampling conditions which were in excess of the acceptable limitations for isokinetic sampling. These test runs were performed again on November 6 and 7. These reruns were called runs 3 and 4.

Test run 5 performed on November 10, 1975 was not used in determining compliance because only one complete traverse was sampled. Heavy rain and high winds forced the cancellation of the second half of the test. This test was rerun again on November 12, 1975 when a complete test was performed, test 6.

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Ogden Reid
Commissioner
W. N. Friedman
Acting Regional Director

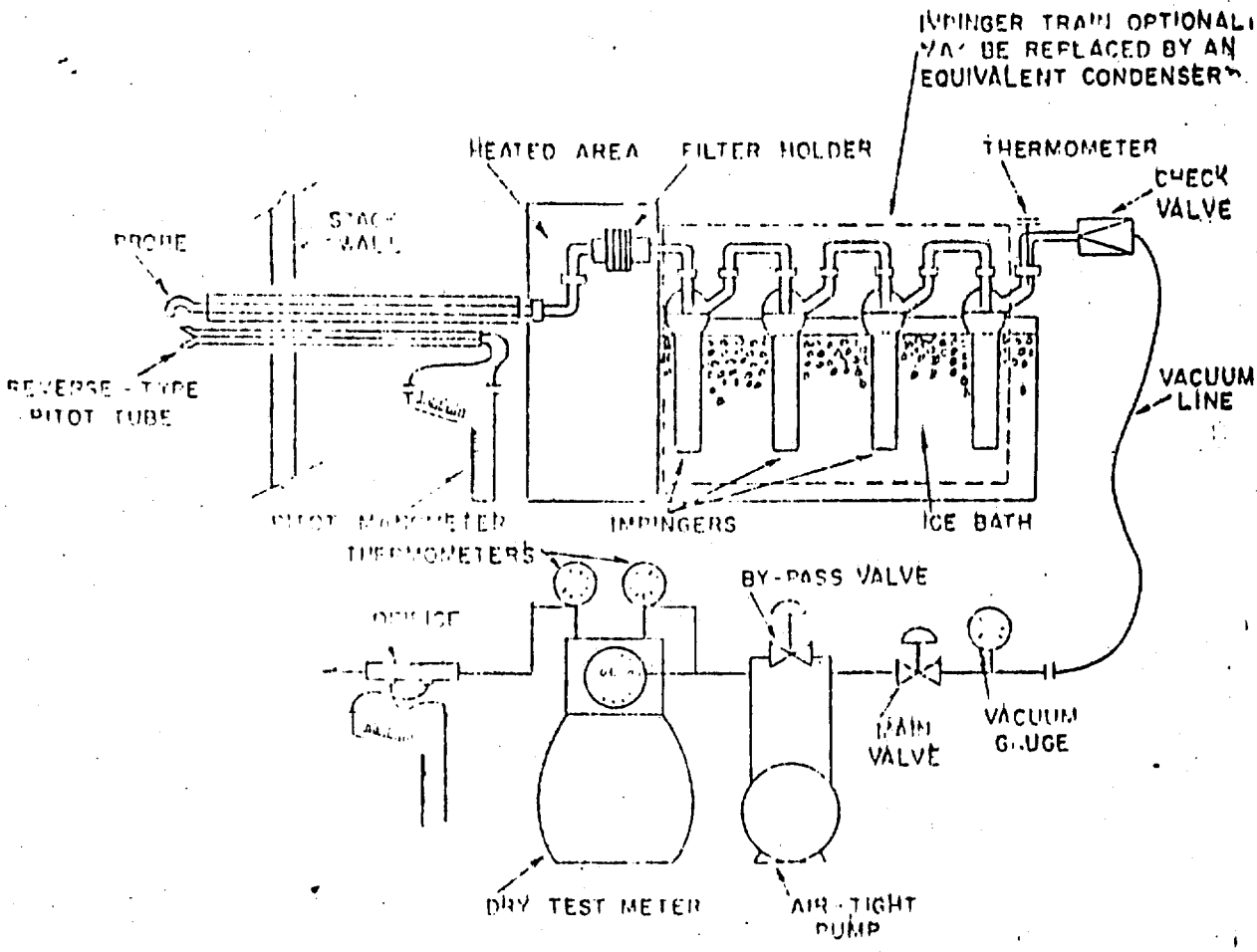

FIGURE 2 - PARTICULATE - SAMPLING TRAIN

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Dunkirk Radiator Corp.
Cupola Scrubber Stack
Port Location

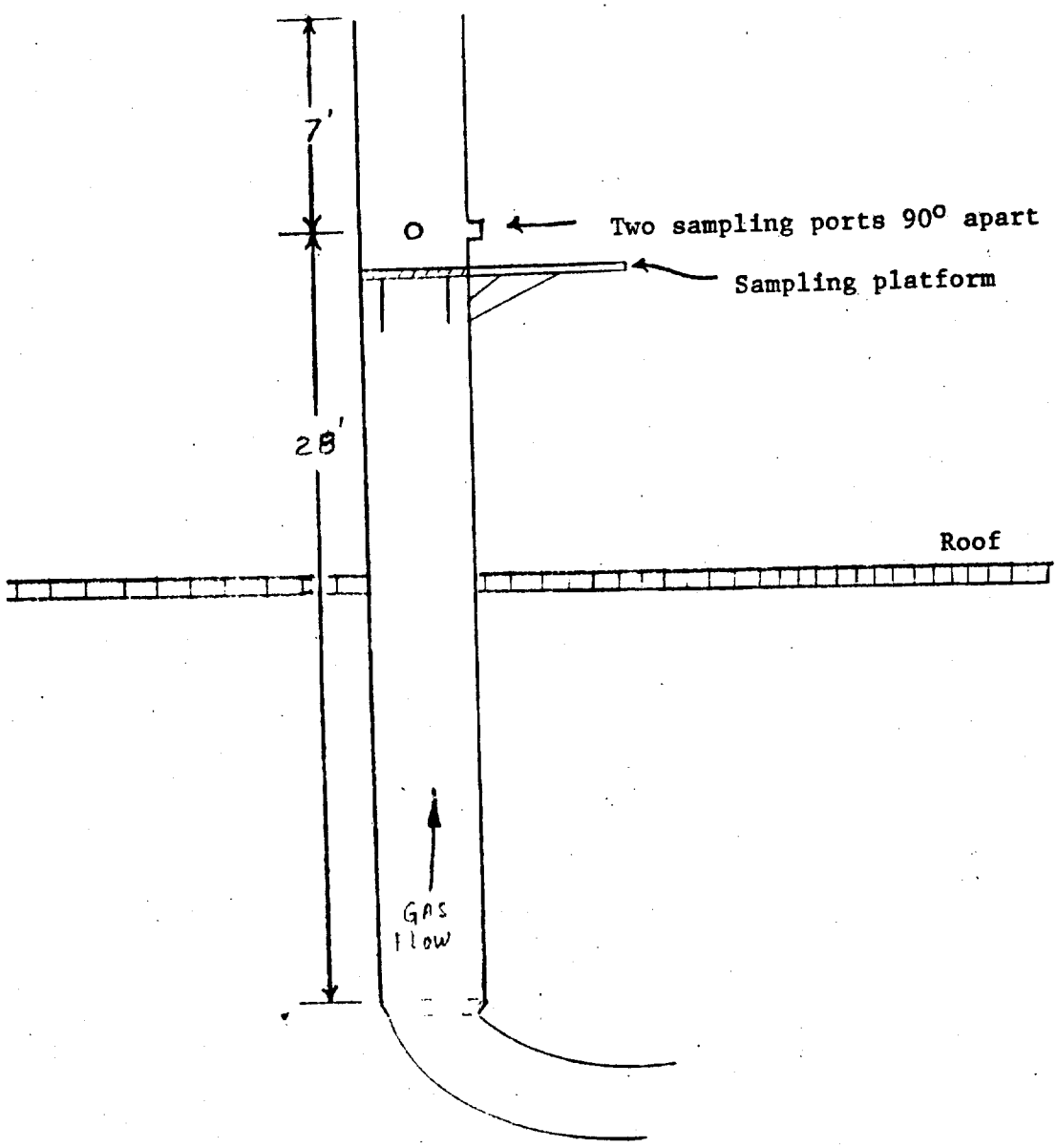

Figure 3

New York State Department of Environmental Conservation

Ogden Reid,
Commissioner

Sampling
Point Location
Dunkirk Radiator
Cupola Scrubber Stack
42" Diameter

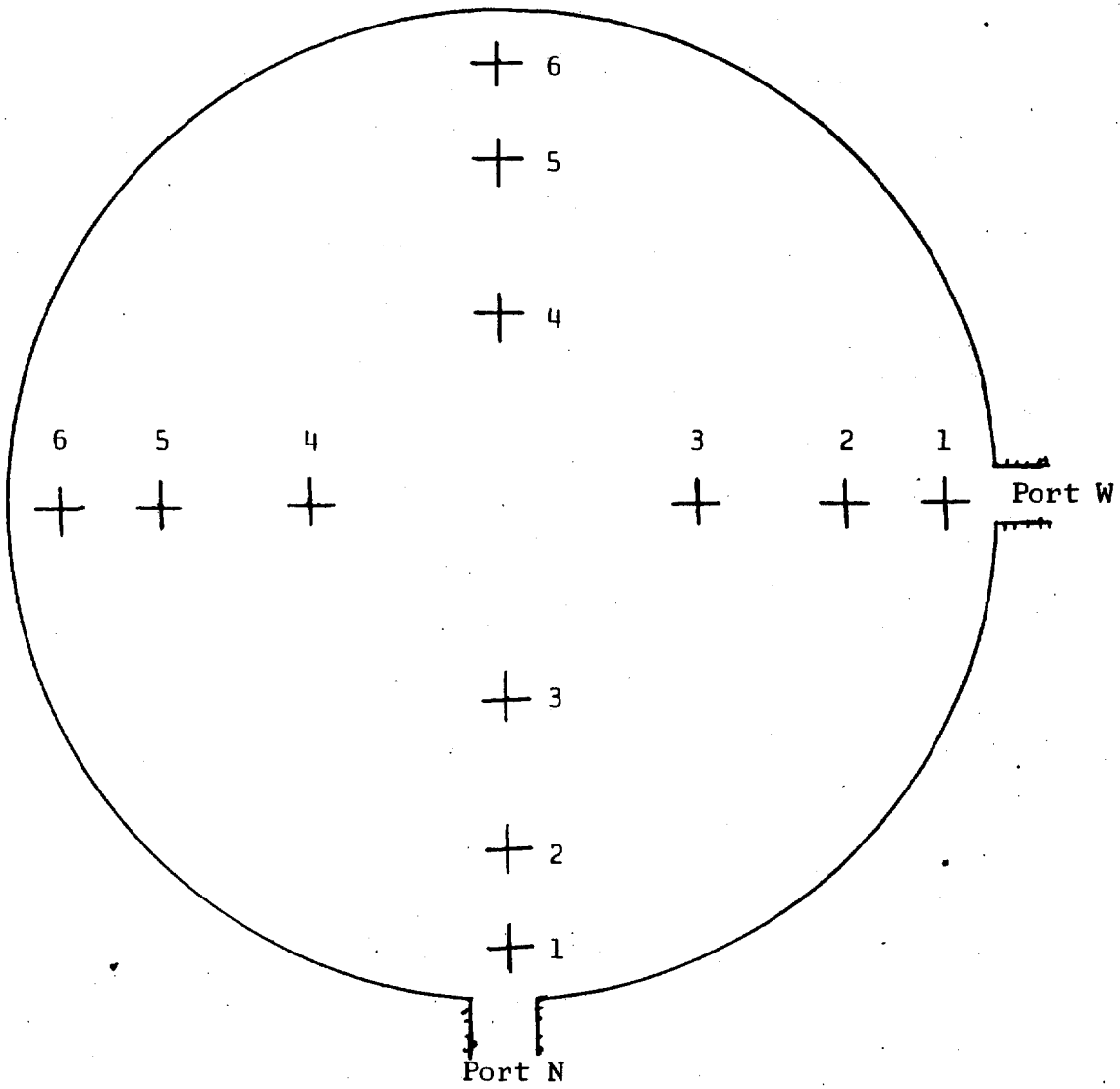

Figure 4

POINT LOCATION
DUNKIRK RADIATOR CORP.
CUPOLA SCRUBBER STACK

Point	% of Stack Diameter	Stack Diameter	Distance from Inside Wall
1	4.4	42"	1.85
2	14.7	42"	6.17
3	29.5	42"	12.39
4	70.5	42"	29.61
5	85.3	42"	35.83
6	95.6	42"	40.15

