BACKGROUND DOCUMENT

REPORT ON REVISIONS TO 5\textsuperscript{TH} EDITION AP-42
CHAPTER 15 - ORDNANCE DETONATION

EMISSION FACTORS DEVELOPED BASED ON PHASE V-A TESTING
CONDUCTED AT DUGWAY PROVING GROUND, UTAH

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NOTICE

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**APPENDIX B:** NEW AP-42 SECTIONS FOR ORDNANCE INCLUDED IN PHASE V-A TESTING AT DUGWAY PROVING GROUND, UTAH
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1.0 INTRODUCTION

Due to the lack of credible data concerning emissions from training ordnance when used in their tactical configurations, the U.S. Army Environmental Command (USAEC) established a program to quantify emissions from the detonation of ordnance. This document presents background information concerning the development of air emission factors for five ordnance types used during training exercises at U.S. Army installations. The air emission factors were developed from test data collected by USAEC. Ordnance for which emission factors have been developed and their corresponding AP-42 sections are identified in Table 1. To help readers easily find those emission factors of interest, the ordnance are organized according to their Department of Defense Identification Code (DODIC).

### TABLE 1 ORDNANCE FOR WHICH EMISSION FACTORS WERE DEVELOPED

<table>
<thead>
<tr>
<th>DODIC</th>
<th>Ordnance Description</th>
<th>AP-42 Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>A365</td>
<td>M181A1 14.5-mm Artillery Training Cartridge</td>
<td>15.1.22</td>
</tr>
<tr>
<td>G930</td>
<td>AN-M8 Hexachloroethylene (HC) Smoke Hand Grenade</td>
<td>15.5.5</td>
</tr>
<tr>
<td>G982</td>
<td>M83 Terephthalic Acid (TA) Smoke Practice Hand Grenade</td>
<td>15.5.12</td>
</tr>
<tr>
<td>L592</td>
<td>TOW Blast Simulator</td>
<td>15.8.17</td>
</tr>
<tr>
<td>M630</td>
<td>M1 Pull Type Demolition Firing Device</td>
<td>15.9.20</td>
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</table>

The emission factors described in this document are based on data obtained during testing conducted at Dugway Proving Ground, Utah, as presented in the final test report titled Sampling Results for AEC Phase V Emission Characterization of Exploding Ordnance and Smoke/Pyrotechnics and the document titled Detailed Test Plan for Phase V Emission Characterization of Exploding Ordnance and Smoke/Pyrotechnics. These documents were supplemented by additional data provided by the testing contractor. For each ordnance, two test runs were conducted. Between one and twelve items were detonated per run, depending upon the ordnance tested. Source test protocols were developed by USAEC before any testing was conducted and were reviewed by the U.S. Environmental Protection Agency’s (EPA’s) Emission Measurement Center. The tests were conducted between November 11 and 18, 2003.

The compounds that were measured included carbon monoxide (CO), carbon dioxide (CO2), oxides of nitrogen (NOx), sulfur dioxide (SO2), total suspended particulate (TSP), particulate matter with an aerodynamic diameter less than or equal to 10 microns (PM-10), particulate matter with an aerodynamic diameter less than or equal to 2.5 microns (PM-2.5), metals, hydrogen chloride (HCl), chlorine (Cl2), ammonia (NH3), volatile organic compounds (VOC), semivolatile organic compounds (SVOC), dioxins/furans (PCDD/PCDF), aldehydes and carbonyls, energetic materials, hydrogen cyanide, perchlorate, and sulfur hexafluoride (SF6). Within each of the AP-42 sections, only emission factors for criteria pollutants, carbon dioxide, hazardous air pollutants (as defined by §112(b)(1) of the Clean Air Act [CAA]), and toxic chemicals (as defined by §313 of the Emergency Planning and Community Right-to-Know Act [EPCRA]) are presented.

The emission factors were developed on a “per item” basis and on a “per net explosive weight (NEW)” basis. Users should choose the appropriate emission factor to estimate emissions based upon the data available; either factor is equally valid. The NEW of each ordnance tested is provided in the corresponding AP-42 section and in Table 2.
TABLE 2  ORDNANCE NET EXPLOSIVE WEIGHT

<table>
<thead>
<tr>
<th>DODIC</th>
<th>Ordnance Description</th>
<th>NEW (lb/item)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A365</td>
<td>M181A1 14.5-mm Artillery Training Cartridge</td>
<td>1.60 E-02</td>
</tr>
<tr>
<td>G930</td>
<td>AN-M8 Hexachloroethane (HC) Smoke Hand Grenade</td>
<td>1.10</td>
</tr>
<tr>
<td>G982</td>
<td>M83 Terephthalic Acid (TA) Smoke Practice Hand Grenade</td>
<td>7.02 E-01</td>
</tr>
<tr>
<td>L592</td>
<td>TOW Blast Simulator</td>
<td>5.65 E-03</td>
</tr>
<tr>
<td>M630</td>
<td>M1 Pull Type Demolition Firing Device</td>
<td>5.70 E-05</td>
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*NEW values were obtained from Reference 4.

This document includes five sections in addition to this Introduction. Section 2 of this document identifies the compounds measured during the test program and describes the emission measurement methods used. Section 3 includes a discussion of the emission factor final test report and ratings for the test data contained therein. Section 4 describes the calculations and methodologies used to develop emission factors for each type of compound measured. Section 5 describes the methodology used to rate the emission factors and provides emission factor ratings for each type of compound measured. Section 6 includes a complete list of the references cited in this document.

There are two appendices included with this document. Appendix A identifies, by ordnance type, all of the compounds for which analyses were performed and the emission factors that were developed. [Note: Compounds present in the method blank at greater than 50 percent of test levels are excluded from Appendix A as described in Section 3.2.4.] Appendix A also identifies the minimum detection levels associated with all compounds that were not detected. Emission factors and minimum detection levels presented in Appendix A were determined from the most accurate method if two sampling or analytical methods were used to measure one compound. Appendix B presents the new AP-42 sections for the five ordnance that were tested.

In addition to this document, there are electronic databases available on the web (http://www.epa.gov/ttn/chief/ap42/index.html) that contain the data used in the development of the emission factors. The general procedures that were followed to develop these emission factors can be found at the same web address under the titles Procedures for Preparing Emission Factor Documents and Draft Detailed Procedures for Preparing Emission Factors.

2.0  COMPOUNDS MEASURED AND EMISSION MEASUREMENT METHODS

The USAEC Phase V-A series testing was conducted in the Smoke Characterization Test Chamber (Smoke Chamber) located at Dugway Proving Ground, Utah. The Smoke Chamber is an aluminum-lined chamber with an interior volume of approximately 820 cubic feet. The chamber is approximately 7 feet wide, 20 feet long, and 6 feet tall for 2/3 of its length and 5 feet tall for the remainder. During sampling, fans inside the chamber keep the gases mixed while stainless steel probes extract gas samples from the chamber through 12 sample ports. Gases extracted from the chamber are replaced by ambient air that enters the chamber through six ½-inch diameter vent lines that are distributed along one side of the chamber. An electrical firing circuit is used to remotely detonate the ordnance and release the tracer gas.

A number of different test methods were employed to collect and analyze the emission data that were used to develop emission factors for detonation of ordnance. Table 3 identifies each emission test
The method used; bracketed information identifies the purpose of using the method. The emissions data were collected using EPA test methods published in Title 40 of the Code of Federal Regulations, Part 50 (40 CFR 50); 40 CFR 60; and in Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air. Some of the sample analytical procedures used were from EPA Office of Solid Waste (OSW) publication SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods. Where necessary, the test methods were adapted to reflect application to the unique testing of ordnance detonation in the Smoke Chamber.

The following sections identify and briefly describe the test methods used to measure each compound or group of compounds. Additional information regarding the operation of the Smoke Chamber and the test methods used is presented in Reference 1. EPA-approved methods were used by the laboratories that provided sampling and analysis data.

**TABLE 3  SAMPLING AND ANALYTICAL METHODS USED**

<table>
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<tr>
<th>Compound</th>
<th>Test Method</th>
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<tr>
<td>CO</td>
<td>40 CFR 60, Appendix A, EPA Method 10 - <em>Determination of Carbon Monoxide Emissions from Stationary Sources</em> [sampling and analysis]</td>
</tr>
<tr>
<td>CO₂</td>
<td>40 CFR 60, Appendix A, EPA Method 3A - <em>Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)</em> [sampling and analysis]</td>
</tr>
<tr>
<td>NOₓ</td>
<td>40 CFR 60, Appendix A, EPA Method 7E - <em>Determination of Nitrogen Oxides Emissions from Stationary Sources (Instrumental Analyzer Procedure)</em> [sampling and analysis]</td>
</tr>
<tr>
<td>SO₂</td>
<td>40 CFR 60, Appendix A, EPA Method 6C - <em>Determination of Sulfur Dioxide Emissions from Stationary Sources (Instrumental Analyzer Procedure)</em> [sampling and analysis]</td>
</tr>
<tr>
<td>TSP</td>
<td>40 CFR 60, Appendix A, EPA Method 5 - <em>Determination of Particulate Matter from Stationary Sources</em> [sampling and analysis]</td>
</tr>
<tr>
<td>PM-10 and PM-2.5</td>
<td>40 CFR 51, Appendix A, EPA Method 201A - <em>Determination of PM-10 Emissions (Constant Sampling Rate Procedure)</em> [sampling and analysis]</td>
</tr>
<tr>
<td>Metals</td>
<td>Metal sample was obtained from TSP sample [sampling]</td>
</tr>
<tr>
<td></td>
<td>40 CFR 60, Appendix A, EPA Method 29 - <em>Determination of Metals Emissions from Stationary Sources</em> [analysis]</td>
</tr>
<tr>
<td></td>
<td>SW-846 Method 6010A - <em>Inductively Coupled Plasma-Atomic Emission Spectrometry</em> [analysis for metals except mercury]</td>
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<td></td>
<td>SW-846 Method 7470 - <em>Mercury in Liquid Waste (Manual Cold-Vapor Technique)</em> [analysis mercury]</td>
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<tr>
<td>HCl, Cl₂, and NH₃</td>
<td>40 CFR 60, Appendix A, EPA Method 26 - <em>Determination of Hydrogen Halide and Halogen Emissions from Stationary Sources (Non-Isokinetic Method)</em> [sampling]</td>
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<td></td>
<td>SW-846 Method 9057 - <em>Determination of Chloride from HCl/Cl₂ Emission Sampling Train (Methods 0050 and 0051) by Anion Chromatography</em> [analysis]</td>
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<td>VOC</td>
<td>EPA Compendium Method TO-12 - <em>Method for the Determination of Non-Methane Organic Compounds (NMOC) in Ambient Air Using Cryogenic Preconcentration and Direct Flame Ionization Detection (FID)</em> [sampling and analysis]</td>
</tr>
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<table>
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<tr>
<td>Speciated VOC</td>
<td>EPA Compendium Method TO-14 - Determination of Volatile Organic Compounds (VOCs) in Ambient Air Using SUMMA Passivated Canister Sampling and Gas Chromatographic Analysis [sampling and analysis]</td>
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<td>SVOC</td>
<td>SW-846 Method 0010 - Modified Method 5 Sampling Train [sampling]</td>
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<td></td>
<td>SW-846 Method 8270 - Semivolatile Organic Compounds by Gas Chromatography/ Mass Spectrometry (GC/MS) [analysis]</td>
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<td>Dioxins and Furans</td>
<td>40 CFR 60, Appendix A, EPA Method 23 - Determination of Polychlorinated Dibenzo-p-dioxins and Polychlorinated Dibenzofurans from Municipal Waste Combustors [sampling]</td>
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<td>SW-846 Method 8290 - Polychlorinated Dibenzodioxins (PCDDs) and Polychlorinated Dibenzofurans (PCDFs) by High-Resolution Gas Chromatography/High-Resolution Mass Spectrometry (HRGC/HRMS) [analysis]</td>
</tr>
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<td>Aldehydes and Carbyols</td>
<td>EPA Compendium Method TO-11A - Determination of Formaldehyde in Ambient Air Using Adsorbent Cartridge Followed by High Performance Liquid Chromatography (HPLC) [sampling and analysis]</td>
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<td>Energetic Materials</td>
<td>SW-846 Method 0010 - Modified Method 5 Sampling Train [sampling]</td>
</tr>
<tr>
<td></td>
<td>SW-846 Method 8095 - Explosives by Gas Chromatography [analysis]</td>
</tr>
<tr>
<td>Hydrogen Cyanide</td>
<td>EPA Conditional Test Method 033 - Sampling and Analysis for Hydrogen Cyanide Emissions from Stationary Sources [sampling and analysis]</td>
</tr>
<tr>
<td>Perchlorate</td>
<td>Perchlorate sample was obtained from TSP sample [sampling]</td>
</tr>
<tr>
<td></td>
<td>EPA Method 314 - Determination of Perchlorate in Drinking Water Using Ion Chromatography [analysis]</td>
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<tr>
<td>Tracer Compound (SF₆)</td>
<td>Grab sample [sampling]</td>
</tr>
<tr>
<td></td>
<td>Gas Chromatograph/Electron Capture Detector [analysis]</td>
</tr>
</tbody>
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2.1 Carbon Monoxide, Carbon Dioxide, Oxides of Nitrogen, and Sulfur Dioxide

Real-time concentrations of CO, CO₂, NOₓ, and SO₂ that resulted from the use of ordnance in the Smoke Chamber were measured using a continuous emissions measurement system (CEMS). CO sampling and analysis was conducted in accordance with 40 CFR Part 60, Appendix A, Method 10 - Determination of Carbon Monoxide Emissions from Stationary Sources. CO₂ sampling and analysis was conducted in accordance with 40 CFR Part 60, Appendix A, Method 10. NOₓ sampling and analysis was conducted in accordance with 40 CFR Part 60, Appendix A, Method 7E - Determination of Nitrogen Oxides Emissions from Stationary Sources. SO₂ sampling and analysis was conducted in accordance with 40 CFR Part 60, Appendix A, Method 6C - Determination of Sulfur Dioxide Emissions from Stationary Sources. For each run, the target minimum sampling time was 20 minutes.

2.2 Total Suspended Particulate

The TSP concentration that resulted from the use of ordnance in the Smoke Chamber was determined using a sampling and analysis procedure based on 40 CFR 60, Appendix A, EPA Method 5 -
Determination of Particulate Matter from Stationary Sources. During each run, duplicate samples were obtained using samplers operating simultaneously. For each run, the target minimum sampling time was 20 minutes. The TSP concentration was computed by dividing the mass of TSP collected by the volume of air sampled, corrected to standard conditions.

2.3 Particulate Matter with an Aerodynamic Diameter Less than or Equal to 10 or 2.5 Microns

The PM-10 and PM-2.5 concentrations that resulted from the use of ordnance in the Smoke Chamber were determined using a modified sampling and analysis procedure based on 40 CFR 51, Appendix A, Method 201A - *Determination of PM-10 Emissions (Constant Sampling Rate Procedure)*. The sample was collected using a short probe and two cyclones in series. Particles larger than 10 microns were removed in the first cyclone. Particles between 10 and 2.5 microns passed through the first cyclone but not the second. Particles smaller than 2.5 microns passed through the second cyclone and were captured on a filter. Each fraction was measured gravimetrically. The particulate concentrations were computed by dividing the mass of PM-10 and PM-2.5 collected by the volume of air sampled, corrected to standard conditions.

2.4 Metals

Metal concentrations that resulted from the use of ordnance in the Smoke Chamber were determined using particulate matter from the TSP samples collected as described in Section 2.2. After the TSP total weight gain was determined in the laboratory, a portion of the TSP filter was digested with concentrated hydrogen fluoride and nitric acid per 40 CFR 60, Appendix A, Method 29 - *Determination of Metals Emissions from Stationary Sources*. The digestate was then analyzed for metals (except mercury) using inductively coupled argon plasma (ICAP) emission spectroscopy in accordance with SW-846 Method 6010A - *Inductively Coupled Plasma-Atomic Emission Spectrometry*. Mercury was determined by cold vapor atomic absorption spectroscopy (CVAAS) in accordance with SW-846 Method 7470 - *Mercury in Liquid Waste (Manual Cold-Vapor Technique)*. The concentration of each target metal was computed by dividing the mass of metal collected by the volume of air sampled, corrected to standard conditions.

2.5 Hydrochloric Acid, Chlorine, and Ammonia

Hydrochloric acid (HCl), chlorine (Cl₂), and ammonia (NH₃) concentrations that resulted from the use of ordnance in the Smoke Chamber were sampled in accordance with 40 CFR Part 60, Appendix A, Method 26 - *Determination of Hydrogen Chloride Emissions from Stationary Sources*. During each run, chamber gases were pulled through two sets of impingers in series containing dilute sulfuric acid and sodium hydroxide solutions. Collected samples were analyzed using SW-846 Method 9057 - *Determination of Chloride from HCl/Cl₂ Emission Sampling Train (Methods 0050 and 0051) by Anion Chromatography*. The concentrations of HCl, Cl₂, and NH₃ were computed by dividing the mass collected by the volume of air sampled, corrected to standard conditions. For each run, the target minimum sampling time was 30 minutes.

2.6 Volatile Organic Compounds

VOC concentrations that resulted from the use of ordnance in the Smoke Chamber were determined using two methods from the Second Supplement to Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air: (1) Method TO-12 - Method for the Determination of Non-methane Organic Compounds in Ambient Air using Cryogenic Preconcentration and Direct Flame Ionization Detection and (2) Method TO-14 - Determination of Volatile Organic Compounds in Ambient Air Using SUMMA Passivated Canister Sampling and Gas Chromatographic...
Analysis. For both procedures, air samples were collected in stainless steel 6-liter SUMMA® canisters. Two or three identical canisters were used for each test run. The minimum sampling time for each VOC canister was 10 minutes.

2.7 Semivolatile Organic Compounds

SVOC concentrations that resulted from the use of ordnance in the Smoke Chamber were determined based on procedures found in SW-846 Method 0010 - Modified Method 5 Sampling Train. During each run, duplicate samples were collected using two PS-1 samplers that contained special sampling inlets (i.e., aluminum sampling modules) designed to hold 100-mm diameter quartz fiber filters to collect particulate matter, followed by XAD-2 adsorbent resin cartridges for collection of vapor phase SVOCs. A 20-minute sampling time was targeted. Following sampling, the filters and resin cartridges underwent solvent extraction and the mass of SVOC collected was quantitatively determined by GC/MS analysis following procedures in SW-846 Method 8270 - Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS). Unknown compounds, if any, were tentatively identified using computerized mass spectral matching techniques of the highest non-target “peaks.”

2.8 Dioxin and Furan Compounds

Dioxin and furan compound concentrations that resulted from the use of ordnance in the Smoke Chamber were determined based on procedures found in 40 CFR 60, Appendix A, EPA Method 23 - Determination of Polychlorinated Dibenzo-p-dioxins and Polychlorinated Dibenzofurans from Municipal Waste Combustors. During each run, duplicate samples were obtained using two modified PS-1 samplers. The modified samplers used standard quartz filters, but the adsorbent cartridges contained XAD-2 resin sandwiched between polyurethane foam (PUF) plugs. A minimum sampling time of 20 minutes was targeted. After sampling, the filters and adsorbent cartridges underwent extraction with the appropriate solvent(s). The mass of dioxin and furan compounds collected was quantitatively determined following SW-846 Method 8290 - Polychlorinated Dibenzodioxins (PCDDs) and Polychlorinated Dibenzofurans (PCDFs) by High-Resolution Gas Chromatography/High-Resolution Mass Spectrometry (HRGC/HRMS).

2.9 Aldehyde and Carbonyl Compounds

Aldehyde and carbonyl compound concentrations that resulted from the use of ordnance in the Smoke Chamber were determined using EPA Compendium Method TO-11A - Determination of Formaldehyde in Ambient Air Using Adsorbent Cartridge Followed by High Performance Liquid Chromatography (HPLC), but using modified sampling and analytical procedures. Dinitrophenylhydrazine (DNPH) laden cartridge tubes were used as a direct probe to trap and derivatize aldehyde and carbonyl compounds. A minimum sampling time of 20 minutes was targeted. Analysis was by HPLC with ultraviolet (UV) absorption detection.

2.10 Energetic Materials

Energetic compound concentrations that resulted from the use of ordnance in the Smoke Chamber were determined based on procedures found in SW-846 Method 0010 - Modified Method 5 Sampling Train. Samples were collected using combination quartz filter/adsorbent cartridges. The adsorbent cartridges contained XAD-2 polymeric resin beads. A minimum sampling time of 20 minutes was targeted. After sampling, the filters and adsorbent cartridge were extracted with acetonitrile. The effluent was then analyzed following the procedures outlined in SW-846 Method 8095 - Explosives by Gas Chromatography.
2.11 Hydrogen Cyanide

Hydrogen cyanide (HCN) concentrations that resulted from the use of ordnance in the Smoke Chamber were determined using EPA Conditional Test Method (CTM) 033 - *Sampling and Analysis for Hydrogen Cyanide Emissions from Stationary Sources*. The sample gas was drawn through a heated quartz-fiber filter and two impingers containing 0.1 normal sodium hydroxide (NaOH). A minimum sampling time of 20 minutes was targeted. The impinger solution and extracted filter were analyzed by ion chromotography.

2.12 Perchlorate

The perchlorate concentrations that resulted from the use of ordnance in the Smoke Chamber were determined based on the procedures in EPA Method 314 - *Determination of Perchlorate in Drinking Water Using Ion Chromatography*. The second of two quartz filters used to collect particulate matter was analyzed for perchlorate. Once weighed for TSP concentration, the perchlorates were leached from the filter by shaking small strips of the filter in reagent water for 1 hour. Ion chromatography was then used to analyze the digestate in accordance with EPA Method 314.

2.13 Tracer Compound

Sulfur hexafluoride (SF₆) was used as a tracer compound during each run to estimate the amount of sample dilution that occurred as a result of ambient air entering the Smoke Chamber during the run. Grab samples were collected five times during each run using evacuated canisters. A minimum sampling time of 2 minutes was targeted for each canister. The canisters were analyzed for the tracer compound using a GC with an electron capture detector.

3.0 TEST DATA ANALYSIS AND RATING

3.1 EPA Guidance Regarding Test Data Quality Ratings

Prior to inclusion of emission factors in AP-42, the reliability of the underlying emission test data must be appraised in accordance with the rating system specified in Reference 5. Under this rating system, test data are assigned a rating from A to D, where an “A” rating is assigned to the highest quality data. The criteria used to assign a specific data quality rating are summarized below.

A  Tests are performed by using an EPA reference test method, or when not applicable, a sound methodology. Tests are reported in enough detail for adequate validation and raw data are provided that can be used to duplicate the emission results presented in the report.

B  Tests are performed by a generally sound methodology, but lacking enough detail for adequate validation. Data are insufficient to completely duplicate the emission result presented in the report.

C  Tests are based on an unproven or new methodology, or are lacking a significant amount of background information.

D  Tests are based on a generally unacceptable method, but the method may provide an order-of-magnitude value for the source.

Four specific criteria are identified in Reference 5 for consideration to assist in the assignment of a test data quality rating. These four criteria are:
1. **Source operation.** If the manner in which the source was operated is well documented in the report and the source was operating within typical parameters during the test, an “A” rating should be assigned. If the report stated parameters that were typical, but lacked detailed information, a “B” rating should be assigned. If there is reason to believe the operation was not typical, a “C” or “D” rating should be assigned.

2. **Test methods and sampling procedures.** In developing the ratings, the estimated accuracy and precision of the test method as well as the adequacy of the documentation should be considered. In general, if a current EPA reference test method, appropriate for the source, was followed, the rating should be higher (“A” or “B”). If other methods were used, an assessment should be made of their validity. If it is judged that the method was likely to be inaccurate or biased, a lower rating (“C” or “D”) should be given. A complete report should indicate whether any procedures deviated from standard methods and explain any deviations. If deviations were reported, an evaluation should be made of whether these were likely to influence the test results.

3. **Process information.** During testing, many variations in the process can occur without warning and sometimes without being noticed. Such variations can induce wide deviations in sampling results. If a large variation between test run results cannot be explained by information contained in the site final test report or from test reports of other sources, the data are suspect and should be given a lower rating or excluded. However, it should be recognized that a process may have highly variable emissions and a lower rating may not be appropriate solely on the basis of wide deviations in sampling results.

4. **Analysis and calculations.** Ideally, final test reports should contain original raw data sheets and other documentation such as gas parameters (dry cubic feet per minute, oxygen percentage), calculation sheets, or example calculations describing how the calculated emission results were obtained. If there are data sheets, the nomenclature and equations used should be compared to those specified by EPA to establish equivalency. The depth of review of the calculations should be dictated by the reviewers’ confidence in the ability and conscientiousness of the tester, based on such factors as consistency of results and completeness of other areas of the final test report. Reports may indicate that raw data sheets were available, but were not included. If the final test report is of high quality based on the other criteria, the quality rating should not be lowered due to a lack of data sheets.

An overall test data quality rating should be assigned based upon the ratings assigned for each of the four criteria.

### 3.2 Analysis of Test Data

Data included in the final test report were rated in accordance with the rating system described above. Results for each of the four criteria are presented in the following sections.