Table 1

DISCUSSION OF RESULTS

The rule that governs the Dunkirk Radiator Corp. cupola is 6 NYCRR 212, Process, Exhaust and Ventilation Systems. Section 212.3(a), Emissions from Existing Emission Points, states "Emissions of contaminants to the outdoor atmosphere from any process or exhaust and/or ventilation system through any emission point shall be restricted as follows: Subpart (a) No person shall cause or allow emissions that contravene Table 2 or Table 3 of this part, for the Environmental Rating issued by the Commissioner."

The process weight, as described in the Cupola Testing Procedure (9AIR 100.81 11/75) is all that material introduced into the cupola prior to and during the melt cycle. The summary of data used to determine the process weight for each stack test is shown in Table 3. The average process weight for the acceptable test runs is 35,688 lb/hr. The charging data for the cupola on the days stack tests were performed is included in the Appendix of this report.

The average allowable emission rate from 6 NYCRR 212, Table 3 is 25.56 lb/hr. The average actual emission rate is 14.26 lb/hr. The summary of test results are shown on Table 4 in this section. The field data and calculations are included in the Appendix of this report.

The Dunkirk Radiator Corp. cupola is in compliance with 6 NYCRR 212.3 and 212.7 Opacity of Emissions Limited.

Dunkirk Radiator Corp.
Cupola Scrubber Test
Summary of Test and Melt Times

Date	Test Run	Test Times	Melt Times	Melt Duration (hr)
11-6-75	3	10:16 - 11:59	9:48 - 2:15	4.45
11-7-75	4	10:28 - 12:18	9:19 - 2:00	4.68
11-12-75	6	10:20 - 12:31	9:14 - 1:40	4.43

Table 2

Dunkirk Radiator Corp.
Cupola Scrubber Stack
Allowable Emissions

Date	Test Run	Average Weight Per Charges (lbs)	# of Charges	Total Charged (lbs) Plus 2600 lb of Coke Bed	Melt Duration Hr	Process Weight (lbs/hr)	Allowable lb/hr Part 212 Table 1
-6-75	3	2,357	62	148,734	4.45	33,423	24.47
-7-75	4	2,357	70	167,590	4.68	35,810	25.62
-12-75	6	2,357	70	167,590	4.43	37,831	26.58
erage						35,688	25.56

Dunkirk Radiator Corp.
Cupola Scrubber Stack
Summary of Test Results

Date	Test Run #	% Isokinetic	Actual (gr/scf)	lb/hr Actual Emissions	lb/hr Allowable Emissions
11-6-75	3	110.8	.1951	16.99	24.47
11-7-75	4	99.0	.1402	13.25	25.62
11-12-75	6	101.2	.1409	12.55	26.58
Average			.1587	14.26	25.56

Table 4

PLUME OBSERVATION

During the testing, opacity observations were made by Frank Shattuck, a Senior Sanitary Engineer with the Region 9 Office. Mr. Shattuck is certified by the Department of Environmental Conservation as an opacity observer. Mr. Shattuck documented his opacity observations on November 5, 6, 7, 10, and 12, 1975 while the cupola scrubber tests were in progress.

General Prohibitions, 6 NYCRR 212.7 (Opacity of Emissions Limited) states "No person shall cause or allow emissions having an opacity of 20% or greater from any process or exhaust and/or ventilation system to be emitted to the atmosphere except only the emission of uncombined water".

During the observation made by Mr. Shattuck, there were no smoke violations of 6 NYCRR 212.7. Copies of the opacity documentation on NYSDEC form AIR 175 (7/68) Smoke Observation Form are included in the Appendix.

APPENDIX

STACK TEST CALCULATION SYMBOLS

V_m =	Volume of dry gas sample through dry gas meter (meter conditions) cu. ft.
$V_{m_{std}}$ =	Volume of dry gas sample through dry gas meter (standard conditions) cu. ft.
$V_{w_{std}}$ =	Volume of water vapor in gas sample (standard conditions) cu. ft.
V_{total} =	Total volume of gas sampled (standard conditions) cu. ft.
V_{l_c} =	Volume of liquid collected in impingers and silica gel, ml.
P_{bar} =	Barometric pressure at orifice meters in. Hg.
P_{std} =	Barometric pressure at standard conditions, 29.92 in. Hg.
P_s =	Absolute stack gas pressure, in. Hg.
T_m =	Absolute average dry gas meter temperature, ^oR
T_{std} =	Absolute temperature at standard conditions, ^oR
T_s =	Absolute average stack gas temperature ^oR
θ =	Total sample time, min.
ΔH =	Average pressure drop across the orifice, inches H_2O
M_d =	Dry molecular weight, lb/lb. - mole
M_s =	Molecular weight of stack gas (wet basis), lb/lb. mole
% CO_2 =	Percent carbon dioxide by volume, dry basis
% O_2 =	Percent oxygen by volume, dry basis
% CO =	Percent carbon monoxide by volume, dry basis
% N_2 =	Percent nitrogen by volume, dry basis
V_s =	Average stack gas velocity, feet per second
K_p =	Units constant for velocity formula 85.48 ft/sec $\left(\frac{lb}{lb\text{-}mole\text{-}^oR}\right)^{1/2}$ when using units in formula
C_p =	Pitot tube coefficient, dimensionless 0.855 for Type S pitot tube
$(\sqrt{\Delta P})$ Ave =	Average velocity head of stack gas, inches H_2O
B_{wo} =	Proportion by volume of water vapor in the gas stream, dimensionless

STACK TEST CALCULATION SYMBOLS
(Cont.)

A_s = Area of stack, sq. ft.

A_n = Area of nozzle, sq. ft.

d = Diameter of stack, inches

Q'_s = Volumetric flow rate, wet basis standard conditions, cubic feet per hour

M_n = Total amount of particulate matter collected, mg. (filter, probe, cyclone, and flask)

C'_s = Concentration of particulate matter in stack gas, dry basis, gr/scf

W'_s = Weight emission rate of particulate, lb/hr

I = Percent of isokinetic sampling

STACK TEST CALCULATION WORK SHEET

Firm: Dunkirk Radiator Corp Test Date 11-6-75

Source: Cupola Scrubber Run No. 3

From Field Data Sheets (AIR 224)

From Analytical Data Sheet (AIR 224.1)

V_m = 54.999 C.F.

θ = 60 min.

P_{bar} = 29.64 in. Hg

P_s = 29.63 in. Hg

T_s = 194 °F + 460 = 654 °R

T_m = 79 °F + 460 = 539 °R

Ave$\sqrt{\Delta p}$ = .539 in. H_2O

ΔH = 3.24 in. H_2O

V_{lc} = 670.5 mL

A_n = .00077 Sq. ft.

M_n = 684.1 mg

9AIR201.02 (6/74)

STACK TEST CALCULATION WORK SHEET

Firm: Dunkirk Radiator Corp. Test Date 11-6-75

Source: Cupola Scrubber Run No. 3

Dry Gas Volume (Standard Conditions)* (SCF)

$$V_{m_{std}} = V_m (17.71) \left[\frac{P_{bar} + \frac{\Delta H}{13.6}}{T_m} \right]$$

$$= 54.999 (17.71) \left[\frac{29.64 + \frac{3.24}{13.6}}{539} \right]$$

$$= 53.993 \text{ SCF}$$

Volume of Water Vapor (Standard Conditions) (SCF)

$$V_{w_{std}} = V_{l_c} (0.0474)$$

$$= 670.5 (0.0474)$$

$$= 31.782 \text{ SCF}$$

9AIR201.03 (6/74)

STACK TEST CALCULATION WORKSHEET

Firm: Dunkirk Radiator Corp. Test Date 11-6-75

Source: Cupola Scrubber Run No. 3

Moisture Content

$$B_{wo} = \frac{V_{w_{std}}}{V_{w_{std}} + V_{m_{std}}} \times 100 = \%$$

$$= \frac{31.782}{31.782 + 53.993} \times 100$$

$$= .371 \text{ or } 37.1\%$$

Dry Molecular Weight (lb/lb - mole)

$$M_d = .44\ (\%\ CO_2) + .32\ (\%\ O_2) + .28\ (\%\ CO + \%\ N_2)$$

$$= .44(13.4) + .32(3.6) + .28(7.2 + 75.7)$$

$$= 30.26 \text{ Lb/Lb-mole}$$

9AIR201.04 (6/74)

STACK TEST CALCULATION WORK SHEET

Firm: Dunkirk Radiator Corp. Test Date 11-6-75

Source: Cupola Scrubber Run No. 3

Molecular Weight of Stack Gas (Wet Basis) (lb/lb - mole)

$$M_s = M_d (1-B_{wo}) + 18 B_{wo}$$

$$= 30.26(1-.371) + 18(.371)$$

$$= 25.71 \text{ Lb/lb-mole}$$

Average Stack Gas Velocity (feet per second)

$$V_s = K_p C_p (\sqrt{\Delta p}) \text{ Ave} \sqrt{\frac{T_s}{P_s M_s}}$$

$$= 85.48(.815)(.539)\sqrt{\frac{654}{29.63 \times 25.71}}$$

$$= 34.792 \text{ fps.}$$

9AIR201.05 (6/74)

STACK TEST CALCULATION WORK SHEET

Firm: Dunkirk Radiator Corp. Test Date 11-6-75

Source Cupola Scrubber Run No. 3

Area of stack (ft^2)

$$A = \frac{\frac{\pi d^2}{4}}{144}$$

$$= \frac{\pi (42)^2/4}{144}$$

$$= 9.62 \ ft^2$$

Volumetric Flow Rate (Wet Basis) (Standard Conditions) (cu. ft./hr)

$$Q'_s = 3600 \ (V_s) \ (A) \left(\frac{T_{std}}{(T_s)}\right)\left(\frac{P_s}{P_{std}}\right)$$

$$= 3600(34.792)(9.62)\left(\frac{530}{654}\right)\left(\frac{29.63}{29.92}\right)$$

$$= 96697.05 \ cu.ft./hr.$$

9AIR201.06 (6/74)