#### 3.2.1 Source Operations

The manner by which the ordnance were deployed (i.e., used) is documented in the final test report. Each of the ordnance that was tested was deployed in a manner similar to that which would occur in the field. The tests appear to have replicated typical ordnance operating parameters; consequently, the test data should be assigned an “A” rating based on this criterion.

#### 3.2.2 Test Methods and Sampling Procedures

The test methods and sampling procedures were evaluated as being appropriate and consistent with EPA test methods or sound methodology. Except as noted below, no problems of any significance were identified; consequently, the test data should be assigned an “A” rating based on this criterion.
3.2.2.1 CEMS-Measured Data

Although summaries of the CEMS data were provided for the tests, raw CEMS data were not provided for the tests or for the pre- and post-test quality control (QC) activities. Furthermore, none of the calibration gas certifications were supplied. There was no evidence of bias in the data; however, based on the issues noted above, the test data for the CEMS-measured compounds (i.e., CO, CO₂, NOₓ, and SO₂) should be assigned a “B” rating based on this criterion.

3.2.2.2 Compounds Sampled or Analyzed Using More than One Test Method or Analytical Method

Fourteen compounds were either sampled or analyzed using two methods; these compounds are identified in Table 4. For each of these compounds, emission factors were calculated based upon the data measured using the more appropriate test or analytical method; data measured using the less appropriate method were ignored. The more appropriate method was identified by reviewing the methods and the target compound lists associated with each method. If a specific compound appeared on the target compound list for one method but not the other, the method targeting the compound was selected. If a specific compound appeared on the target compound lists for both methods, the method judged to provide the most accurate data was selected.

### TABLE 4 SELECTED SAMPLING OR ANALYTICAL METHOD FOR COMPOUNDS MEASURED USING TWO SAMPLING OR ANALYTICAL METHODS

<table>
<thead>
<tr>
<th>Compound</th>
<th>Selected Method</th>
<th>Other Method Employed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butyraldehyde</td>
<td>TO-11A (Aldehydes)</td>
<td>TO-14 (VOC)</td>
</tr>
<tr>
<td>1,2-Dichlorobenzene</td>
<td>TO-14 (VOC)</td>
<td>SW8270 (SVOC)</td>
</tr>
<tr>
<td>1,3-Dichlorobenzene</td>
<td>TO-14 (VOC)</td>
<td>SW8270 (SVOC)</td>
</tr>
<tr>
<td>1,4-Dichlorobenzene</td>
<td>TO-14 (VOC)</td>
<td>SW8270 (SVOC)</td>
</tr>
<tr>
<td>1,3-Dinitrobenzene</td>
<td>SW8095 (Energetics)</td>
<td>SW8270 (SVOC)</td>
</tr>
<tr>
<td>2,4-Dinitrotoluene</td>
<td>SW8095 (Energetics)</td>
<td>SW8270 (SVOC)</td>
</tr>
<tr>
<td>2,6-Dinitrotoluene</td>
<td>SW8095 (Energetics)</td>
<td>SW8270 (SVOC)</td>
</tr>
<tr>
<td>Hexachlorobutadiene</td>
<td>TO-14 (VOC)</td>
<td>SW8270 (SVOC)</td>
</tr>
<tr>
<td>Naphthalene</td>
<td>SW8270 (SVOC)</td>
<td>TO-14 (VOC)</td>
</tr>
<tr>
<td>Nitrobenzene</td>
<td>SW8095 (Energetics)</td>
<td>SW8270 (SVOC), TO-14 (VOC)</td>
</tr>
<tr>
<td>1,2,4-Trichlorobenzene</td>
<td>TO-14 (VOC)</td>
<td>SW8270 (SVOC)</td>
</tr>
<tr>
<td>Acetone</td>
<td>TO-11A (Aldehydes)</td>
<td>TO-14 (VOC)</td>
</tr>
<tr>
<td>p-Ethyltoluene</td>
<td>TO-14 (VOC)</td>
<td>TO-12 (VOC)</td>
</tr>
<tr>
<td>1,3,5-Trinitrobenzene</td>
<td>SW8095 (Energetics)</td>
<td>SW8270 (SVOC)</td>
</tr>
</tbody>
</table>
TABLE 4 (cont.)

a For DODICs G930 and L592, data analyzed using the TO-14 analytical method were used to develop emission factors because this compound had a relative percent difference greater than 100 percent between the TO-11A analytical results.
b For DODICs G982 and M630, data analyzed using the SW8270 analytical method were used to develop emission factors because this compound had a relative percent difference greater than 100 percent between SW8095 analytical results.
c For DODICs A365, G930, and L592, data analyzed using the SW8270 analytical method were used to develop emission factors because this compound had a relative percent difference greater than 100 percent between SW8095 analytical results.
d For DODIC G930, data analyzed using the SW8270 analytical method were used to develop emission factors because this compound had a relative percent difference greater than 100 percent between SW8095 analytical results.
e For DODIC A365, data analyzed using the TO-14 analytical method were used to develop emission factors because this compound had a relative percent difference greater than 100 percent between TO-11A analytical results.

For compounds analyzed using both the TO-11A (aldehydes) and TO-14 (VOC) methods, the TO-11A method analysis was judged to be more accurate and was selected. For compounds analyzed using both the TO-12 (VOC) and TO-14 (VOC) methods, the TO-14 method analysis was judged to be more accurate and was selected. For compounds analyzed using both the SW8270 (SVOC) and TO-14 (VOC) methods, the TO-14 method analysis was judged to be more accurate and was selected. [Note: Naphthalene was analyzed using both SW8270 (SVOC) and TO-14 (VOC), but only appears on the target compound list for SW8270; therefore, this method analysis was selected.] For compounds analyzed using both the SW8270 (SVOC) and SW8095 (energetics) methods, the SW8095 method analysis was judged to be more accurate and was selected.

Occasionally, the compound measurement from the less accurate method was chosen because the compound had poor precision between test runs for the sampling method that would have been more accurate under normal circumstances. These cases are noted in the footnotes to Table 4.

3.2.2.3 Tentatively Identified Compounds

During the analysis of the VOC and SVOC data, the highest nontarget “peaks” were tentatively identified using computerized mass spectral matching techniques. Emission factors were developed for these tentatively identified compounds (TICs) if all of the following criteria were met.

1. The TIC corresponded to a unique compound (e.g., fluorene). Emission factors were not developed if the TIC corresponded to a class of compounds (e.g., unknown alcohol).
2. The TIC was not identified using another analysis method that provided higher confidence data. Emission factors were developed based upon the higher confidence analysis method if such data were available.
3. The TIC was not present in the method blank. Emission factors were not developed if the TIC was found in the corresponding method blank.

The number of VOC that were tentatively identified as unique compounds, were not identified using a higher confidence method, and were not present in the method blank varied from zero to four compounds per ordnance. The number of SVOC that were tentatively identified as unique compounds, were not identified using a higher confidence method, and were not present in the method blank varied from one to 29 compounds per ordnance. Emission factors were developed for all of these
TICs, but because of the uncertainty in the true identity of the TICs, the test data were assigned a “C” rating.

3.2.3 Process Information

Ordinance are manufactured to tight tolerances and are expected to deploy in a very repeatable fashion. Consequently, the test data should be assigned an “A” rating based upon this criterion. However, large relative percent differences (i.e., greater than 100 percent) between test runs or sample trains were noted for several compounds. Specific instances in which these differences were noted are identified in Table 5. The equation below illustrates calculation of relative percent difference:

\[
\text{relative percent difference} = \frac{\text{test 1 concentration} - \text{test 2 concentration}}{\text{average of test 1 and test 2 concentrations}} \times 100\%
\]

Due to the large relative percent differences between test runs, the test data specifically identified in Table 5 were assigned a “C” rating. The remainder of the data should be assigned an “A” rating based on this criterion.

**TABLE 5** COMPOUNDS FOR WHICH LARGE RELATIVE PERCENT DIFFERENCES WERE NOTED BETWEEN TEST RUNS OR SAMPLE TRAINS

<table>
<thead>
<tr>
<th>Compound</th>
<th>Applicable DODIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetaldehyde</td>
<td>L592</td>
</tr>
<tr>
<td>Ammonia</td>
<td>G982</td>
</tr>
<tr>
<td>Antimony</td>
<td>G930, G982</td>
</tr>
<tr>
<td>Barium</td>
<td>G982</td>
</tr>
<tr>
<td>Carbon tetrachloride</td>
<td>G930</td>
</tr>
<tr>
<td>Chloroform</td>
<td>G930</td>
</tr>
<tr>
<td>Copper</td>
<td>G982</td>
</tr>
<tr>
<td>Crotonaldehyde</td>
<td>A365, M630</td>
</tr>
<tr>
<td>Formaldehyde</td>
<td>A365, L592</td>
</tr>
<tr>
<td>1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin</td>
<td>G930, L592</td>
</tr>
<tr>
<td>1,2,3,4,6,7,8-Heptachlorodibenzofuran</td>
<td>G930, L592</td>
</tr>
<tr>
<td>1,2,3,4,7,8,9-Heptachlorodibenzofuran</td>
<td>G930</td>
</tr>
<tr>
<td>Hexachlorobenzene</td>
<td>G930</td>
</tr>
<tr>
<td>Hexachlorocyclopentadiene</td>
<td>G930</td>
</tr>
<tr>
<td>1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin</td>
<td>L592</td>
</tr>
<tr>
<td>1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin</td>
<td>L592</td>
</tr>
<tr>
<td>1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin</td>
<td>L592</td>
</tr>
<tr>
<td>1,2,3,4,7,8-Hexachlorodibenzofuran</td>
<td>G930</td>
</tr>
<tr>
<td>1,2,3,6,7,8-Hexachlorodibenzofuran</td>
<td>G930, L592</td>
</tr>
<tr>
<td>1,2,3,7,8,9-Hexachlorodibenzofuran</td>
<td>G930, L592</td>
</tr>
<tr>
<td>Compound</td>
<td>Applicable DODIC</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>2,3,4,6,7,8-Hexachlorodibenzofuran</td>
<td>G930</td>
</tr>
<tr>
<td>Hexachloroethane</td>
<td>G930</td>
</tr>
<tr>
<td>Hydrochloric acid</td>
<td>G982, L592</td>
</tr>
<tr>
<td>Lead</td>
<td>G982</td>
</tr>
<tr>
<td>Methylene chloride</td>
<td>G930</td>
</tr>
<tr>
<td>Nitroglycerin</td>
<td>A365, G930</td>
</tr>
<tr>
<td>1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin</td>
<td>G930, L592</td>
</tr>
<tr>
<td>1,2,3,4,6,7,8,9-Octachlorodibenzofuran</td>
<td>G930</td>
</tr>
<tr>
<td>Pentachlorobenzene</td>
<td>G930</td>
</tr>
<tr>
<td>1,2,3,7,8-Pentachlorodibenzo-p-dioxin</td>
<td>L592</td>
</tr>
<tr>
<td>1,2,3,7,8-Pentachlorodibenzofuran</td>
<td>G930</td>
</tr>
<tr>
<td>2,3,4,7,8-Pentachlorodibenzofuran</td>
<td>G930</td>
</tr>
<tr>
<td>Propionaldehyde</td>
<td>L592, M630</td>
</tr>
<tr>
<td>Selenium</td>
<td>G982</td>
</tr>
<tr>
<td>2,3,7,8-Tetrachlorodibenzo-furan</td>
<td>G930</td>
</tr>
<tr>
<td>Thallium</td>
<td>A365</td>
</tr>
<tr>
<td>Trichloroethylene</td>
<td>G930</td>
</tr>
<tr>
<td>2,4,5-Trichlorophenol</td>
<td>G982</td>
</tr>
<tr>
<td>2,4,6-Trichlorophenol</td>
<td>G930</td>
</tr>
<tr>
<td>Vinyl chloride</td>
<td>L592</td>
</tr>
<tr>
<td>Acetone</td>
<td>L592, M630</td>
</tr>
<tr>
<td>4-Amino-2,6-dinitrotoluene</td>
<td>G930, G982, M630</td>
</tr>
<tr>
<td>Benzaldehyde</td>
<td>L592</td>
</tr>
<tr>
<td>Chloroacetonitrile</td>
<td>G930</td>
</tr>
<tr>
<td>2,6-Dichlorophenol</td>
<td>G930</td>
</tr>
<tr>
<td>Hexachloropropene</td>
<td>G930</td>
</tr>
<tr>
<td>Hexaldehyde</td>
<td>G982, L592</td>
</tr>
<tr>
<td>HMX</td>
<td>L592, M630</td>
</tr>
<tr>
<td>Isovaleraldehyde</td>
<td>L592</td>
</tr>
<tr>
<td>Magnesium</td>
<td>G982</td>
</tr>
<tr>
<td>N-Nitrosomethylethylamine</td>
<td>G930</td>
</tr>
<tr>
<td>4-Nitrotoluene</td>
<td>A365, G982, L592</td>
</tr>
<tr>
<td>PETN</td>
<td>G930, M630</td>
</tr>
</tbody>
</table>
### TABLE 5 (cont.)

<table>
<thead>
<tr>
<th>Compound</th>
<th>Applicable DODIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>RDX</td>
<td>G930, G982, M630</td>
</tr>
<tr>
<td>1,2,4,5-Tetrachlorobenzene</td>
<td>G930</td>
</tr>
<tr>
<td>2,3,4,6-Tetrachlorophenol</td>
<td>G930</td>
</tr>
<tr>
<td>Tetryl</td>
<td>G982, L592, M630</td>
</tr>
<tr>
<td>o,m,p-Tolualdehyde</td>
<td>G982, L592</td>
</tr>
<tr>
<td>2,4,6-Trinitrotoluene</td>
<td>G982, M630</td>
</tr>
<tr>
<td>Valeraldehyde</td>
<td>G982, L592</td>
</tr>
</tbody>
</table>

#### 3.2.4 Analysis and Calculations

The test report, detailed test plan, and analytical data supporting the test report were reviewed to determine whether they contained all of the original raw data, other documentation, and example calculations. Although the test report did not contain raw field data, the data were made available upon request. The test report also lacked certain calibration data. However, the missing information was judged insufficient to result in a downgrade of the test data quality rating.

The raw data and sample calculations presented in the final test report, detailed test plan, and analytical data supporting the test report were reviewed to determine if the emission factors presented in the report could be duplicated. Where differences were found between the emission factors calculated using the Excel spreadsheets and those presented in the test report, an examination was made to determine the reason for the differences.

Several minor errors were noted in the calculation of the emission factors within the test report, particularly with respect to the incorporation of “0” values into the emission factors (see Section 4.4) and the net explosive weight assumed for each ordnance. The emission factors presented in AP-42 are based upon the corrected spreadsheets. Based upon the raw data, other documentation, and the Excel spreadsheet calculations, the test data should be assigned an “A” rating.

Emission factors developed for compounds present in the method blank at levels of 20 percent to 50 percent of both test values were assumed to be biased high. Antimony met this criterion for DODIC G930 and 1,2,3,4,6,7,8,9-octachlorodibenzo-p-dioxin met this criterion for DODIC A365. The test data for both of these compounds were assigned “B” ratings.

When compounds were found in the method blank at levels greater than 50 percent of both test values, the data were assumed to be suspect and no emission factors were developed. Several compounds met this criterion and are identified in Table 6.
TABLE 6 COMPOUNDS FOUND IN THE METHOD BLANK AT LEVELS GREATER THAN 50 PERCENT OF BOTH TEST VALUES

<table>
<thead>
<tr>
<th>Compound</th>
<th>Applicable DODIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorine</td>
<td>A365, G982, L592, M630</td>
</tr>
<tr>
<td>1,2,3,4,7,8-Hexachlorodibenzofuran</td>
<td>L592</td>
</tr>
<tr>
<td>1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin</td>
<td>M630</td>
</tr>
<tr>
<td>2,3,7,8-Tetrachlorodibenzo-furan</td>
<td>A365</td>
</tr>
<tr>
<td>Diethylphthalate</td>
<td>A365, G930, G982, L592, M630</td>
</tr>
</tbody>
</table>

3.3 Test Data Quality Ratings

Upon completing the analysis described in the preceding section of this document, the test data quality ratings assigned as a result of the four criteria were reviewed. This review led to a downgrading of some of the test data from an “A” rating to either a “B” rating or a “C” rating. Table 7 identifies the data quality ratings for all compounds that did not receive an “A” rating.

TABLE 7 DOWNGRADED DATA QUALITY RATINGS

<table>
<thead>
<tr>
<th>Compound</th>
<th>Data Quality Rating</th>
<th>Applicable DODIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon dioxide</td>
<td>B</td>
<td>All DODICs</td>
</tr>
<tr>
<td>Carbon monoxide</td>
<td>B</td>
<td>All DODICs</td>
</tr>
<tr>
<td>Oxides of nitrogen</td>
<td>B</td>
<td>All DODICs</td>
</tr>
<tr>
<td>Sulfur dioxide</td>
<td>B</td>
<td>All DODICs</td>
</tr>
<tr>
<td>Acetaldehyde</td>
<td>C</td>
<td>L592</td>
</tr>
<tr>
<td>Acetic acid, chloro-</td>
<td>C</td>
<td>G982</td>
</tr>
<tr>
<td>Ammonia</td>
<td>C</td>
<td>G982</td>
</tr>
<tr>
<td>Antimony</td>
<td>C</td>
<td>G930, G982</td>
</tr>
<tr>
<td>Barium</td>
<td>C</td>
<td>G982</td>
</tr>
<tr>
<td>Benzene, pentachloro(trichloroethenyl)-</td>
<td>C</td>
<td>G930</td>
</tr>
<tr>
<td>Biphenyl</td>
<td>C</td>
<td>A365, G982, L592</td>
</tr>
<tr>
<td>Carbon tetrachloride</td>
<td>C</td>
<td>G930</td>
</tr>
<tr>
<td>Chloroform</td>
<td>C</td>
<td>G930</td>
</tr>
<tr>
<td>Copper</td>
<td>C</td>
<td>G982</td>
</tr>
<tr>
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4.0 EMISSION FACTOR CALCULATIONS

The methodologies and procedures that were used to develop emission factors from the test data are described in this section. A similar approach was used to calculate emission factors for TSP, PM-10, PM-2.5, metals, HCl, Cl₂, NH₃, SVOC, dioxin/furan compounds, aldehydes and carbonyls, energetic materials, hydrogen cyanide, and perchlorate. The calculation steps that were performed for each sampling train and each run are summarized below.

1. For compounds for which more than one test sample was obtained, analytical detection limits were incorporated into the test data.
2. The background compound concentration was calculated by dividing the mass of compound detected during the background run by the background run sample volume.
3. The test compound concentration was calculated by dividing the mass of compound detected during the test run by the test run sample volume.
4. A background-corrected concentration was calculated by subtracting the background concentration from the test concentration.
5. A dilution-corrected concentration was calculated by dividing the background-corrected concentration by the dilution correction factor.
6. The mass of compound released during the test run was calculated by multiplying the dilution-corrected concentration by the volume of the Smoke Chamber.
7. Emission factors for each sample and sampling train or test run were calculated by dividing the mass of compound released by the number of ordnance detonated during the test run or by the NEW detonated during the test run, as appropriate.
8. Average emission factors were calculated for each compound.

Because concentration data (i.e., milligrams per cubic meter [mg/m³], parts per million by volume [ppmv], or parts per billion by volume [ppbv]) were recorded for VOC and CEMS-measured compounds, it was not necessary to calculate background and test concentrations as described in steps 2 and 3. Detection limits were applied directly to test compound concentrations of VOC and CEMS-measured compounds, as described in step 1. Where present, ppmv and ppbv values were converted to mg/m³. Emission factors for VOC and CEMS-measured compounds were then estimated in accordance with steps 4 through 8 described above.

The following sections describe each of the eight emission factor calculation steps listed above in more detail.

4.1 Incorporation of Analytical Detection-Limits to the Test Data

In many cases, more than one test sample was obtained for a specific compound (i.e., more than one sample was obtained for a given test run or more than one test run was conducted). When multiple samples were obtained for the same compound, a comparison was made of all the sample data collected. Based upon the results of the comparison, the following adjustments were made to the test data:

1. If all of the samples indicated that a compound was “not detected,” the sample data were not adjusted.
2. If all of the samples indicated that a compound was detected, the sample data were not adjusted.
3. If one or more of the samples indicated that a compound was detected and one or more of the samples indicated that a compound was not detected, the “not detected” values were replaced.
with a value equal to one half of the compound’s analytical detection limit. The assumption inherent to this adjustment was that the measured presence of a compound in one or more samples was indicative of the compound’s presence in all samples. The analytical detection limits for each sample were obtained from the test report.

4.2 Determination of Background Concentration

For TSP, PM-10, PM-2.5, metals, HCl, Cl2, NH3, SVOC, dioxin/furan compounds, aldehydes and carbonyls, energetic materials, hydrogen cyanide, and perchlorate compounds, the background compound concentration (BC) was calculated by dividing the mass of compound detected during the background run (Bkgd mass) by the background run sample volume (Bkgd V). This calculation is illustrated by the following equation:

\[ BC = \frac{Bkgd \ mass}{Bkgd \ V} \]

For VOC compounds, the background run data were used directly. Background data for CEMS-measured compounds were recorded for each test run between the time the CEMS began sampling and the time of detonation. The background concentrations were assumed to equal representative values over the sampling period.

4.3 Determination of Test Compound Concentration

For TSP, PM-10, PM-2.5, metals, HCl, Cl2, NH3, SVOC, dioxin/furan compounds, aldehydes and carbonyls, energetic materials, hydrogen cyanide, and perchlorate compounds, the test compound concentration (TC) was calculated by dividing the mass of compound measured during the test run (Test mass) by the test run sample volume (Test V). This calculation is illustrated by the following equation:

\[ TC = \frac{Test \ mass}{Test \ V} \]

For VOC compounds, the test run data were used directly. For CEMS-measured compounds, the test compound concentration was determined as the arithmetic mean of the test data collected from the initial steady-state point until the end of the test.

4.4 Determination of Background-Corrected Concentration

For all compounds, the calculation of the background-corrected concentration (BCC) was dependent on whether the background (BC) and test (TC) concentrations were detected and whether they were less than, equal to, or greater than one another. The procedures used to calculate the background-corrected concentration for each sampling train and compound are described below and are displayed graphically in Figure 1.

1. If the test concentration was not detected (ND), the background-corrected concentration equaled ND.
2. If the test concentration was detected and the background concentration was not detected, the background-corrected concentration equaled the test concentration.
3. If the test and background concentrations were detected and the test concentration was less than or equal to the background concentration, the background-corrected concentration equaled 0.
Figure 1  Calculation of background-corrected concentration (BCC).

TC = Test Concentration
BC = Background Concentration
ND = Not Detected
BCC = Background-Corrected Concentration
4. If the test and background concentrations were detected and the test concentration was greater than the background concentration, the background concentration was subtracted from the test concentration. This calculation is illustrated by the following equation:

\[ BCC = TC - BC \]

4.5 Determination of Dilution-Corrected Concentration

The dilution-corrected concentration (DCC) was calculated by dividing the background-corrected concentration by the applicable dilution correction factor (DCF). This calculation is illustrated by the following equation:

\[ DCC = \frac{BCC}{DCF} \]

4.6 Determination of Mass of Compound Released

The mass of compound released was calculated by multiplying the dilution-corrected concentration by the volume of the Smoke Chamber. This calculation is illustrated by the following equation:

\[ \text{Mass compound released} = DCC \times \text{Smoke Chamber volume} \]

4.7 Determination of Emission Factors

Once the mass of compound released was calculated, two emission factors were developed for each sample or sampling train and for each test run: the mass of compound released per item (i.e., per single ordnance) and the mass of compound released per pound NEW. The NEW for all ordnance were determined from Reference 4.

4.8 Determination of Average Emission Factors

Steps 1 through 7, as described in Sections 4.1 through 4.7, are applicable to individual samples or sampling trains within individual test runs. The final step in the emission factor calculation process was to calculate average emission factors for each compound in terms of mass released per item and mass released per pound NEW. The average emission factors for each compound were calculated as the arithmetic mean of the individual samples associated with the compound. If all samples indicated that the compound was not detected (ND), then the average emission factor was assigned a value of ND. [Note: The minimum detection levels associated with the compounds that were not detected are presented in Appendix A.] Total dioxin/furan emission factors were calculated by summing the average emission factors for all dioxin/furan compounds.

5.0 EMISSION FACTOR RATINGS

The emission factors were appraised in accordance with the rating system specified in Reference 5. Under this rating system, emission factors are assigned a rating from A to E, where an “A” rating is assigned to the highest quality factors. The criteria used to assign a specific emission factor rating are summarized below.
A Excellent. The emission factor was developed primarily from A- and B-rated source test data taken from many randomly chosen facilities in the industry population. The source category population was sufficiently specific to minimize variability.

B Above average. The emission factor was developed primarily from A- or B-rated test data from a moderate number of facilities. Although no specific bias was evident, it was not clear if the facilities tested represented a random sample of the industry. As with the “A” rating, the source category population was sufficiently specific to minimize variability.

C Average. The emission factor was developed primarily from A-, B- and/or C-rated test data from a reasonable number of facilities. Although no specific bias was evident, it was not clear if the facilities tested represented a random sample of the industry. As with the “A” rating, the source category population was sufficiently specific to minimize variability.