STACK TEST CALCULATION WORK SHEET

Firm: Dunkirk Radiator Corp Test Date 11-6-75

Source Cyclo Scrubber Run No. 3

Concentration in grains per standard cubic foot (gr/scf)

$$C'_s = .0154 \left(\frac{M_n}{V_{m_{std}}} \right)$$

$$= .0154 \left(\frac{684.1}{53.993} \right)$$

$$= .1951 \text{ gr/scf.}$$

Total Volume Sampled (Standard Conditions) (SCF)

$$V_{total} = V_{m_{std}} + V_{w_{std}}$$

$$= 53.993 + 31.782$$

$$= 85.775 \text{ SCF}$$

9AIR201.07 (6/74)

STACK TEST CALCULATION WORK SHEET

Firm: Dunkirk Radiator Corp Test Date 11-6-75

Source: Cupola Scrubber Run No. 3

Emission Rate in Pounds Per Hour (lb/hr)

$$W'_s = \frac{(1.0 \text{ lb}/454{,}000 \text{ mg})\ M_n}{V_{total}}\ Q's$$

$$= \frac{(1.0/454{,}000)\ 684.1}{85.775} \times 966997.05$$

$$= 16.99 \text{ lb/hr}$$

Isokinetic Variation (Percent)

$$I = \left[\frac{V_{total}\ (T_s)}{A_n\ V_s\ P_s\ \theta}\right] \left(\frac{29.92}{530}\right) \left(\frac{1}{60}\right) 100$$

$$= \left[\frac{(85.775)(654)}{(.0077)(34.792)(29.63)(60)}\right] \left(\frac{29.92}{530}\right) \left(\frac{1}{60}\right) 100$$

$$= 110.8\%$$

9ATR201.08 (1/76)

ORSAT ANALYSIS

Dunkirk Radiator Corp. Date 11-6-75

Dunkirk, New York

Cupola Scrubber

NYSDEC R-9 Sample No. 3

Test No.	Orsat Reading	% CO_2	Orsat Reading	% O_2	Orsat Reading	% CO	% H_2	
1	13.2	13.2	16.9	3.7	23.9	7.0	76.1	
2	13.5	13.5	17.2	3.7	24.4	7.2	75.6	
3	13.5	13.5	17.0	3.5	24.5	7.5	75.5	
Ave		13.4		3.6		7.2	75.7	

ANALYTICAL DATA

Plant: DUNKIRK RADIATOR CORP.
Source: CUPOLA SCRUBBER
Date: 11-6-75 Run No. 3

Correction for Acetone Particulate Content

Net Acetone Wash Particulate Weight (mg) = Evaporated Solids from Acetone Washings (mg) - Volume of Acetone Wash Sample (ml) X Acetone Blank Particulate Residue (mg/ml)

Probe, Cyclone, and Flask Wash

49.2 mg = 56.4 mg - (268 ml X .027 mg/ml)

Impinger Wash

11.5 mg = 18.9 mg - (275 ml X .027 mg/ml)

Weight of Particulate Collected (mg)			
Container No.	Final Weight	Tare Weight	Weight Gain
1 Filter (s)			634.9 mg
2 Probe, Cyclone & Flask Wash			49.2 mg
TOTAL			684.1 mg

Wet Catch (mg)	
Container No.	Particulate Weight
5 Impinger Wash	11.5 mg
3 Impinger Condensate Suspended Solids	12.9 mg
3 Impinger Condensate Evaporated Solids	45.1 mg
TOTAL WET CATCH	69.5 mg

Volume of Condensate Collected (ml)				
Container Number	Final	Initial	Liquid Collected	
3 Impinger #1	531 ml	200 ml		331.0 ml
3 Impinger #2 & #3	492 ml	200 ml		292.0 ml
4 Silica Gel	1624.0g	1576.5g	47.5 g*	47.5 ml
TOTAL CONDENSATE VOLUME				670.5 ml

*Convert Weight of Water to Volume by dividing Total Weight increase by density of water (1 g./ml)

$$\frac{\text{Increase g.}}{\text{1 g./ml}} = \text{Volume Water ml.}$$

AIR-224 (3/7

NEW YORK STATE DEPARTMENT ENVIRONMENTAL CONSERVATION
AIR POLLUTION CONTROL PROGRAM

STACK SAMPLE COLLECTION DATA

Date	Name of Source	Address of Source	FILTER NOS.	CONDENSATE; milliliters			SILICA GEL
11-6-75	Dunkirk Radiator Corp	Middle Rd Dunkirk		Impinger	No. 1	No. 2	
Description of Installation: Cupola	Tested by: NYSDEC R-9	Run No.: 3	9-141	Final	273 258	182 310	834.0 [illegible]
Sample Box No.: K-9	Meter Box No.: R-9	Meter ΔH in. Hg: 2.033	C factor: .63	Initial	200	200	809.9 [illegible]
Meter Box Setting, °F: 300°	Probe Length, ft.: 3'	Nozzle Diameter, in.: 3/8	Probe Heater Setting, °F: 6 Amps	Difference	331	292	24.1 [illegible]

Sample Point No.	Clock Time min.	Sampling Time (t), min.	Dry Gas Meter Reading cf	Pitot Δp in. water	Orifice ΔH in. water	Dry Gas Meter Temperature, °F In	Dry Gas Meter Temperature, °F Out	Stack Temp. °F	Vacuum at Pump in. Hg	Sample Box Temp. °F	Impinger Temp. °F	Stack Pressure in. Hg	Stack Gas Velocity fps
N-1	10:16	0	444.850	.22	2.45	69	64	193	4	230	58	-.08	
2		5	448.82	.26	2.95	83	66	193	7	250	58	-.09	
3		10	453.10	.27	3.05	90	68	193	11	255	66	-.10	
4		15	457.45	.30	3.40	97	71	193	16	265	90+	-.10	
5		20	462.26	.31	3.50	101	75	194	20	270	81	-.11	
6	11:20	25	466.842 467.211	.32	3.60	74	70	197	4	235	51	-.13	
		30	472.055		Change		Port						
6	11:29	0	472.055	.31	3.40	79	70	197	5	240	58	-.13	
5		5	476.74	.31	3.40	87	71	196	8	255	60	-.12	
4		10	481.48	.30	3.30	92	73	195	10	250	75	-.16	
3	11:49	15	486.172	.31	3.40	84	72	193	13	255	51	-.16	
2		20	490.9[illegible]	.30	3.30	91	73	193	16	255	61	-.11	
1		25	495.62	.28	3.10	93	74	192	18	255	71	-.10	
		30	500.218		END	OF	TEST						
[illegible]			[illegible]	[illegible]	[illegible]	[illegible]		[illegible]					

CHANGE BOX + LEAK CHECK

-.369 CF

STACK TEST CALCULATION WORK SHEET

Firm: DUNKIRK RADIATOR CORP Test Date 11-7-75

Source: Cupola Scrubber Run No. 4

From Field Data Sheets (AIR 224)

From Analytical Data Sheet (AIR 224.1)

V_m = 54.661 C.F.

θ = 60 min.

P_{bar} = 29.31 in. Hg

P_s = 29.30 in. Hg

T_s = 191 °F + 460 = 651 °R

T_m = 86 °F + 460 = 546 °R

Ave$\sqrt{\Delta p}$ = .559 in. H_2O

ΔH = .328 in. H_2O

V_{lc} = 55.3 mL

A_n = .00077 Sq. ft.

M_n = 477.0 mg

9AIR201.02 (6/74)

STACK TEST CALCULATION WORK SHEET

Firm: Dunkirk Radiator Corp. Test Date 11-7-75

Source: Cupola Scrubber. Run No. 4

Dry Gas Volume (Standard Conditions) (SCF)

$$V_{m_{std}} = V_m (17.71) \left[\frac{P_{bar} + \frac{\Delta H}{13.6}}{T_m} \right]$$

$$= 54.661 (17.71) \left[\frac{29.31 + \frac{3.28}{13.6}}{546} \right]$$

$$= 52.394 \text{ S.C.F.}$$

Volume of Water Vapor (Standard Conditions) (SCF)

$$V_{w_{std}} = V_{l_c} (0.0474)$$

$$= 551.3 (0.0474)$$

$$= 26.132 \text{ S.C.F.}$$

9AIR201.03 (6/74)

STACK TEST CALCULATION WORKSHEET

Firm: DUNKIRK RADIATOR Corp Test Date 11-7-75

Source: Cupola Scrubber Run No. 4

Moisture Content

$$B_{wo} = \frac{V_{w_{std}}}{V_{w_{std}} + V_{m_{std}}} \times 100 = \%$$

$$= \frac{26.132}{26.132 + 52.394} \times 100$$

$$= .333 \text{ or } 33.3\%$$

Dry Molecular Weight (lb/lb - mole)

$$M_d = .44\ (\%\ CO_2) + .32\ (\%\ O_2) + .28\ (\%\ CO + \%\ N_2)$$

$$= .44(13.1) + .32(4.3) + .28(6.1 + 76.5)$$

$$= 30.27 \text{ lb/lb-mole.}$$

9AIR201.04 (6/74)

STACK TEST CALCULATION WORK SHEET

Firm: Dunkirk Radiator Corp Test Date 11-7-75

Source: Cupola Scrubber Run No. 4

Molecular Weight of Stack Gas (Wet Basis) (lb/lb - mole)

$$M_s = M_d (1-B_{wo}) + 18 B_{wo}$$

$$= 30.27(1-.333) + 18(.333)$$

$$= 26.18 \text{ Lb/Lb-mole}$$

Average Stack Gas Velocity (feet per second)

$$V_s = K_p C_p (\sqrt{\Delta p})_{Ave} \sqrt{\frac{T_s}{P_s M_s}}$$

$$= 85.48(.815)(.559)\sqrt{\frac{651}{29.30 \times 26.18}}$$

$$= 35.876 \text{ FPS}$$

9AIR201.05 (6/74)

STACK TEST CALCULATION WORK SHEET

Firm: Dunkirk Radiator Corp. Test Date 11-7-75

Source: Cupola Scrubber Run No. 4

Area of stack (ft^2)

$$A = \frac{\frac{\pi d^2}{4}}{144}$$

$$= \frac{\pi (42)^2/4}{144}$$

$$= 9.62 \ ft^2$$

Volumetric Flow Rate (Wet Basis) (Standard Conditions) (cu. ft./hr)

$$Q'_s = 3600 \ (V_s) \ (A) \left(\frac{T_{std}}{(T_s)}\right)\left(\frac{P_s}{P_{std}}\right)$$

$$= 3600 \ (35.876)(9.62)\left(\frac{530}{651}\right)\left(\frac{29.30}{29.92}\right)$$

$$= 990563.9 \ cu\ ft/hr.$$

9AIR201.06 (6/74)

STACK TEST CALCULATION WORK SHEET

Firm: Dunkirk Radiator Corp Test Date 11-7-75

Source Cupola Scrubber Run No. 4

Concentration in grains per standard cubic foot (gr/scf)

$$C'_s = .0154\left(\frac{M_n}{V_{m_{std}}}\right)$$

$$= .0154\left(\frac{477.0}{52.394}\right)$$

$$= .1402 \text{ gr/scf}$$

Total Volume Sampled (Standard Conditions) (SCF)

$$V_{total} = V_{m_{std}} + V_{w_{std}}$$

$$= 52.394 + 26.132$$

$$= 78.526 \text{ SCF}$$

9AIR201.07 (6/74)