D Below average. The emission factor was developed primarily from A-, B-, and C-rated test data from a small number of facilities, and there may have been reason to suspect that these facilities did not represent a random sample of the industry. There also may have been evidence of variability within the source category population.

E Poor. The emission factor was developed from C- and D-rated test data from a very limited number of facilities, and there may have been reason to suspect that the facilities tested did not represent a random sample of the industry. There also may have been evidence of variability within the source category population.

Two analyses were conducted to assign ratings to the ordnance emission factors. First, an analysis was conducted on an ordnance-specific basis. Second, an analysis was conducted using all available ordnance emission factor data. The second analysis was conducted to determine whether a sufficient correlation existed between emission factors for different but similar ordnance to allow the number of test data points to be increased to the point that higher emission factor ratings could be assigned than were possible when using the ordnance-specific approach. Both analyses are described below.

5.1 Emission Factor Ratings Assigned – Based on Ordnance-Specific Test Data

As previously described, emission factor ratings are dependent upon the test data quality, the number of test data points, the amount of variability present within a source category population, and the randomness of the source category sample. The following test data facts pertain to these rating criteria:

1. As described in Section 3 of this Background Document, the ordnance test data was primarily rated A or B. The test data for a few compounds was rated C.

2. Two tests were conducted or two sampling trains were used per ordnance.

3. Ordnance are manufactured to very tight tolerance levels so there is little variability within a specific type of ordnance.

4. There was no evidence that suggested the tested items within each type of ordnance were specially selected.

Emission factor ratings were assigned based upon these facts. The rationale used to accept or reject specific emission factor ratings follow.

A: Rejected. The number of test data points was deemed to be insufficient to assign an A emission factor rating.
B: Rejected. The number of test data points was deemed to be insufficient to assign a B emission factor rating.

C: Accepted for most ordnance. The emission factors were developed using A- and B-rated test data, there is little variability among items, and there was no evidence that suggested the tested items were specially selected. Because of the limited number of data points, a C rating was deemed appropriate for this set of circumstances.

D: Accepted for some ordnance. The emission factors were developed using C-rated test data, there is little variability among items, and there was no evidence that suggested the tested items were specially selected. Because of the limited number of data points, a D rating was deemed appropriate for this set of circumstances.

E: Rejected. The ordnance described in this report were developed primarily using A- and B-rated test data rather than C- or D-rated data, there is little variability among items, and there was no evidence that suggested the tested items were specially selected. Therefore, an E emission factor rating was deemed inappropriate.

5.2 Emission Factor Ratings Assigned – Based on All Available Test Data

The proceeding sections of this Background Document concern the emission measurement methods, data analysis, and calculations used to develop emission factors for specific ordnance. However, USAEC’s ordnance emission factor development program includes more than 200 ordnance that have been tested under more than 25 separate test series. Because many of these ordnance are similar in size and/or chemical composition, a statistical analysis was conducted to assess the similarity of the emission factors developed for similar ordnance. The results of this analysis were used to reevaluate the emission factor ratings assigned on an ordnance-specific basis.

USAEC characterized individual ordnance as falling into one of 17 separate categories, depending upon the size and/or chemical composition of the ordnance. The ordnance and their respective categories are identified in Table 8 along with a comment field describing the number of data points.

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<td>M882 9-mm Ball Cartridge</td>
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<td>G815²</td>
<td>Red Phosphorus Smoke Screening Grenade Launcher (UK)</td>
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<td>G930</td>
<td>AN-M8 HC Smoke Hand Grenade</td>
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<td>M18 Green Smoke Hand Grenade</td>
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<td>M18 Red Smoke Hand Grenade (new formulation)</td>
<td>DPG V</td>
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<td>M18 Violet Smoke Hand Grenade</td>
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<td>G955</td>
<td>M18 Violet Smoke Hand Grenade (new formulation)</td>
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<td>ABC-M5 HC Ground Smoke Pot (MILES)</td>
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<td>M4A2 Floating Smoke Pot</td>
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² Although testing may have been completed, emission factors for this ordnance have not yet been analyzed for inclusion in AP-42; therefore, these data were not included when the data correlation was assessed.

Within each of the 17 ordnance categories identified by USAEC, emission factors for each compound were compared. To allow the comparison of emission factors for ordnance with similar
constituents but significant differences in net explosive weight, the comparison was made using the normalized emission factor units of mass of compound released per pound NEW. Based upon information provided by EPA, the following procedures were used to assess the data correlation:

1. The relative standard deviation, defined as the standard deviation divided by the mean, was calculated for each compound within each ordnance category.

2. If the relative standard deviation was less than 1.0, the evaluated emission factors were considered to demonstrate good correlation. As such, the rating for these emission factors could be elevated to a maximum of an A, depending on the number of data points within the evaluated ordnance category.

3. If the relative standard deviation was between 1.0 and 2.0, the evaluated emission factors were considered to demonstrate fair correlation. As such, the rating for these emission factors could be elevated to a maximum of a B, depending on the number of data points within the evaluated ordnance category.

4. If the relative standard deviation was greater than 2.0, the evaluated emission factors were considered to demonstrate poor correlation. As such, the emission factor rating could not be elevated, regardless of the amount of data available.

A poor correlation between emission factors was not necessarily construed as being indicative of poor test data. Rather, a poor correlation was more likely to indicate that the ordnance included in the category were not as similar in nature as anticipated by USAEC when the ordnance categories were defined.

In addition to assessing the data correlation, an assessment was made of the number of test data points available within each of the 17 ordnance categories. Because each ordnance test consisted of two test data points (i.e., two test runs per ordnance or two independent sampling trains were used during an ordnance test), the number of test data points available in each of the ordnance categories varied from 2 to 68. Based upon information provided by EPA, the following assumptions were used to assess whether sufficient category-specific test data points were available to justify elevating the emission factor ratings based on ordnance-specific data only:

1. If 20 or more data points were available, the emission factor rating could be elevated to a maximum of an A, provided that the data also demonstrated a good correlation.

2. If at least 10 but less than 20 data points were available, the emission factor rating could be elevated to a maximum of a B, provided that the data also demonstrated a good correlation.

3. If less than 10 data points were available, the emission factor rating could not be elevated, regardless of the data correlation.

4. If the data demonstrated a fair correlation and 20 or more data points were available, the emission factor rating could be elevated to a maximum of a B.

5. If the data demonstrated a fair correlation and at least 10 but less than 20 data points were available, the emission factor rating could be elevated to a maximum of a C.

Using the criteria specified above, the emission factor ratings assigned to ordnance in each of the 17 ordnance categories were reevaluated. This evaluation indicated that some of the emission factor ratings associated with ordnance included in nine categories could be elevated from a C or D rating to an A or B rating. These nine categories are:

1. Demolition
2. Illumination
3. Medium – Firing Point
4. Projectiles
A final assessment was made as to the emission factor rating assigned based on ordnance-specific test data only. If the original emission factor data rating assigned was a C, then the emission factor rating was elevated to an A or B, as appropriate, based upon the data for the whole ordnance category. If the original emission factor data rating assigned was a D, then the emission factor rating was elevated to a B or C, as appropriate, based upon the data for the whole ordnance category. The analysis is documented in an Excel spreadsheet that is located on the EPA website at: http://www.epa.gov/ttn/chief/ap42/index.html.

Within the current test series, DODIC A365 was included in the Small Arm-FP category, and DODICs L592 and M630 were included in the Pyrotechnic category. Both of these categories include more than 20 data points. As a result, some emission factor ratings associated with each of these ordnance were elevated. DODIC G930 was included in the Smoke category, which includes more than 10 test data points. As a result, some emission factor ratings associated with this ordnance were also elevated. Finally, DODIC G982 was included in the Grenade category, which includes less than 10 test data points. As a result, none of the emission factor ratings associated with this ordnance were elevated. The emission factor ratings assigned are presented in Appendix A.

6.0 REFERENCES


9. Information regarding the relationship between emission factor data correlation, the number of data points available, and the resulting emission factor rating assigned supplied upon request by Mr. Ron Myers, Measurement Policy Group, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC, June 2006.
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APPENDIX A