STACK TEST CALCULATION WORK SHEET

Firm: Dunkirk Radiator Test Date 11-7-75

Source: Cupola Scrubber Run No. 4

Emission Rate in Pounds Per Hour (lb/hr)

$$W'_s = \frac{(1.0 \text{ lb}/454{,}000 \text{ mg})\ M_n}{V_{total}}\ Q's$$

$$= \frac{(1.0/454{,}000)\ 477.0}{78.526} \times 990563.9$$

$$= 13.25 \text{ Lb/hr.}$$

Isokinetic Variation (Percent)

$$I = \left[\frac{V_{total}\ (T_s)}{A_n\ V_s\ P_s\ \theta}\right] \left(\frac{29.92}{530}\right) \left(\frac{1}{60}\right) 100$$

$$= \left[\frac{(78.526)(651)}{(.00077)(35.876)(29.30)(60)}\right] \left(\frac{29.92}{530}\right)\left(\frac{1}{60}\right) 100$$

$$= 99.0\ \%$$

9ATR201.08 (1/76)

Dunkirk Radiator Date 11-7-75

Dunkirk, New York

Cupola Scrubber

Tested by NYSDEC R-9 Sample No. 4

Test No.	Orsat Reading	% CO_2	Orsat Reading	% O_2	Orsat Reading	% CO	% N_2
1	13.0	13.0	17.3	4.3	23.2	5.9	76.8
2	13.1	13.1	17.4	4.3	23.5	6.1	76.5
3	13.1	13.1	17.4	4.3	23.7	6.3	76.3
AVE		13.1		4.3		6.1	76.5

ANALYTICAL DATA

Plant Dunkirk Radiator Corp.
Source Cupola Scrubber
Date 11-7-75 Run No. 4

Correction for Acetone Particulate Content

Net Acetone Wash Particulate Weight (mg) = Evaporated Solids from Acetone Washings (mg) - Volume of Acetone Wash Sample (ml) X Acetone Blank Particulate Residue (mg/ml)

Probe, Cyclone, and Flask Wash

52.3 mg = 59.7 mg - (275 ml X .027 mg/ml)

Impinger Wash

6.4 mg = 11.8 mg - (200 ml X .027 mg/ml)

Weight of Particulate Collected (mg)			
Container No.	Final Weight	Tare Weight	Weight Gain
1 Filter (s)			424.7 mg
2 Probe, Cyclone & Flask Wash			52.3 mg
TOTAL			477.0 mg

Wet Catch (mg)	
Container No.	Particulate Weight
5 Impinger Wash	6.4 mg
3 Impinger Condensate Suspended Solids	8.0 mg
3 Impinger Condensate Evaporated Solids	37.6 mg
TOTAL WET CATCH	52.0 mg

Volume of Condensate Collected (ml)				
Container Number	Final	Initial	Liquid Collected	
3 Impinger #1	589 ml	200 ml		389.0 ml
3 Impinger #2 & #3	226 ml	100 ml		126.0 ml
4 Silica Gel	1817.7 g	1781.4 g	36.3 g*	36.3 ml
TOTAL CONDENSATE VOLUME				551.3 ml

*Convert Weight of Water to Volume by dividing Total Weight increase by density of water (1 g./ml)

$$\frac{\text{Increase g.}}{1\ \text{g./ml}} = \text{Volume Water ml.}$$

9AIR 224.1 (10/74)

AIR-224 (5/74)

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
AIR POLLUTION CONTROL PROGRAM

STACK SAMPLE COLLECTION DATA

Date	Name of Source	Address of Source	FILTER NOS.	CONDENSATE; milliliters			SILICA GEL
4-7-75	Dunkirk Radiator			Impinger	No. 1	No. 2	
Description of Installation: Cupola	Tested by: N.Y.S.D.E.C.	Run No. 4	9-143	Final	589	226	900.7 / 917.0
Sample Box No. R-9	Meter Box No. R-9	Meter ΔH in. Hg 2.033	C factor .60	Initial	200	100	879.9 / 901.5
Meter Box Setting, °F 300°	Probe Length, ft. 3'	Nozzle Diameter, in. 3/8	Probe Heater Setting, °F 6 amps	Difference	389	126	36.3
			OTHER #2 Probe (Glass)				

Sample Point No.	Clock Time min.	Sampling Time (t), min.	Dry Gas Meter Reading cf	Pitot Δp in. water	Orifice ΔH in. water	Dry Gas Meter Temperature, °F In	Dry Gas Meter Temperature, °F Out	Stack Temp. °F	Vacuum at Pump in. Hg	Sample Box Temp. °F	Impinger Temp. °F	Stack Pressure in. Hg	Stack Gas Velocity fps	
W-6	10:28	0	500.326	.33	3.50	79	71	191	7	250	65	-.13		
5		5	505.00	.34	3.60	86	72	191	9	260	65	-.14		
4		10	509.75	.33	3.50	92	73	189	11	255	65	-.12		
3		15	514.48	.29	3.00	97	76	190	11½	255	67	-.10		
2		20	518.88	.27	2.80	101	78	192	12	255	73	-.08		
1		25	523.15	.23	2.40	103	81	192	12½	255	72	-.04		
	10:58	30	527.126			Change	Port &	changed	Silica	Gel &	1st	impinger.		
						Leak	Test	OK	@ 25".					
W-6	11:16	0	527.800	.37	3.90	87	82	192	13	255	62	-.13		
5		5	533.65	.35	3.70	94	83	192	18	255	62	-.09		
4		10	537.76	.30	3.10	99	83	190	18½	255	62	-.11		
3		15	542.24	.31	3.20	103	85	193	21	260	64	-.13		
** 2		20	546.521	.34	3.60	87	83	193	5½	265	65	-.14		
** 1		25	551.10	.30	3.10	87	82	190	6	265	62	-.10		
	12:18	30	555.661	AVE .559	AVE 3.28	AVE 86		AVE 191				AVE .11		

* stop sampling at 11:21 - No steam plume - Resumed sampling 11:23

** stop to change Filters 11:39 - START 12:02

** stop sampling at 12:07 - No steam plume - resumed sampling 12:13

STACK TEST CALCULATION WORK SHEET

Firm: Dunkirk Radiator Corp Test Date 11-10-75

Source: Cupola Scrubber Run No. 5

From Field Data Sheets (AIR 224)

From Analytical Data Sheet (AIR 224.1)

V_m = 26.650 C.F.

θ = 30 min.

P_{bar} = 29.97 in. Hg

P_s = 29.96 in. Hg

T_s = 186 °F + 460 = 646 °R

T_m = 80 °F + 460 = 540 °R

Ave$\sqrt{\Delta p}$ = .534 in. H_2O

ΔH = 3.03 in. H_2O

V_{lc} = 274.1 mL

A_n = .00077 Sq. ft.

M_n = 300.2 mg

9AIR201.02 (6/74)

STACK TEST CALCULATION WORK SHEET

Firm: Dunkirk Radiator Corp. Test Date 11-10-75

Source: Cupola Scrubber Run No. 5

Dry Gas Volume (Standard Conditions) (SCF)

$$V_{m_{std}} = V_m (17.71) \left[\frac{P_{bar} + \frac{\Delta H}{13.6}}{T_m} \right]$$

$$= 26.650 (17.71) \left[\frac{29.97 + \frac{3.03}{13.6}}{540} \right]$$

$$= 26.389 \text{ SCF.}$$

Volume of Water Vapor (Standard Conditions) (SCF)

$$V_{w_{std}} = V_{1_c} (0.0474)$$

$$= 274.1 (0.0474)$$

$$= 12.992 \text{ SCF.}$$

9AIR201.03 (6/74)

STACK TEST CALCULATION WORKSHEET

Firm: Dunkirk Radiator Corp. Test Date 11-10-75

Source: Cupola Scrubber Run No. 5

Moisture Content

$$B_{wo} = \frac{V_{w_{std}}}{V_{w_{std}} + V_{m_{std}}} \times 100 = \%$$

$$= \frac{12.992}{12.992 + 26.389}$$

$$= .330 \text{ or } 33\%$$

Dry Molecular Weight (lb/lb - mole)

$$M_d = .44\ (\%\ CO_2) + .32\ (\%\ O_2) + .28\ (\%\ CO + \%\ N_2)$$

Average Dry Molecular Weight from Run 3, 4, & 6.

$M_{d_{Ave}}$ = 30.25 Lb/Lb-mole.

9AIR201.04 (6/74)

STACK TEST CALCULATION WORK SHEET

Firm: Dunkirk Radiator Corp. Test Date 11-10-75

Source: Cupola Scrubber Run No. 5

Molecular Weight of Stack Gas (Wet Basis) (lb/lb - mole)

$$M_s = M_d (1-B_{wo}) + 18 B_{wo}$$

$$= 30.25(1-.330) + 18(.330)$$

$$= 26.21 \text{ Lb/Lb-mole.}$$

Average Stack Gas Velocity (feet per second)

$$V_s = K_p C_p (\sqrt{\Delta p}) \text{ Ave} \sqrt{\frac{T_s}{P_s M_s}}$$

$$= 85.48(.815)(.534)\sqrt{\frac{646}{29.96 \times 26.21}}$$

$$= 33.742 \text{ fps.}$$

9AIR201.05 (6/74)

STACK TEST CALCULATION WORK SHEET

Firm: Dunkirk Radiator Corp. Test Date 11-10-75

Source Cupola Scrubber Run No. 5

Area of stack (ft^2)

$$A = \frac{\frac{\pi d^2}{4}}{144}$$

$$= \frac{\pi (42)^2/4}{144}$$

$$= 9.62 \ ft^2$$

Volumetric Flow Rate (Wet Basis) (Standard Conditions) (cu. ft./hr)

$$Q'_s = 3600 \ (V_s) \ (A) \left(\frac{T_{std}}{(T_s)}\right)\left(\frac{P_s}{P_{std}}\right)$$

$$= 3600(33.742)(9.62)\left(\frac{530}{646}\right)\left(\frac{29.96}{29.92}\right)$$

$$= 960001.62 \text{ cu ft./hr.}$$

9AIR201.06 (6/74)

STACK TEST CALCULATION WORK SHEET

Firm: Dunkirk Radiator Corp. Test Date 11-10-75

Source Cupola Scrubber Run No. 5

Concentration in grains per standard cubic foot (gr/scf)

$$C'_s = .0154\left(\frac{M_n}{V_{m_{std}}}\right)$$

$$= .0154\left(\frac{300.2}{26.389}\right)$$

$$= .1752 \text{ gr./scf.}$$

Total Volume Sampled (Standard Conditions) (SCF)

$$V_{total} = V_{m_{std}} + V_{w_{std}}$$

$$= 26.389 + 12.992$$

$$= 39.381 \text{ S.C.F.}$$

9AIR201.07 (6/74)

STACK TEST CALCULATION WORK SHEET

Firm: Dunkirk Radiator Corp Test Date 11-10-75

Source: Cupola Scrubber Run No. 5

Emission Rate in Pounds Per Hour (lb/hr)

$$W'_s = \frac{(1.0 \text{ lb}/454{,}000 \text{ mg})\ M_n}{V_{total}}\ Q'_s$$

$$= \frac{(1.0/454{,}000)\ 300.2}{39.381} \times 960001.62$$

$$= 16.12 \text{ lb/hr.}$$

Isokinetic Variation (Percent)

$$I = \left[\frac{V_{total}\ (T_s)}{A_n\ V_s\ P_s\ \theta}\right] \left(\frac{29.92}{530}\right) \left(\frac{1}{60}\right) 100$$

$$= \left[\frac{(39.381)(646)}{(.00077)(33.142)(29.96)(30)}\right] \left(\frac{29.92}{530}\right) \left(\frac{1}{60}\right) 100$$

$$= 102.5\%$$

9ATR201.08 (1/76)

ANALYTICAL DATA

Plant Dunkirk Radiator Corp.
Source Cupola Scrubber
Date 11-10-75 Run No. 5

Correction for Acetone Particulate Content

Net Acetone Wash Particulate Weight (mg) = Evaporated Solids from Acetone Washings (mg) - Volume of Acetone Wash Sample (ml) X Acetone Blank Particulate Residue (mg/ml)

Probe, Cyclone, and Flask Wash

107.4 mg = 114.1 mg - (250 ml X .027 mg/ml)

Impinger Wash

2.8 mg = 9.5 mg - (250 ml X .027 mg/ml)

Weight of Particulate Collected (mg)			
Container No.	Final Weight	Tare Weight	Weight Gain
1 Filter (s)			192.8 mg
2 Probe, Cyclone & Flask Wash			107.4 mg
TOTAL			300.2 mg

Wet Catch (mg)	
Container No.	Particulate Weight
5 Impinger Wash	2.8 mg
3 Impinger Condensate Suspended Solids	1.7 mg
3 Impinger Condensate Evaporated Solids	16.1 mg
TOTAL WET CATCH	20.6 mg

Volume of Condensate Collected (ml)				
Container Number	Final	Initial	Liquid Collected	
3 Impinger #1	302 ml	100 ml	202.0 ml	
3 Impinger #2 & #3	156 ml	100 ml	56.0 ml	
4 Silica Gel	901.8 g	885.7 g	16.1 g*	16.1 ml
TOTAL CONDENSATE VOLUME				274.1 ml

*Convert Weight of Water to Volume by dividing Total Weight increase by density of water (1 g./ml)

$$\frac{\text{Increase g.}}{1\ \text{g./ml}} = \text{Volume Water ml.}$$

AIR-224 (3/7)

NEW YORK STATE DEPARTMENT ENVIRONMENTAL CONSERVATION
AIR POLLUTION CONTROL PROGRAM

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STACK SAMPLE COLLECTION DATA

Date	Name of Source	Address of Source	FILTER NOS.	CONDENSATE: milliliters			SILICA GEL
11-10-75	Dunkirk Radiator	Middle Rd Dunkirk		Impinger	No. 1	No. 2	
Description of Installation: Cupola Scrubber	Tested by: NYSDEC R-9	Run No. 5	9-145	Final	302	156	901.8
Sample Box No.: R-9	Meter Box No.: R-9	Meter ΔH in. Hg: 2.033		Initial	100	100	885.1
Meter Box Setting, °F: 30[illegible]	Probe Length, ft.: 3	Nozzle Diameter, in.: 3/8		Difference	202	56	16.1
Ambient Temp. °F: 68	Bar. Pres. in. Hg: 29.97	Assumed Moisture, %: 35					
Probe Heater Setting, °F: 6 Amps	OTHER: Probe #2						

Sample Point No.	Clock Time min.	Sampling Time (t), min.	Dry Gas Meter Reading cf	Pitot Δp in. water	Orifice ΔH in. water	Dry Gas Meter Temperature, °F In	Dry Gas Meter Temperature, °F Out	Stack Temp. °F	Vacuum at Pump in. Hg	Sample Box Temp. °F	Impinger Temp. °F	Stack Pressure in. Hg	Stack Gas Velocity fps	
N-6	1014	0	555.926	.30	3.15	[illegible]	91	190	5	240	[illegible]	-.1		
5		5	561.44	.31	3.30	83	92	18[illegible]	[illegible]	[illegible]	[illegible]	-.13	Stopped	[illegible]
4	[illegible]	[illegible]	[illegible]	.33	3.50	92	94	182	9[illegible]	250	60	-.15	[illegible]	[illegible]
3		15	[illegible]	[illegible]	3.05	85	95	183	10	250	65	-.11	[illegible]	[illegible]
[illegible]		20	[illegible]	.25	2.75	[illegible]	[illegible]	186	10	255	[illegible]	[illegible]		
		25	578.60	.22	2.30	93	97	186	10	255	64	-.08		
		30	58[illegible]		End	of	North		Port					
	[illegible]	30	[illegible]	.52[illegible]	3.03	[illegible]		[illegible]				-.12		

STACK TEST CALCULATION WORK SHEET

Firm: Dunkirk Radiator Corp. Test Date 11-12-75

Source: Cupola Scrubber Run No. 6

From Field Data Sheets (AIR 224)

From Analytical Data Sheet (AIR 224.1)

V_m = 51.615 C.F.

θ = 60 min.

P_{bar} = 29.20 in. Hg

P_s = 29.19 in. Hg

T_s = 181 °F + 460 = 641 °R

T_m = 73 °F + 460 = 533 °R

Ave$\sqrt{\Delta p}$ = .533 in. H_2O

ΔH = 2.91 in. H_2O

V_{lc} = 564.9 mL

A_n = .00077 Sq. ft.

M_n = 461.5 mg

9AIR201.02 (6/74)

STACK TEST CALCULATION WORK SHEET

Firm: Dunkirk Radiator Corp. Test Date 11-12-75

Source: Cupola Scrubber Run No. 6

Dry Gas Volume (Standard Conditions)* (SCF)

$$V_{m_{std}} = V_m (17.71) \left[\frac{P_{bar} + \frac{\Delta H}{13.6}}{T_m} \right]$$

$$= 51.615 (17.71) \left[\frac{29.20 + \frac{2.91}{13.6}}{533} \right]$$

$$= 50.445 \text{ SCF}$$

Volume of Water Vapor (Standard Conditions) (SCF)

$$V_{w_{std}} = V_{l_c} (0.0474)$$

$$= 564.9 (0.0474)$$

$$= 26.776 \text{ SCF}$$

9AIR201.03 (6/74)

STACK TEST CALCULATION WORKSHEET

Firm: Dunkirk Radiator Corp Test Date 11-12-75

Source: Cupola Scrubber Run No. 6

Moisture Content

$$B_{wo} = \frac{V_{w_{std}}}{V_{w_{std}} + V_{m_{std}}} \times 100 = \%$$

$$= \frac{26.776}{26.776 + 50.445} \times 100$$

$$= .347 \text{ or } 34.7\%$$

Dry Molecular Weight (lb/lb - mole)

$$M_d = .44\ (\%\ CO_2) + .32\ (\%\ O_2) + .28\ (\%\ CO + \%\ N_2)$$

$$= .44(12.8) + .32(4.3) + .28(6.9 + 76.0)$$

$$= 30.22 \text{ Lb/Lb-mole}$$

9AIR201.04 (6/74)

STACK TEST CALCULATION WORK SHEET

Firm: Dunkirk Radiator Corp. Test Date 11-12-75

Source: Cupola Scrubber Run No. 6

Molecular Weight of Stack Gas (Wet Basis) (lb/lb - mole)

$$M_s = M_d (1-B_{wo}) + 18 B_{wo}$$

$$= 30.22(1-.347) + 18(.347)$$

$$= 25.98 \text{ lb/lb-mole}$$

Average Stack Gas Velocity (feet per second)

$$V_s = K_p C_p (\sqrt{\Delta p}) \text{ Ave} \sqrt{\frac{T_s}{P_s M_s}}$$

$$= 85.48(.815)(.533)\sqrt{\frac{641}{29.19 \times 25.98}}$$

$$= 34.138 \text{ f.p.s.}$$

9AIR201.05 (6/74)

STACK TEST CALCULATION WORK SHEET

Firm: Dunkirk Radiator Corp. Test Date 11-12-75

Source Cupola Scrubber Run No. 6

Area of stack (ft^2)

$$A = \frac{\frac{\pi d^2}{4}}{144}$$

$$= \frac{\pi (42)^2/4}{144}$$

$$= 9.62 \ ft^2$$

Volumetric Flow Rate (Wet Basis) (Standard Conditions) (cu. ft./hr)

$$Q'_s = 3600 \ (V_s) \ (A) \left(\frac{T_{std}}{(T_s)}\right)\left(\frac{P_s}{P_{std}}\right)$$

$$= 3600 (34.138)(9.62)\left(\frac{530}{641}\right)\left(\frac{29.19}{29.92}\right)$$

$$= 953687.29 \ cu.ft./hr.$$

9AIR201.06 (6/74)

STACK TEST CALCULATION WORK SHEET

Firm: Dunkirk Radiator Corp Test Date 11-12-75

Source Cupola Scrubber Run No. 6

Concentration in grains per standard cubic foot (gr/scf)

$$C'_s = .0154\left(\frac{M_n}{V_{m_{std}}}\right)$$

$$= .0154\left(\frac{461.5}{50.445}\right)$$

$$= .1409 \text{ gr/scf.}$$

Total Volume Sampled (Standard Conditions) (SCF)

$$V_{total} = V_{m_{std}} + V_{w_{std}}$$

$$= 50.445 + 26.776$$

$$= 77.221 \text{ SCF.}$$

9AIR201.07 (6/74)

STACK TEST CALCULATION WORK SHEET

Firm: Dunkirk Radiator Corp. Test Date 11-12-75

Source: Cupola Scrubber Run No. 6

Emission Rate in Pounds Per Hour (lb/hr)

$$W'_s = \frac{(1.0 \text{ lb}/454{,}000 \text{ mg})\ M_n}{V_{total}}\ Q's$$

$$= \frac{(1.0/454{,}000)\,461.5}{77.221} \times 953687.29$$

$$= 12.55 \text{ lb/hr}$$

Isokinetic Variation (Percent)

$$I = \left[\frac{V_{total}\ (T_s)}{A_n\ V_s\ P_s\ \theta}\right] \left(\frac{29.92}{530}\right) \left(\frac{1}{60}\right) 100$$

$$= \left[\frac{(77.221)(641)}{(.00077)(34.138)(29.19)(60)}\right] \left(\frac{29.92}{530}\right) \left(\frac{1}{60}\right) 100$$

$$= 101.2\ \%$$

9ATR201.08 (1/76)

ORSAT ANALYSIS WORK

Name of Firm: Dunkirk Radiator Corp Date: 11-12-75

Address of Firm: Dunkirk New York

Description of equipment: Cupola Scrubber

Tested by: NYSDEC R-9 Sample No. 6

Remarks:

Test No.	Orsat Reading	% CO_2	Orsat Reading	% O_2	Orsat Reading	% CO	% N_2	
1	12.7	12.7	16.8	4.1	23.7	6.9	76.3	
2	13.0	13.0	17.3	4.3	24.2	6.9	75.8	
3	12.8	12.8	17.2	4.4	24.0	6.8	76.0	
Ave.		12.8		4.3		6.9	76.0	