COMPOUNDS ANALYZED AND EMISSION FACTORS DEVELOPED FOR ORDNANCE INCLUDED IN PHASE V-A TESTING AT DUGWAY PROVING GROUND, UTAH
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<th>CASRN&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Compound</th>
<th>Emission Factor&lt;sup&gt;b,c&lt;/sup&gt;</th>
<th>Minimum Detection Level&lt;sup&gt;e&lt;/sup&gt;</th>
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<td></td>
<td></td>
<td>lb per item</td>
<td>lb per lb NEW&lt;sup&gt;d&lt;/sup&gt;</td>
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<td>Lead</td>
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<td>8.1 E-02</td>
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<td>7.1 E-03</td>
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<td>PM-2.5&lt;sup&gt;g&lt;/sup&gt;</td>
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<td>PM-10&lt;sup&gt;g&lt;/sup&gt;</td>
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<td>Total nonmethane hydrocarbons</td>
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<td>8.5 E-04</td>
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<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>CASRN(^a)</td>
<td>Compound</td>
<td>Emission Factor(^bc)</td>
<td>Minimum Detection Level mg/m(^3)(^e)</td>
</tr>
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<td>191-24-2</td>
<td>Benzo[g,h,i]perylene(^f)</td>
<td>ND</td>
<td>4.0 E-03</td>
</tr>
<tr>
<td>50-32-8</td>
<td>Benzo[a]pyrene(^f)</td>
<td>ND</td>
<td>1.2 E-03</td>
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<tr>
<td>100-44-7</td>
<td>Benzyl chloride</td>
<td>ND</td>
<td>5.8 E-03</td>
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<tr>
<td>7440-41-7</td>
<td>Beryllium</td>
<td>ND</td>
<td>2.3 E-04</td>
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<tr>
<td>92-52-4</td>
<td>Biphenyl(^i)</td>
<td>5.4 E-07</td>
<td>3.4 E-05</td>
</tr>
<tr>
<td>75-25-2</td>
<td>Bromoform</td>
<td>ND</td>
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<td>74-83-9</td>
<td>Bromomethane</td>
<td>ND</td>
<td>4.3 E-03</td>
</tr>
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<td>101-55-3</td>
<td>4-Bromophenylphenylether</td>
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</tr>
<tr>
<td>106-99-0</td>
<td>1,3-Butadiene(^f)</td>
<td>1.7 E-07</td>
<td>1.0 E-05</td>
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<td>71-36-3</td>
<td>n-Butanol</td>
<td>ND</td>
<td>1.3 E-02</td>
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<tr>
<td>85-68-7</td>
<td>Butylbenzylphthalate</td>
<td>ND</td>
<td>1.5 E-03</td>
</tr>
<tr>
<td>123-72-8</td>
<td>Butyraldehyde</td>
<td>3.8 E-07</td>
<td>2.4 E-05</td>
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<td>7440-43-9</td>
<td>Cadmium</td>
<td>ND</td>
<td>1.3 E-04</td>
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<td>86-74-8</td>
<td>Carbazole</td>
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<td>75-15-0</td>
<td>Carbon disulfide(^g)</td>
<td>1.2 E-06</td>
<td>7.2 E-05</td>
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<td>56-23-5</td>
<td>Carbon tetrachloride</td>
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<td>7.0 E-03</td>
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<td>106-47-8</td>
<td>4-Chloroaniline</td>
<td>ND</td>
<td>1.5 E-02</td>
</tr>
<tr>
<td>108-90-7</td>
<td>Chlorobenzene</td>
<td>ND</td>
<td>5.2 E-03</td>
</tr>
<tr>
<td>75-00-3</td>
<td>Chloroethane</td>
<td>ND</td>
<td>3.0 E-03</td>
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<tr>
<td>111-91-1</td>
<td>bis(2-Chloroethoxy)methane</td>
<td>ND</td>
<td>1.2 E-03</td>
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<td>bis(2-Chloroethyl)ether</td>
<td>ND</td>
<td>1.4 E-03</td>
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<td>67-66-3</td>
<td>Chloroform</td>
<td>ND</td>
<td>5.4 E-03</td>
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<td>bis(2-Chloroisopropyl)ether</td>
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<td>74-87-3</td>
<td>Chloromethane(^f)</td>
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<td>9.0 E-03</td>
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<td>2-Chloronaphthalene</td>
<td>ND</td>
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<tr>
<td>7005-72-3</td>
<td>4-Chlorophenylphenyl ether</td>
<td>ND</td>
<td>1.2 E-03</td>
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<td>Chromium</td>
<td>4.8 E-07</td>
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<td>218-01-9</td>
<td>Chrysene(^g)</td>
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<td>7440-48-4</td>
<td>Cobalt</td>
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<td>7440-50-8</td>
<td>Copper(^g)</td>
<td>2.5 E-06</td>
<td>1.5 E-04</td>
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<td>4170-30-3</td>
<td>Crotonaldehyde(^h)</td>
<td>5.7 E-08</td>
<td>3.5 E-06</td>
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<tr>
<td>98-82-8</td>
<td>Cumene</td>
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<td>110-82-7</td>
<td>Cyclohexane</td>
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<tr>
<td>53-70-3</td>
<td>Dibenz[a,h]anthracene(^g)</td>
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<tr>
<td>132-64-9</td>
<td>Dibenzofuran</td>
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<td>CASRN</td>
<td>Compound</td>
<td>Emission Factor&lt;sup&gt;b,c&lt;/sup&gt;</td>
<td>Minimum Detection Level&lt;sup&gt;e&lt;/sup&gt;</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>lb per item</td>
<td>lb per lb NEW&lt;sup&gt;g&lt;/sup&gt;</td>
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<tr>
<td>106-93-4</td>
<td>1,2-Dibromoethane</td>
<td>ND</td>
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<td>84-74-2</td>
<td>Dibutylphthalate</td>
<td>ND</td>
<td>ND</td>
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<td>95-50-1</td>
<td>1,2-Dichlorobenzene</td>
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<td>1,3-Dichlorobenzene</td>
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<td>3,3'-Dichlorobenzidine</td>
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<td>1,2-Dichloroethane&lt;sup&gt;f&lt;/sup&gt;</td>
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<td>2,4-Dichlorophenol</td>
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<td>1,2-Dichloropropane</td>
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<td>trans-1,3-Dichloro-1-propene</td>
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<td>Dichlorotetrafluoroethane</td>
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<td>60-11-7</td>
<td>p-Dimethylaninoazobenzene</td>
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<tr>
<td>57-97-6</td>
<td>7,12-Dimethylben[z,a]anthracene</td>
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<td>3,3'-Dimethylbenzidine</td>
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<td>2,4-Dimethylphenol</td>
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<td>ND</td>
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<td>534-52-1</td>
<td>4,6-Dinitro-o-cresol</td>
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<td>2,4-Dinitrophenol</td>
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<td>121-14-2</td>
<td>2,4-Dinitrotoluene</td>
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<td>2,6-Dinitrotoluene</td>
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<tr>
<td>88-85-7</td>
<td>Dinoeb</td>
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<tr>
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<td>1,4-Dioxane</td>
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<td>ND</td>
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<tr>
<td></td>
<td>Total dioxin/furan compounds&lt;sup&gt;g&lt;/sup&gt;</td>
<td>1.5E-12</td>
<td>9.5E-11</td>
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<tr>
<td>122-39-4</td>
<td>Diphenylamine</td>
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<td>ND</td>
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<td>122-66-7</td>
<td>1,2-Diphenylhydrazine</td>
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<td>ND</td>
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<tr>
<td>100-41-4</td>
<td>Ethylbenzene&lt;sup&gt;g&lt;/sup&gt;</td>
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<td>ND</td>
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<tr>
<td>74-85-1</td>
<td>Ethylene&lt;sup&gt;g&lt;/sup&gt;</td>
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<td>ND</td>
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<tr>
<td>117-81-7</td>
<td>bis(2-Ethylhexyl)phthalate</td>
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<td>ND</td>
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<tr>
<td>206-44-0</td>
<td>Fluoranthene&lt;sup&gt;g&lt;/sup&gt;</td>
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<td>ND</td>
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<tr>
<td>86-73-7</td>
<td>Fluorene&lt;sup&gt;g&lt;/sup&gt;</td>
<td>ND</td>
<td>ND</td>
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<tr>
<td>50-00-0</td>
<td>Formaldehyde&lt;sup&gt;h&lt;/sup&gt;</td>
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<td>1.7 E-05</td>
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<tr>
<td>CASRN&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Compound</td>
<td>Emission Factor&lt;sup&gt;b,c&lt;/sup&gt;</td>
<td>Minimum Detection Level mg/m³&lt;sup,e&lt;/sup&gt;</td>
</tr>
<tr>
<td>------------------</td>
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<td>------------------------</td>
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<td></td>
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<td>lb per lb NEW&lt;sup&gt;d&lt;/sup&gt;</td>
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<tr>
<td>76-13-1</td>
<td>Freon 113</td>
<td>ND</td>
<td>ND</td>
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<tr>
<td>35822-46-9</td>
<td>1,2,3,4,6,7,8-Heptachlorobenzodioxin&lt;sup&gt;g&lt;/sup&gt;</td>
<td>ND</td>
<td>ND</td>
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<tr>
<td>67562-39-4</td>
<td>1,2,3,4,6,7,8-Heptachlorodibenzo-furan&lt;sup&gt;g&lt;/sup&gt;</td>
<td>ND</td>
<td>ND</td>
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<tr>
<td>55673-89-7</td>
<td>1,2,3,4,7,9-Heptachlorodibenzo-furan</td>
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<td>118-74-1</td>
<td>Hexachlorobenzene</td>
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<td>87-68-3</td>
<td>Hexachlorobutadiene</td>
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<td>77-47-4</td>
<td>Hexachlorocyclopentadiene</td>
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<td>39227-28-6</td>
<td>1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin</td>
<td>ND</td>
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<td>57653-85-7</td>
<td>1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin&lt;sup&gt;f&lt;/sup&gt;</td>
<td>ND</td>
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<td>19408-74-3</td>
<td>1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin&lt;sup&gt;g&lt;/sup&gt;</td>
<td>ND</td>
<td>ND</td>
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<td>70648-26-9</td>
<td>1,2,3,4,7,8-Hexachlorodibenzo-furan&lt;sup&gt;f&lt;/sup&gt;</td>
<td>8.9E-14</td>
<td>5.5E-12</td>
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<tr>
<td>57117-44-9</td>
<td>1,2,3,6,7,8-Hexachlorodibenzo-furan&lt;sup&gt;g&lt;/sup&gt;</td>
<td>ND</td>
<td>ND</td>
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<tr>
<td>72918-21-9</td>
<td>1,2,3,7,8,9-Hexachlorodibenzo-furan</td>
<td>ND</td>
<td>ND</td>
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<td>60851-34-5</td>
<td>2,3,4,6,7,8-Hexachlorodibenzo-furan</td>
<td>ND</td>
<td>ND</td>
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<td>67-72-1</td>
<td>Hexachloroethane</td>
<td>ND</td>
<td>ND</td>
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<tr>
<td>110-54-3</td>
<td>Hexane&lt;sup&gt;e&lt;/sup&gt;</td>
<td>ND</td>
<td>ND</td>
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<td>Hydrochloric acid</td>
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<td>ND</td>
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<td>74-90-8</td>
<td>Hydrogen cyanide&lt;sup&gt;g&lt;/sup&gt;</td>
<td>1.3E-06</td>
<td>8.0E-05</td>
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<tr>
<td>193-39-5</td>
<td>Indeno[1,2,3-cd]pyrene&lt;sup&gt;f&lt;/sup&gt;</td>
<td>ND</td>
<td>ND</td>
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<td>78-59-1</td>
<td>Isophorone</td>
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<td>ND</td>
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<td>67-63-0</td>
<td>Isopropyl alcohol</td>
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<td>ND</td>
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<td>120-58-1</td>
<td>Isosafrole</td>
<td>ND</td>
<td>ND</td>
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<td>7439-92-1</td>
<td>Lead</td>
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<td>8.1E-02</td>
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<td>Manganese</td>
<td>2.1E-07</td>
<td>1.3E-05</td>
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<td>Mercury</td>
<td>ND</td>
<td>ND</td>
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<td>126-98-7</td>
<td>Methacrylonitrile</td>
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<td>ND</td>
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<td>96-33-3</td>
<td>Methyl acrylate</td>
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<td>ND</td>
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<td>56-49-5</td>
<td>3-Methylcholanthrene</td>
<td>ND</td>
<td>ND</td>
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<td>75-09-2</td>
<td>Methylene chloride&lt;sup&gt;g&lt;/sup&gt;</td>
<td>3.1E-07</td>
<td>1.9E-05</td>
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<tr>
<td>108-10-1</td>
<td>Methyl isobutyl ketone</td>
<td>ND</td>
<td>ND</td>
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<tr>
<td>CASRN(^a)</td>
<td>Compound</td>
<td>Emission Factor(^b,c)</td>
<td>Minimum Detection Level</td>
</tr>
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<td>------------</td>
<td>---------------------------------</td>
<td>-------------------------</td>
<td>-------------------------</td>
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<tr>
<td>80-62-6</td>
<td>Methyl methacrylate</td>
<td>ND</td>
<td>1.8 E-02</td>
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<tr>
<td>91-57-6</td>
<td>2-Methylnaphthalene</td>
<td>ND</td>
<td>1.2 E-03</td>
</tr>
<tr>
<td>95-48-7</td>
<td>2-Methylphenol</td>
<td>ND</td>
<td>7.5 E-03</td>
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<td>1634-04-4</td>
<td>Methyl tert-butyl ether</td>
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<tr>
<td>91-20-3</td>
<td>Naphthalene(^f)</td>
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<td>1.5 E-03</td>
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<tr>
<td>134-32-7</td>
<td>1-Naphthylamine</td>
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<td>2.5 E-02</td>
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<td>91-59-8</td>
<td>2-Naphthylamine</td>
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<td>2.5 E-02</td>
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<tr>
<td>7440-02-0</td>
<td>Nickel</td>
<td>4.4 E-07</td>
<td>2.7 E-05</td>
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<tr>
<td>100-01-6</td>
<td>4-Nitroaniline</td>
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<td>5.0 E-03</td>
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<td>98-95-3</td>
<td>Nitrobenzene</td>
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<td>8.9 E-04</td>
</tr>
<tr>
<td>55-63-0</td>
<td>Nitroglycerin(^h)</td>
<td>2.9 E-08</td>
<td>1.8 E-06</td>
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<tr>
<td>88-75-5</td>
<td>2-Nitrophenol</td>
<td>ND</td>
<td>1.2 E-03</td>
</tr>
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<td>100-02-7</td>
<td>4-Nitrophenol</td>
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<td>79-46-9</td>
<td>2-Nitropropane</td>
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<td>924-16-3</td>
<td>N-Nitroso-di-n-butylamine</td>
<td>ND</td>
<td>1.2 E-03</td>
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<td>55-18-5</td>
<td>N-Nitrosodiethylamine</td>
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<td>N-Nitroso-di-n-propylamine</td>
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<td>59-89-2</td>
<td>N-Nitrososomorpholine</td>
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Other Pollutants

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<sup>a</sup> CASRN = Chemical Abstracts Service Registry Number.
<sup>b</sup> ND = nondetected.
<sup>c</sup> Emission factors rated C unless otherwise noted.
<sup>d</sup> NEW = net explosive weight. The NEW for this ordnance is 1.60 E-02 pounds per item.
<sup>e</sup> Data provided for compounds that were not detected.
<sup>f</sup> Emission factor rated A because of correlation with emission factors for similar ordnance and number of test data points.
<sup>g</sup> Emission factor rated B because of correlation with emission factors for similar ordnance and number of test data points.
<sup>h</sup> Emission factor rated D because the factor is based upon C-rated test data.
<sup>i</sup> Emission factor rated D because the factor is for a tentatively identified compound.
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<tr>
<th>CASRN&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Compound</th>
<th>Emission Factor&lt;sup&gt;b,c&lt;/sup&gt;</th>
<th>Minimum Detection Level mg/m&lt;sup&gt;3&lt;/sup&gt;&lt;sup&gt;e&lt;/sup&gt;</th>
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<td>Hexachlorobutadiene</td>
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<td>Hexachlorocyclopentadiene$^g$</td>
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<td>3-Methylcholanthrene</td>
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<td>Methylene chloride$^g$</td>
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<td>1.2 E-05</td>
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Notes:
- CASRNa: Chemical Abstracts Service Registry Number
- Table A2 (cont.)
- Emission Factor: lb per item, lb per lb
- Minimum Detection Level: mg/m$^3$
<table>
<thead>
<tr>
<th>CASRN&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Compound</th>
<th>Emission Factor&lt;sup&gt;b,c&lt;/sup&gt;</th>
<th>Minimum Detection Level</th>
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<td></td>
<td></td>
<td>lb per item</td>
<td>lb per lb NEW&lt;sup&gt;d&lt;/sup&gt;</td>
<td>mg/m&lt;sup&gt;3&lt;/sup&gt;&lt;sup&gt;e&lt;/sup&gt;</td>
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<td>Compound</td>
<td>Emission Factor(^{b,c})</td>
<td>Minimum Detection Level (\text{mg/m}^3)(^e)</td>
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<td>2.8 E-06</td>
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<tr>
<td>106-98-9</td>
<td>1-Butene</td>
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<td>8.9 E-07</td>
<td>--</td>
</tr>
<tr>
<td>590-18-1</td>
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<tr>
<td>624-64-6</td>
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<tr>
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<td>3.7 E-06</td>
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</tr>
<tr>
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<td>59-50-7</td>
<td>4-Chloro-3-methylphenol</td>
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<tr>
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<td>ND</td>
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</tr>
<tr>
<td>95-57-8</td>
<td>2-Chlorophenol</td>
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<td>ND</td>
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<tr>
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<td>1,3-Cyclopentadiene, 1,2,3,4-tetrachloro&lt;sup&gt;i&lt;/sup&gt;</td>
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<tr>
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<td>ND</td>
<td>ND</td>
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<tr>
<td>156-59-2</td>
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<tr>
<td>156-60-5</td>
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<td>ND</td>
<td>ND</td>
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<tr>
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<td>2,6-Dichlorophenol&lt;sup&gt;g&lt;/sup&gt;</td>
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<td>2.0 E-07</td>
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<tr>
<td>5779-94-2</td>
<td>2,5-Dimethylbenzaldehyde</td>
<td>ND</td>
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<tr>
<td>75-83-2</td>
<td>2,2-Dimethylbutane</td>
<td>ND</td>
<td>ND</td>
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</tr>
<tr>
<td>79-29-8</td>
<td>2,3-Dimethylbutane</td>
<td>ND</td>
<td>ND</td>
<td>1.6 E-02</td>
</tr>
<tr>
<td>565-59-3</td>
<td>2,3-Dimethylpentane</td>
<td>ND</td>
<td>ND</td>
<td>1.9 E-02</td>
</tr>
<tr>
<td>CASRN(^a)</td>
<td>Compound</td>
<td>Emission Factor(^{b,c})</td>
<td>Minimum Detection Level (\text{mg/m}^3)(^e)</td>
<td></td>
</tr>
<tr>
<td>------------</td>
<td>----------</td>
<td>----------------</td>
<td>-------------------</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lb per item</td>
<td>lb per lb</td>
<td>(\text{mg/m}^3)</td>
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<td>ND</td>
<td>ND</td>
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</tr>
<tr>
<td>117-84-0</td>
<td>Di-n-octylphthalate</td>
<td>ND</td>
<td>ND</td>
<td>5.9 E-03</td>
</tr>
<tr>
<td>74-84-0</td>
<td>Ethane</td>
<td>ND</td>
<td>ND</td>
<td>1.4 E-01</td>
</tr>
<tr>
<td>64-17-5</td>
<td>Ethanol(^f)</td>
<td>3.7 E-06</td>
<td>3.3 E-06</td>
<td>--</td>
</tr>
<tr>
<td>60-29-7</td>
<td>Ethyl ether</td>
<td>ND</td>
<td>ND</td>
<td>1.4 E-02</td>
</tr>
<tr>
<td>97-63-2</td>
<td>Ethyl methacrylate</td>
<td>ND</td>
<td>ND</td>
<td>2.1 E-02</td>
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<tr>
<td>62-50-0</td>
<td>Ethyl methanesulfonate</td>
<td>ND</td>
<td>ND</td>
<td>5.3 E-03</td>
</tr>
<tr>
<td>593-63-5</td>
<td>Ethyne, chloro,(^h)</td>
<td>5.5 E-06</td>
<td>5.0 E-06</td>
<td>--</td>
</tr>
<tr>
<td>620-14-4</td>
<td>m-Ethyltoluene</td>
<td>ND</td>
<td>ND</td>
<td>2.3 E-02</td>
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<tr>
<td>611-14-3</td>
<td>o-Ethyltoluene</td>
<td>ND</td>
<td>ND</td>
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<td>p-Ethyltoluene</td>
<td>ND</td>
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<td>142-82-5</td>
<td>n-Heptane</td>
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<td>ND</td>
<td>2.3 E-02</td>
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<tr>
<td>1888-71-7</td>
<td>Hexachloropropene(^g)</td>
<td>3.2 E-05</td>
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<tr>
<td>66-25-1</td>
<td>Hexaldehyde</td>
<td>ND</td>
<td>ND</td>
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<tr>
<td>591-78-6</td>
<td>2-Hexanone</td>
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<td>ND</td>
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<tr>
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<td>8.6 E-04</td>
<td>7.8 E-04</td>
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<td>75-28-5</td>
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<td>ND</td>
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<td>78-79-5</td>
<td>Isoprene</td>
<td>ND</td>
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<td>Isovaleraldehyde</td>
<td>ND</td>
<td>ND</td>
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<tr>
<td>5989-27-5</td>
<td>d-Limonene</td>
<td>ND</td>
<td>ND</td>
<td>1.2 E-01</td>
</tr>
<tr>
<td>7439-95-4</td>
<td>Magnesium(^f)</td>
<td>7.6 E-05</td>
<td>6.9 E-05</td>
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<tr>
<td>108-87-2</td>
<td>Methylcyclohexane</td>
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<td>ND</td>
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<tr>
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<td>589-81-1</td>
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<td>ND</td>
<td>2.1 E-02</td>
</tr>
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<td>591-76-4</td>
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</tr>
<tr>
<td>589-34-4</td>
<td>3-Methylhexane</td>
<td>ND</td>
<td>ND</td>
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</tr>
<tr>
<td>66-27-3</td>
<td>Methyl methanesulfonate</td>
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<td>ND</td>
<td>5.8 E-03</td>
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<tr>
<td>107-83-5</td>
<td>2-Methylpentane</td>
<td>ND</td>
<td>ND</td>
<td>1.6 E-02</td>
</tr>
<tr>
<td>96-14-0</td>
<td>3-Methylpentane</td>
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<td>ND</td>
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<td>2234-13-1</td>
<td>Naphthalene, octachloro,(^h)</td>
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<tr>
<td>88-74-4</td>
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<td>ND</td>
<td>5.3 E-03</td>
</tr>
<tr>
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<td>3-Nitroaniline</td>
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<td>ND</td>
<td>2.1 E-02</td>
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<td>Compound</td>
<td>Emission Factor(^b,c)</td>
<td>Minimum Detection Level (\text{mg/m}^3)(^e)</td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>----------</td>
<td>------------------------</td>
<td>-------------------------------</td>
<td></td>
</tr>
<tr>
<td>10595-95-6</td>
<td>N-Nitrosomethylamine(^g)</td>
<td>3.9 E-07 3.6 E-07</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>930-55-2</td>
<td>N-Nitrosopyrrolidine</td>
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<td>5.3 E-03</td>
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<tr>
<td>88-72-2</td>
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<td>ND ND</td>
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<tr>
<td>111-84-2</td>
<td>n-Nonane</td>
<td>ND ND</td>
<td>2.4 E-02</td>
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</tr>
<tr>
<td>111-65-9</td>
<td>n-Octane</td>
<td>ND ND</td>
<td>2.1 E-02</td>
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</tr>
<tr>
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<td>i-Pentane</td>
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<tr>
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<td>n-Pentane</td>
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<td>1.3 E-02</td>
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<tr>
<td>109-67-1</td>
<td>1-Pentene</td>
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<tr>
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<td>ND ND</td>
<td>1.3 E-02</td>
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<td>Perchlorate</td>
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<td>127-91-3</td>
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<tr>
<td>74-98-6</td>
<td>Propane</td>
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<td>2.0 E-01</td>
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<tr>
<td>103-65-1</td>
<td>n-Propylbenzene</td>
<td>ND ND</td>
<td>2.8 E-02</td>
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<td>95-94-3</td>
<td>1,2,4,5-Tetrachlorobenzene(^g)</td>
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<td>58-90-2</td>
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<td>Tetryl</td>
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<tr>
<td>1334-78-7</td>
<td>o,m,p-Tolualdehyde</td>
<td>ND ND</td>
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<td>526-73-8</td>
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<td>1,3,5-Trinitrobenzene</td>
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<td>2,4,6-Trinitrotoluene</td>
<td>ND ND</td>
<td>6.7 E-04</td>
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<td>1120-21-4</td>
<td>Undecane</td>
<td>ND ND</td>
<td>2.9 E-02</td>
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<td>110-62-3</td>
<td>Valeraldehyde</td>
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<td>1.5 E-03</td>
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<td>CASRN</td>
<td>Chemical Abstracts Service Registry Number.</td>
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<td>--------------------------------------------</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>ND</td>
<td>nondetected.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emission factors rated C unless otherwise noted.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NEW</td>
<td>net explosive weight. The NEW for this ordnance is 1.10 pounds per item.</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Data provided for compounds that were not detected.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Emission factor rated B because of correlation with emission factors for similar ordnance and number of test data points.</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emission factor rated D because the factor is based upon C-rated test data.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emission factor rated D because the factor is for a tentatively identified compound.</td>
<td></td>
<td></td>
<td></td>
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### TABLE A3  COMPOUNDS ANALYZED AND EMISSION FACTORS DEVELOPED FOR DODIC G982, M83 TEREPHTHALIC ACID (TA) SMOKE PRACTICE HAND GRENADE

<table>
<thead>
<tr>
<th>CASRN(^a)</th>
<th>Compound</th>
<th>Emission Factor(^b,c)</th>
<th>Minimum Detection Level (\text{mg/m}^3)(^e)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>lb per item</td>
<td>lb per lb NEW(^d)</td>
</tr>
<tr>
<td>124-38-9</td>
<td>Carbon dioxide</td>
<td>1.3 E-01</td>
<td>1.9 E-01</td>
</tr>
<tr>
<td>630-08-0</td>
<td>Carbon monoxide</td>
<td>1.8 E-02</td>
<td>2.5 E-02</td>
</tr>
<tr>
<td>7439-92-1</td>
<td>Lead(^f)</td>
<td>5.8 E-05</td>
<td>8.3 E-05</td>
</tr>
<tr>
<td>--</td>
<td>Oxides of nitrogen</td>
<td>3.5 E-04</td>
<td>5.1 E-04</td>
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<td>--</td>
<td>PM-2.5</td>
<td>2.8 E-02</td>
<td>4.0 E-02</td>
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<td>PM-10</td>
<td>3.6 E-02</td>
<td>5.2 E-02</td>
</tr>
<tr>
<td>7446-09-5</td>
<td>Sulfur dioxide</td>
<td>9.5 E-06</td>
<td>1.4 E-05</td>
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<tr>
<td>--</td>
<td>Total nonmethane hydrocarbons</td>
<td>9.5 E-03</td>
<td>1.3 E-02</td>
</tr>
<tr>
<td>12789-66-1</td>
<td>Total suspended particulate</td>
<td>4.7 E-02</td>
<td>6.7 E-02</td>
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</tbody>
</table>

**Carbon Dioxide, Criteria Pollutants, Total Nonmethane Hydrocarbons, and Total Suspended Particulates**

**Hazardous Air Pollutants and Toxic Chemicals**

<table>
<thead>
<tr>
<th>CASRN(^a)</th>
<th>Compound</th>
<th>Emission Factor(^b,c)</th>
<th>Minimum Detection Level (\text{mg/m}^3)(^e)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>lb per item</td>
<td>lb per lb NEW(^d)</td>
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<tr>
<td>83-32-9</td>
<td>Acenaphthene</td>
<td>2.0 E-07</td>
<td>2.8 E-07</td>
</tr>
<tr>
<td>208-96-8</td>
<td>Acenaphthylene</td>
<td>4.4 E-07</td>
<td>6.3 E-07</td>
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<td>75-07-0</td>
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<td>Acetic acid, chloro-(^g)</td>
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<td>7429-90-5</td>
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<td>4-Aminobiphenyl</td>
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<td>7664-41-7</td>
<td>Ammonia(^f)</td>
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<td>62-53-3</td>
<td>Aniline</td>
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<td>120-12-7</td>
<td>Anthracene</td>
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<td>1.2 E-07</td>
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<tr>
<td>7440-36-0</td>
<td>Antimony(^f)</td>
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<td>7440-38-2</td>
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<td>7440-39-3</td>
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<td>Compound</td>
<td>Emission Factor(^b,c)</td>
<td>Minimum Detection Level</td>
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<td>Beryllium</td>
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<td>101-55-3</td>
<td>4-Bromophenylphenylether</td>
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<td>1,3-Butadiene</td>
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<td>71-36-3</td>
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<td>85-68-7</td>
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<td>Minimum Detection Level (\text{mg/m}^3)</td>
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<td>Emission Factor&lt;sup&gt;b,c&lt;/sup&gt;</td>
<td>Minimum Detection Level&lt;sup&gt;mg/m^3&lt;/sup&gt;</td>
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<td>76-13-1</td>
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<td>35822-46-9</td>
<td>1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin</td>
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<td>Hydrochloric acid&lt;sup&gt;f&lt;/sup&gt;</td>
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<td>CASRN(^a)</td>
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<td>Emission Factor(^b,c)</td>
<td>Minimum Detection Level mg/m(^3)(^e)</td>
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<td>lb per lb NEW(^d)</td>
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<td>Methyl methacrylate</td>
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<td>2-Methylphenol</td>
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<td>Minimum Detection Level mg/m(^3)(^c)</td>
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<td>Furan(^g)</td>
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<td>Compound</td>
<td>Emission Factor&lt;sup&gt;b,c&lt;/sup&gt;</td>
<td>Minimum Detection Level (mg/m&lt;sup&gt;3&lt;/sup&gt;)&lt;sup&gt;e&lt;/sup&gt;</td>
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<td>lb per lb NEW&lt;sup&gt;d&lt;/sup&gt;</td>
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<td>alpha-Pinene</td>
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<td>beta-Pinene</td>
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<td>n-Propylbenzene</td>
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<td>95-94-3</td>
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<td>2,3,4,6-Tetrachlorophenol</td>
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<td>Tetryl&lt;sup&gt;f&lt;/sup&gt;</td>
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<td>1334-78-7</td>
<td>o.m.p-Tolualdehyde&lt;sup&gt;f&lt;/sup&gt;</td>
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<td>3.2 E-05</td>
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<td>2437-56-1</td>
<td>1-Tridecene&lt;sup&gt;g&lt;/sup&gt;</td>
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<td>1,3,5-Trimethylbenzene</td>
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<td>1,3,5-Trinitrobenzene</td>
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<td>118-96-7</td>
<td>2,4,6-Trinitrotoluene&lt;sup&gt;e&lt;/sup&gt;</td>
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<td>Triphenylmethane&lt;sup&gt;g&lt;/sup&gt;</td>
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<td>1120-21-4</td>
<td>Undecane</td>
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<td>Valeraldehyde&lt;sup&gt;f&lt;/sup&gt;</td>
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<td>90-47-1</td>
<td>Xanthone&lt;sup&gt;g&lt;/sup&gt;</td>
<td>3.6 E-06</td>
<td>5.1 E-06</td>
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</tbody>
</table>