AIR

ANALYTICAL DATA

Plant DUNKIRK RADIATOR CORP.
Source CUPOLA SCRUBBER
Date 11-12-75 Run No. 6

Correction for Acetone Particulate Content

Net Acetone Wash Particulate Weight (mg) = Evaporated Solids from Acetone Washings (mg) - Volume of Acetone Wash Sample (ml) X Acetone Blank Particulate Residue (mg/ml)

Probe, Cyclone, and Flask Wash

33.3 mg = 44.4 mg - (300 ml X .027 mg/ml)

Impinger Wash

3.98 mg = 13.7 mg - (360 ml X .027 mg/ml)

Weight of Particulate Collected (mg)			
Container No.	Final Weight	Tare Weight	Weight Gain
1 Filter (s)			428.2 mg
2 Probe, Cyclone & Flask Wash			33.3 mg
TOTAL			461.5 mg

Wet Catch (mg)	
Container No.	Particulate Weight
5 Impinger Wash	3.98 mg
3 Impinger Condensate Suspended Solids	4.2 mg
3 Impinger Condensate Evaporated Solids	31.4 mg
TOTAL WET CATCH	39.58 mg

Volume of Condensate Collected (ml)				
Container Number	Final	Initial	Liquid Collected	
3 Impinger #1	590 ml	200 ml		390.0 ml
3 Impinger #2 & #3	241 ml	100 ml		141.0 ml
4 Silica Gel	1797.5 g	1763.6 g	33.9 g*	33.9 ml
TOTAL CONDENSATE VOLUME				564.9 ml

*Convert Weight of Water to Volume by dividing Total Weight increase by density of water (1 g./ml)

$$\frac{\text{Increase g.}}{1\ \text{g./ml}} = \text{Volume Water ml.}$$

9AIR 224.1 (10/74)

AIR-224 (3/7

NEW YORK STATE DEPARTMENT ENVIRONMENTAL CONSERVATION
AIR POLLUTION CONTROL PROGRAM

Pg 1 of 1

STACK SAMPLE COLLECTION DATA

Date	Name of Source	Address of Source	Run No.
11-12-75	Dunkirk Radiator Corp	Dunkirk	6

Description of Installation: Cupola Scrubber

Tested by: NYSDEC R-9

Sample Box No.	Meter Box No.	Meter ΔH in. Hg	C factor	Ambient Temp. °F	Bar. Pres. in. Hg	Assumed Moisture, %
R-9	R-9	2.053	.60	59	29.20	35

Meter Box Setting, °F	Probe Length, ft.	Nozzle Diameter, in.	Probe Heater Setting, °F	OTHER
300°	3'	3/8"	6 Amp	Probe #2 (Glass)

FILTER NOS.: 9-146, 9-147

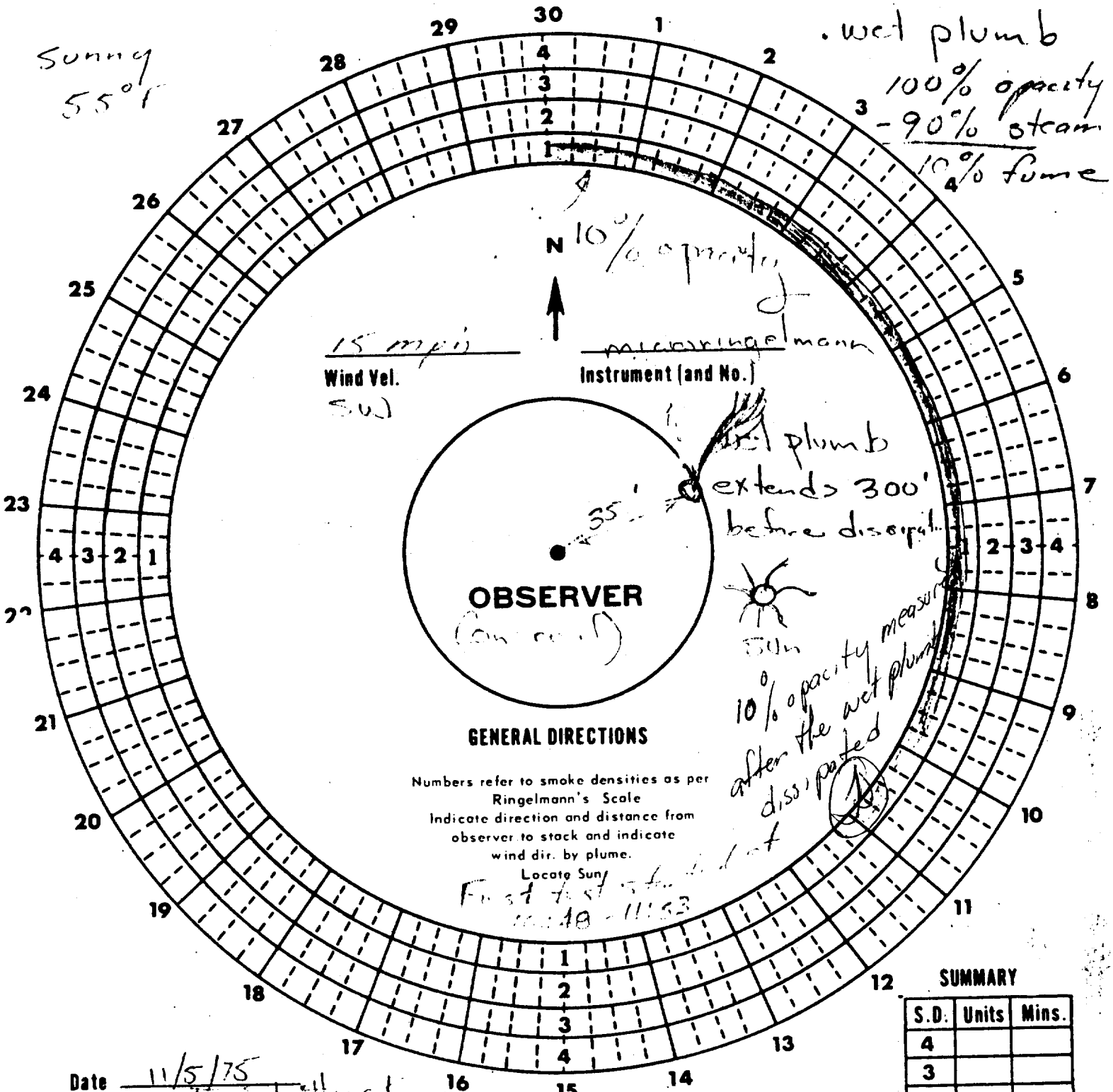
CONDENSATE: milliliters			SILICA GEL
Impinger	No. 1	No. 2	
Final	590	241	899.5 / 897.5 / 898.4
Initial	200	100	885.2
Difference	390	141	21.3 / 12.6

Sample Point No.	Clock Time min.	Sampling Time (t), min.	Dry Gas Meter Reading cf	Pitot Δp in. water	Orifice ΔH in. water	Dry Gas Meter Temperature, °F In	Dry Gas Meter Temperature, °F Out	Stack Temp. °F	Vacuum at Pump in. Hg	Sample Box Temp. °F	Impinger Temp. °F	Stack Pressure in. Hg	Stack Gas Velocity fps
N-6	10:20	0	583.027	.26	2.65	61	59	177	4	245	56	-.14	
5		5	587.27	.29	3.00	73	60	174	6	250	54	-.11	
4		10	591.60	.29	2.95	79	61	175	8	250	55	-.11	
3		15	595.83	.31	3.15	84	64	174	10	250	61	-.11	
2		20	600.21	.29	2.95	88	66	176	12	255	55	-.09	
1		25	604.55	.24	2.45	91	68	178	12½	255	70	-.07	
		30	608.602		End	of	Port						
Leak Check		Change	Filter 9-147	1st	Impinger	-	Silica	Gel					Shut down at 5 min 0 sec
N-6	11:59	0	608.814	.29	2.95	61	[illegible]	181	5	[illegible]	60	-.14	
5	12:13	5	613.50	[illegible]	[illegible]	[illegible]	[illegible]	182	7	275	65	-.12	
4	12:18	10	617.78	.31	3.15	83	65	185	8	275	57	-.13	Ditto at 14 min 5 sec
3	12:20 (Restart) 12:21	15	622.31	.29	2.95	83	67	185	8½	275	58	-.12	
2		20	626.76	.28	2.85	90	69	187	10½	275	59	[illegible]	
1		25	630.95	.23	2.35	93	70	187	10	275	62	-.08	
		30	634.954		End	of	Test						
			51.82 − .212 CF (Leak Check)										
			[illegible]										

New York State
DIVISION AIR RESOURCES

Department of Environmental Conservation
SMOKE OBSERVATION FORM

Sunny
55°F



wet plumb
100% opacity
-90% steam
10% fume

First test started at
10:48 - 11:53

SUMMARY

S.D.	Units	Mins.
4		
3		
2		
1		
TOTAL		

Date 11/5/75
Observer F. Shattuck
Hours' from 10:53 am to
NAME Dunkirk Radiator Corp
LOCATION Middle Rd Dunkirk Chautauqua Co
STACK DESCRIPTION 18 of the roof, metal 42 stack
venting iron cupola with high energy
scrubber

(10)

USE REVERSE FOR ADDITIONAL DATA

R 175 (7/68)

New York State

DIVISION AIR RESOURCES

Department of Environmental Conservation

SMOKE OBSERVATION FORM

T = 60°F

Sunny

95% opacity

- 85% steam

10% opacity

N

15 mph

Wind Vel.

SW

microringelman

Instrument (and No.)

35'

OBSERVER

on roof

10% opacity measured after the wet plume disappeared

Run # 2

scraped

GENERAL DIRECTIONS

Numbers refer to smoke densities as per Ringelmann's Scale

Indicate direction and distance from observer to stack and indicate wind dir. by plume.

Locate Sun

End test 1:14

stop 1:20 PM

SUMMARY

S.D.	Units	Mins.
4		
3		
2		
1		
TOTAL		

Date 11/5/95

Observer [illegible]

Hours' from [illegible] to

NAME [illegible]

LOCATION middle Rd [illegible]

STACK DESCRIPTION 18' stack off roof 12" diameter [illegible] through

USE REVERSE FOR ADDITIONAL DATA

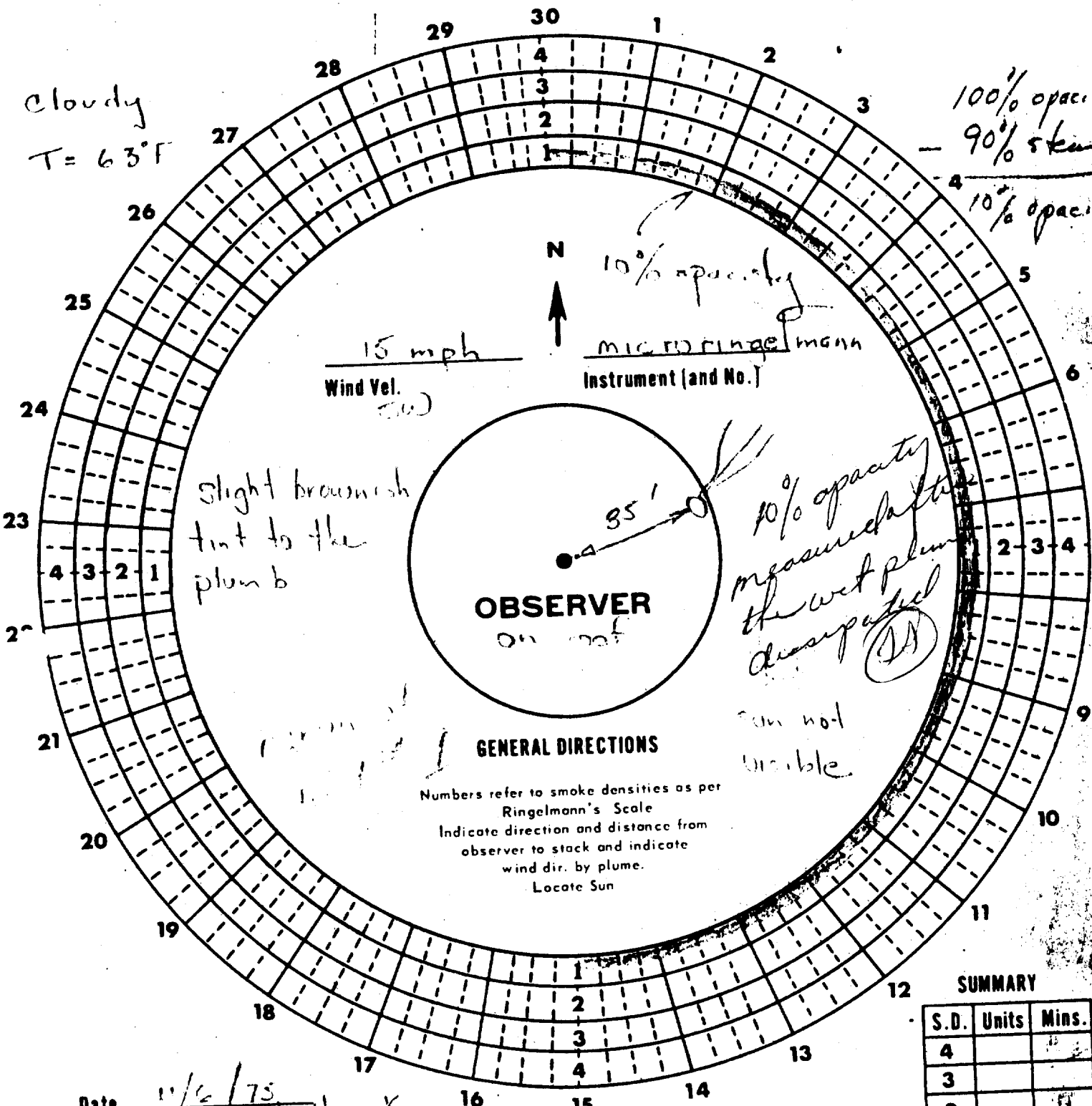
AIR 175 (7/68)

New York State
DIVISION AIR RESOURCES

Department of Environmental Conservation
SMOKE OBSERVATION FORM

Cloudy
T= 63°F

100% opacity
− 90% steam
10% opacity



SUMMARY

S.D.	Units	Mins.
4		
3		
2		
1		
TOTAL		

Date 11/6/75
Observer F Shattuck
Hours' from 11:41 to
NAME Dunkirk Radiator Corp.
LOCATION Middle Rd Dunkirk Chaut
STACK DESCRIPTION 18' steel stack off the roof 42" diameter [illegible] iron foundry

* [illegible] throughout the day

USE REVERSE FOR ADDITIONAL DATA

AIR 175 (7/68)

New York State

DIVISION AIR RESOURCES

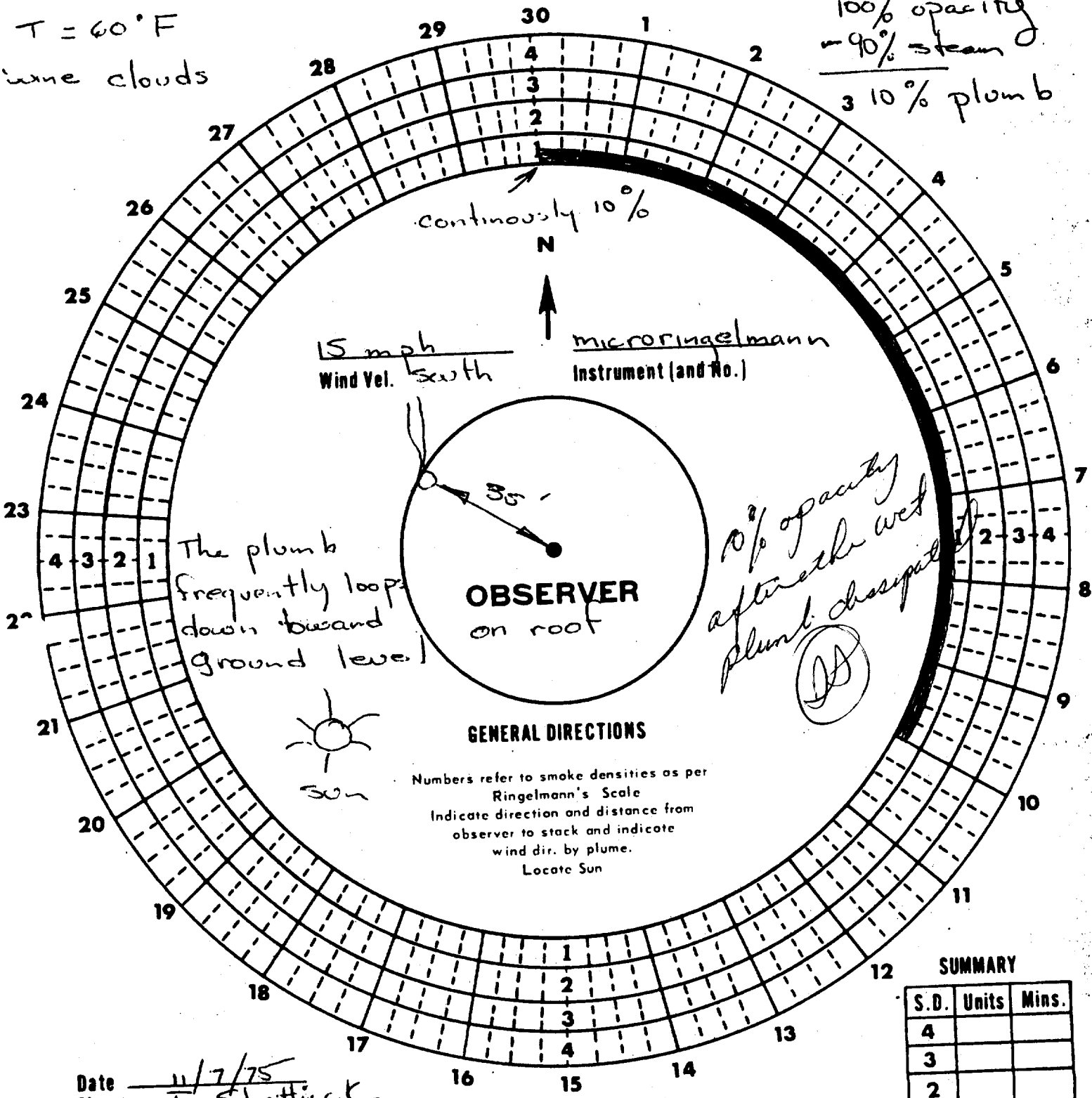
Department of Environmental Conservation

SMOKE OBSERVATION FORM

T = 60°F

some clouds

100% opacity
- 90% steam
3 10% plumb



SUMMARY

S.D.	Units	Mins.
4		
3		
2		
1		
TOTAL		

Date 11/7/75
Observer F. Shattuck
Hours' from 10:29 to 10:30 Am
NAME Dunkirk Radiator Corp
LOCATION Middle Rd Dunkirk Chautauqua Co
STACK DESCRIPTION 18' stack above the roof 42" metal stack which vents grey iron foundry with venturi scrubber

USE REVERSE FOR ADDITIONAL DATA

AIR 175 (7/68)

New York State

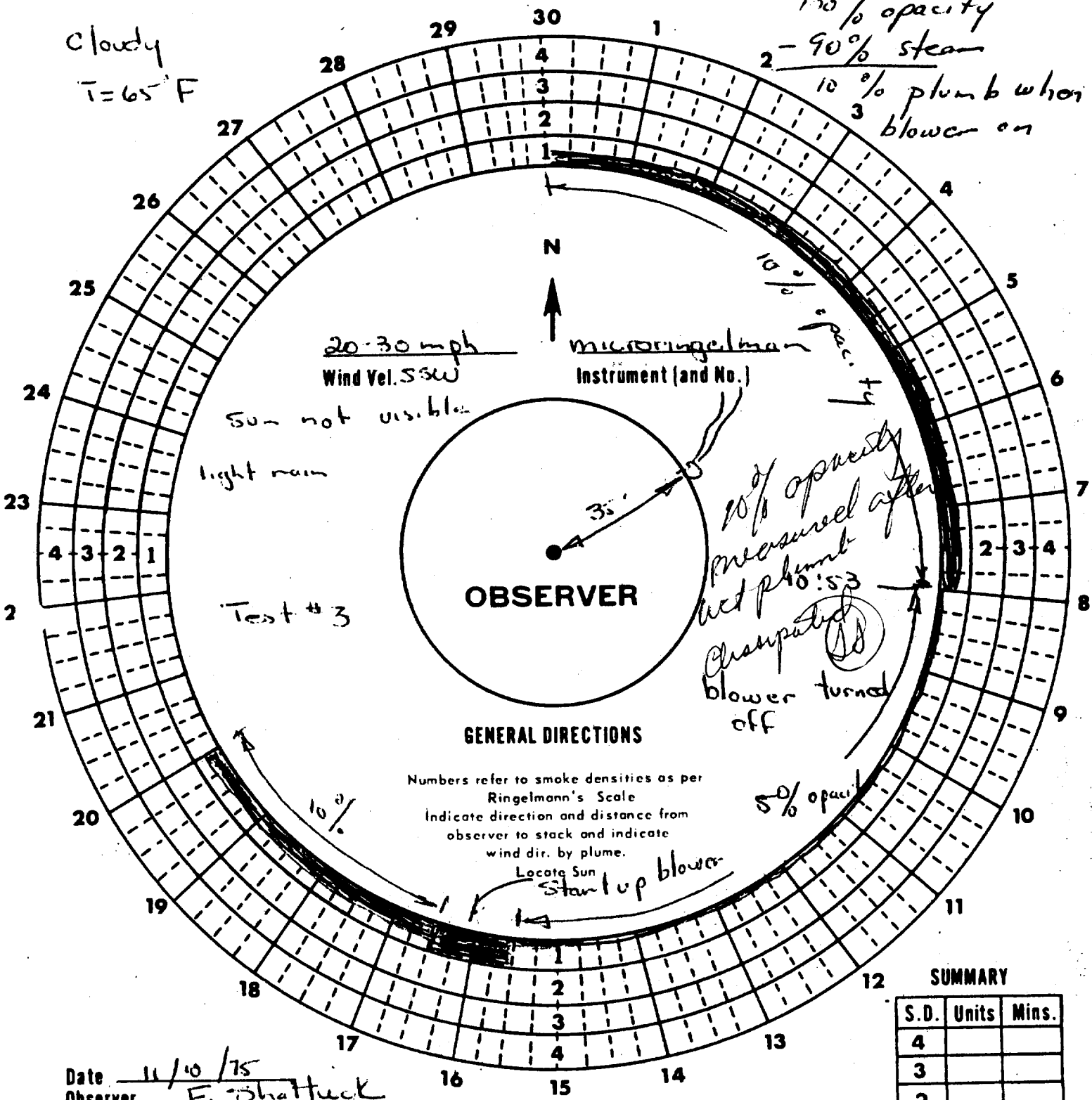
DIVISION AIR RESOURCES

Department of Environmental Conservation

SMOKE OBSERVATION FORM

Cloudy
T=65°F

100% opacity
- 90% steam
10% plume when blower on



SUMMARY

S.D.	Units	Mins.
4		
3		
2		
1		
TOTAL		

Date 11/10/75
Observer F. Shattuck
Hours' from 10:45 to 11:05 Am

NAME Dunkirk Radiator Corp
LOCATION Middle Rd Dunkirk Chautauqua County
STACK DESCRIPTION 15' above the roof metal stack 42" diameter venting grey iron cupola with venturi scrubber

USE REVERSE FOR ADDITIONAL DATA

AIR 175 (7/68)

Test run #3 on 11/10/75
Dunkirk Radiator Corp
Dunkirk

by F. Shattuck

The following is a summary of the DEC test #3 preform on the subject date:

During the first half of the test the tyre blower had to be shut off since the firm was melting metal faster than it could be poured into the ladles. During this period we stopped testing. When the blower was turned off the wet plumb disappeared and the opacity dropped to 5%. The firm was turned off at 10:53 Am. At 11:00 Am the blower was again turned on. Four a period of 1 minute the opacity was 20% without a wet plumb. The the steam appeared and the plumb was 10% opacity without the steam. The plumb usally is a constant 10% opacity

At the start of the second half of the test it began to rain very hard. The ~~[illegible]~~ ~~[illegible]~~ cam down for a few minutes. The winds then pick up ~~[illegible]~~ ~~[illegible]~~ to the point where it was unsafe to be on the platform. I stopped the test and we brought the equipment down

Frank Shattuck

New York State
DIVISION AIR RESOURCES

Department of Environmental Conservation
SMOKE OBSERVATION FORM

T = 55 °F
cloudy
light mist

100% opacity
-90% steam
3 10% plume

10% opacity

N

15 mph
Wind Vel. South

microringelmann
Instrument (and No.) equivalent

wet plume

35'

OBSERVER
on roof

Run #3
(second half)

GENERAL DIRECTIONS

Numbers refer to smoke densities as per Ringelmann's Scale
Indicate direction and distance from observer to stack and indicate wind dir. by plume.
Locate Sun

SUMMARY

S.D.	Units	Mins.
4		
3		
2		
1		
TOTAL		

Date 11/12/75
Observer F. Shattuck
Hours' from 10:21 to 10:33 Am
NAME Dunkirk Radiator Corp
LOCATION Middle Rd Dunkirk Chautauqua Co
STACK DESCRIPTION 18' above roof metal stack venting 42" diameter from grey iron foundry with scrubber

41

USE REVERSE FOR ADDITIONAL DATA

Nov 6, 1975

6 15	Pollution on
7 20 am	Coke in; fire on # 2600
7 55	Wind on; 350 lbs/m
8 05	Wind ↑ 700 lbs/m
9 10	Wind off
9 10	Charging starts
9 30	Wind on; 700+ lbs/m
9 48	Tap out; cap spray on
2 00	Charge stopped
2 15	Wind off
2 28	bottom dropped
3 00	pollution stopped
	# charges: 62

Pig	700
Scrap	700
Remelt	600
Coke	260
Si C	20
Fe Mn	2
Limestone	75
	2357

For:
Frank Shattuck

Nov 7, 1975

6:55 am	Fire on; 2600#
7:45	Wind on; 350 lbs/min
8:00	Wind full ↑; 700+ lbs/min
8:15	Wind off ↓
8:35	Charging started
9:03	Wind on; 700+ lbs/min
9:19	Taps out
9:23	Cap opening on
1:45 pm	Cut iron
2:00	Wind off
2:00	Cap up
2:20	Bottom dropped
2:30	Pallition off
	No of Charges: 70

Pig	700
Scrap	700
Remelt	600
Coke	260
Fe C	20
Fe Mn	2
Limestone	75
	2357

→ Frank

RDPHL
Water
Air ✓
Gen
Circ
File

Nov 10, 1975

7 30 am	Fire on; 2600# coke
8 00	Wind on; 350 lbs/min
8 05	Wind full; 700+ lbs/min
8 15	Wind off
8 30	Charging Started
8 55	Wind on
9 15	Tap out
9 20	Cap Spray on
1 10 pm	Cut in
1 37	Wind off
1 50	Cap up
2 01	Bottom dipped
2 30	Pollution off
	No of Charges 61

Pig	700
Scrap	700
Remelt	600
Coke	260
Si C	20
Fe Mn	2
Limestone	75
	2357

fes

RECEIVED
NOV 1 1975
N. Y. S. DEPT. OF
ENVIRONMENTAL CONSERVATION
REGION 9 HEADQUARTERS

att: Frank Shattuck

→ Frank

RDPHE
Water ✓
Air
Gen
Circ.
File

Nov 12, 1975

Charge
Same composition and weight

7 00 pm	Fire on; 2600# coke
7 40	Wind on; 400 lbs/min
8 00	Balance of coke added (2600#) Wind increased to 700+ lbs/min
8 20	Wind off
8 30	Charging starts
8 58	Wind on full 700+ lbs/min
9 14	Tap out; cap spray on
1 10 pm	Charging stops
1 40	Wind off
1 50	Cap up
2 07	Bottom dropped

No of charges: 70

RECEIVED
NOV 14 1975
N. Y. S. DEC
ENVIRONMENTAL CO
REGION 9 HEADQU

att: Frank Shattuck

Mr. Hanson - Syracuse Lab
Mr. Armbrust - Region 9 Office
Stack Samples for Analysis, Dunkirk Cupola Scrubber Stack

November 17, 1975

Stack samples for the Dunkirk Cupola Scrubber Stack are enclosed for analysis. These samples were obtained by the Region 9 test team from 11/6 to 11/12/75.

The following samples are included for analysis:

Dunkirk Cupola Scrubber Stack

11/6/75	Run #3	Filter #9-141 9-142
Quantity		**Sample**
3		Impinger catbh condensate
1		Impinger wash acetone
1		Probe wash acetone
11/7/75	Run #4	Filter #9-143 9-144
2		Impinger catch condensate
1		Impinger wash acetone
1		Probe wash acetone
11/10/75	Run #5	Filter #9-145
1		Impinger catch acetone
1		Impinger wash condensate
1		Probe wash acetone
11/12/75	Run #6	Filter #9-146 9-147
2		Impinger catch condensate
1		Impinger catch acetone
1		Probe wash acetone

1 Gallon Glass Jar - Silica Gel to be dried and returned for reuse.

1 Acetone Blank

Please notify the Region 9 Office of the results of this analysis. We also request that the empty sample bottles and Petri dishes be returned to this office for reuse.

DPB/lb
cc: Mr. McCabe

NEW YORK STATE DEPARTMENT OF HEALTH
DIVISION OF LABORATORIES AND RESEARCH
CENTRAL NEW YORK LABORATORY
677 SOUTH SALINA STREET, SYRACUSE 13202

Clear File

November 25, 1975

To: R. Armbrust, Region 9

From: A. Hanson A. H.

Subject: Particulate Results from Dunkirk Radiator, Cupola Scrubber Stack, Chautauqua County. Collected 11/6-12/1975.

Test Number	Filter Number	Sample Weight (milligrams)	Condensate Volume (ml.)	Evap'd Solids (milligrams)	Notes
3,4,5,6			175	4.7	Acetone blank
3	9-142	358.2			
3	9-141	276.7			
3			268	56.4	Probe wash
3			275	18.9	Impinger catch
3	M.F. #1	12.9			Impinger condensate, suspended solids
3			1010	45.1	Impinger condensate, evap'd solids
4	9-143	356.0			
4	9-144	68.7			
4			275	59.7	Probe wash
4			200	11.8	Impinger catch
4	M.F. #2	8.0			Impinger condensate, suspended solids
4			825	37.6	
5	9-145	192.8			
5			250	114.1	Probe wash
5			250	9.5	Impinger catch
5	M.F. #3	1.7			Impinger condensate, suspended solids
5			450	16.1	Impinger condensate, evap'd solids
6	9-146	242.4			
6	9-147	185.8			
6			300	41.4	Probe wash
6			360	13.7	Impinger catch
6	M.F. #4	4.2			Impinger condensate, suspended solids
6			825	31.4	Impinger condensate, evap'd solids

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NOV 26 1975
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ENVIRONMENTAL CONSERVATION
REGION 9 HEADQUARTERS

New York State Department of Environmental Conservation
584 Delaware Avenue, Buffalo, N.Y. 14202

Ogden Reid
Commissioner

Acting Regional Director
W. M. Friedman, P.E.

CUPOLA TESTING PROCEDURE

In performing or witnessing stack tests on cupolas, the following procedure shall be iollowed in obtaining the required samples to determine compliance with applicable air pollution rules.

All testing will be performed according to EPA approved testing methods. These methods are published in the Federal Register of December 23, 1971 and New York State Department of Environmental Conservation publications AIR 100.8 (12/73), AIR 200 (7/73), AIR 200.1 (3/73), AIR 200.3 (3/73), AIR 200.5 (3/73), and AIR 201 (12/73). Any deviations from these methods requires prior approval in writing from the New York State Department of Environmental Conservation Regional Office.

The required sampling will be identical for jobbing foundries and production foundries. The definitions of these two types of foundries are included in 6 NYCRR 213.

Three test runs will be required during the melt cycle of the cupola. 6 NYCRR 213 defines the melt cycle as "the time in which the metal is melting and available at the spout or tap hole, excluding any time the equipment is idle, preheating or preparing for shut down". The first of the test runs will be at the beginning of the melt cycle at the time the metal is available at the tap hole. The other two runs will be performed immediately following the first while still operating in the "melt cycle". Sampling for any test run must be completed within 15 minutes of the last charge to the cupola.

If any of the air pollution control equipment is not normally operated during the preheat phase of cupola operation, a second test consisting of three runs is required to be performed during this period with only the air pollution equipment normally operated for preheating in use. This test will begin when the tuyere blower is turned on to ignite the coke bed during the preheat phase and continue through the preheating whether or not the blower is operating.

Compliance will be determined by averaging the results of the three test runs and comparing these results with the allowable emissions based on process weight.

Process weight is all that material introduced into the cupola prior to and during the melt cycle. The process weight per hour equals the process weight divided by the time of the melt cycle. If the testing was performed on two or more days, the process weight used to determine the allowable input will be averaged for all the days during which testing was performed.