<sup>a</sup> CASRN = Chemical Abstracts Service Registry Number.

<sup>b</sup> ND = nondetected.

<sup>c</sup> Emission factors rated C unless otherwise noted.

<sup>d</sup> NEW = net explosive weight. The NEW for this ordnance is 7.02 E-01 pounds per item.

<sup>e</sup> Data provided for compounds that were not detected.

<sup>f</sup> Emission factor rated D because the factor is based upon C-rated test data.

<sup>g</sup> Emission factor rated D because the factor is for a tentatively identified compound.
<table>
<thead>
<tr>
<th>CASRN</th>
<th>Compound</th>
<th>Emission Factor&lt;sup&gt;b,c&lt;/sup&gt;</th>
<th>Minimum Detection Level&lt;sup&gt;d,e&lt;/sup&gt;</th>
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<td>124-38-9</td>
<td>Carbon dioxide&lt;sup&gt;e&lt;/sup&gt;</td>
<td>3.6 E-04</td>
<td>6.3 E-02</td>
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<td>630-08-0</td>
<td>Carbon monoxide&lt;sup&gt;e&lt;/sup&gt;</td>
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<td>Lead</td>
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<td>Oxides of nitrogen&lt;sup&gt;e&lt;/sup&gt;</td>
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<td>Sulfur dioxide</td>
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<td>Total nonmethane hydrocarbons</td>
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<td>12789-66-1</td>
<td>Total suspended particulate&lt;sup&gt;f&lt;/sup&gt;</td>
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**Carbon Dioxide, Criteria Pollutants, Total Nonmethane Hydrocarbons, and Total Suspended Particulates**

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<td>Compound</td>
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<td>Minimum Detection Level mg/m(^3)(^e)</td>
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<td>lb per lb NEW&lt;sup&gt;d&lt;/sup&gt;</td>
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<td>4.5 E-06</td>
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<td>3-Methylcholanthrene</td>
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<td>Compound</td>
<td>Emission Factor(^{b,c})</td>
<td>Minimum Detection Level mg/m(^3)(^e)</td>
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<td>----------------------------------------</td>
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<td>lb per item lb per lb NEW(^d)</td>
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<td>Phenol(^g)</td>
<td>8.4 E-08</td>
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</tbody>
</table>

\(^a\) CASRN: Chemical Abstracts Service Registry Number

\(^b\) Emission factor in lb per item or lb per lb of the substance.

\(^c\) The emission factor is based on stoichiometry.

\(^d\) NEW: New emission factor

\(^e\) Detection level in mg/m\(^3\).

\(^f\) Octachlorodibenzofuran

\(^g\) Octachlorodibenzop-dioxin
<table>
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<tr>
<th>CASRN(^a)</th>
<th>Compound</th>
<th>Emission Factor(^{bc})</th>
<th>Minimum Detection Level (\text{mg/m}^3)</th>
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<td>lb per lb NEW(^d)</td>
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<td>Vinyl chloride(^b)</td>
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<td>Zinc</td>
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\(^a\) CASR = Chemical Abstracts Service Registry Number

\(^b\) Inferred from the literature

\(^c\) Emission factors are based on a typical burn rate of 10,000 pounds

\(^d\) NEW = New Emission Monitoring System

\(^e\) mg/m^3 = Milligrams per cubic meter

\(^f\) ND = Not Detected

\(^g\) TCE = Tetrachloroethylene

\(^h\) VCD = Vinyl Chloride Dioxide
TABLE A4 (cont.)

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<tr>
<th>CASRN&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Compound</th>
<th>Emission Factor&lt;sup&gt;b,c&lt;/sup&gt;</th>
<th>Minimum Detection Level&lt;sup&gt;d,e&lt;/sup&gt;</th>
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<tr>
<td></td>
<td></td>
<td>lb per item lb per lb NEW&lt;sup&gt;d&lt;/sup&gt;</td>
<td>mg/m³&lt;sup&gt;e&lt;/sup&gt;</td>
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<td>Acetone&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.7 E-06 3.1 E-04</td>
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<td>Acetylene&lt;sup&gt;g&lt;/sup&gt;</td>
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<td>Benzaldehyde&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>4748-78-1</td>
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<td>26974-29-8</td>
<td>Benzenesulfinothioic acid, 4-methoxy-, Si&lt;sup&gt;3&lt;/sup&gt;</td>
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<td>624-64-6</td>
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<td>Emission Factor&lt;sup&gt;b,c&lt;/sup&gt;</td>
<td>Minimum Detection Level&lt;sup&gt;mg/m&lt;sup&gt;3&lt;/sup&gt;e&lt;/sup&gt;</td>
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<td>lb per lb NEW&lt;sup&gt;d&lt;/sup&gt;</td>
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<td>CASRN(^a)</td>
<td>Compound</td>
<td>Emission Factor(^{b,c})</td>
<td>Minimum Detection Level mg/m(^3)(^e)</td>
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<td>lb per item</td>
<td>lb per lb NEW(^d)</td>
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<td>n-Octane</td>
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<td>2,3,4,6-Tetrachlorophenol</td>
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<td>9.4 E-07</td>
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<td>Valeraldehyde(^h)</td>
<td>2.8 E-08</td>
<td>4.9 E-06</td>
</tr>
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\(^a\) CASRN = Chemical Abstracts Service Registry Number
\(^b\) Emission Factor: lb per item or lb per lb
\(^c\) Table A4 (cont.)
\(^d\) New Emission Working Group
\(^e\) Minimum detection level in mg/m\(^3\) for NDIR analysis

---

**TABLE A4 (cont.)**
TABLE A4 (cont.)

a CASRN = Chemical Abstracts Service Registry Number.
b ND = nondetected.
c Emission factors rated C unless otherwise noted.
d NEW = net explosive weight. The NEW for this ordnance is 5.65 E-03 pounds per item.
e Data provided for compounds that were not detected.
f Emission factor rated A because of correlation with emission factors for similar ordnance and number of test data points.
g Emission factor rated B because of correlation with emission factors for similar ordnance and number of test data points.
h Emission factor rated D because the factor is based upon C-rated test data.
i Emission factor rated D because the factor is for a tentatively identified compound.
### TABLE A5  COMPOUNDS ANALYZED AND EMISSION FACTORS DEVELOPED FOR DODIC M630, M1 PULL TYPE DEMOLITION FIRING DEVICE

<table>
<thead>
<tr>
<th>CASRN&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Compound</th>
<th>Emission Factor&lt;sup&gt;b,c&lt;/sup&gt;</th>
<th>Minimum Detection Level&lt;sup&gt;d&lt;/sup&gt;</th>
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<tr>
<td></td>
<td></td>
<td>lb per item lb per lb NEW&lt;sup&gt;d&lt;/sup&gt; mg/m&lt;sup&gt;3,c&lt;/sup&gt;</td>
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</tbody>
</table>

#### Carbon Dioxide, Criteria Pollutants, Total Nonmethane Hydrocarbons, and Total Suspended Particulates

<table>
<thead>
<tr>
<th>Compound</th>
<th>lb per item</th>
<th>lb per lb NEW&lt;sup&gt;d&lt;/sup&gt;</th>
<th>mg/m&lt;sup&gt;3,c&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>124-38-9 Carbon dioxide&lt;sup&gt;e&lt;/sup&gt;</td>
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<tr>
<td>630-08-0 Carbon monoxide&lt;sup&gt;e&lt;/sup&gt;</td>
<td>7.3 E-06</td>
<td>1.3 E-01</td>
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<tr>
<td>7439-92-1 Lead</td>
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<td>-- Oxides of nitrogen&lt;sup&gt;e&lt;/sup&gt;</td>
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<td>1.2 E-02</td>
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<td>-- PM-2.5</td>
<td>3.3 E-07</td>
<td>5.7 E-03</td>
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<td>-- PM-10&lt;sup&gt;e&lt;/sup&gt;</td>
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<td>7446-09-5 Sulfur dioxide</td>
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<td>-- Total nonmethane hydrocarbons</td>
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<td>12789-66-1 Total suspended particulate&lt;sup&gt;f&lt;/sup&gt;</td>
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#### Hazardous Air Pollutants and Toxic Chemicals

<table>
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<tr>
<th>CASRN&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Compound</th>
<th>lb per item</th>
<th>lb per lb NEW&lt;sup&gt;d&lt;/sup&gt;</th>
<th>mg/m&lt;sup&gt;3,c&lt;/sup&gt;</th>
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<tr>
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<td>Acenaphthene</td>
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<td>mg/m&lt;sup&gt;3&lt;/sup&gt;&lt;sup&gt;e&lt;/sup&gt;</td>
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<td>123-72-8</td>
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<td>7440-50-8</td>
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<td>4170-30-3</td>
<td>Crotonaldehyde&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>Emission Factor&lt;sup&gt;b,c&lt;/sup&gt;</td>
<td>Minimum Detection Level</td>
<td>CASRN&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>lb per lb NEW&lt;sup&gt;d&lt;/sup&gt;</td>
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<td>Propionaldehyde(^h)</td>
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<td>4.2 E-05</td>
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</table>

\(^a\) CASR = Chemical Abstracts Service Registry Number

\(^b\) lb per item

\(^c\) lb per lb NEW

\(^d\) NEW = Next Expanded Warning

\(^e\) mg/m\(^3\)

\(^f\) Octachlorodibenzofuran

\(^g\) Phenol and Phosphorus were not available in the complete dataset.

\(^h\) Propionaldehyde is a byproduct of the reaction.
<table>
<thead>
<tr>
<th>CASRN(^a)</th>
<th>Compound</th>
<th>Emission Factor(^b, c)</th>
<th>Minimum Detection Level mg/m(^3, e)</th>
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Other Pollutants

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<tr>
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<th>Compound</th>
<th>Emission Factor(^b, c)</th>
<th>Minimum Detection Level mg/m(^3, e)</th>
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<td></td>
<td>Acetone(^h)</td>
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\(^a\) CASRN: Chemical Abstracts Service Registry Number
\(^b\) Emission Factor: lb per item or lb per lb
\(^c\) SEE Table A4 for units
\(^d\) NEW: New Emission Guidelines
\(^e\) mg/m\(^3\): Concentration in air
\(^f\) Propylene
\(^g\) 2,3,7,8-Tetrachlorodibenzo-p-dioxin
\(^h\) Acetone
\(^i\) 2,3,7,8-Tetrachlorodibenzofuran

DRAFT
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<tr>
<th>CASRN(^a)</th>
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<th>Emission Factor(^b,c)</th>
<th>Minimum Detection Level (\text{mg/m}^3)(^e)</th>
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<td>lb per lb NEW(^d)</td>
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<td>7206-19-1</td>
<td>3-Octadecene, (E)(^{-1})</td>
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<td>n-Octane</td>
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<td>4.4 E-09</td>
<td>7.8 E-05</td>
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<td>2,3,4-Trimethylpentane</td>
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<td>2,4,6-Trinitrotoluene(^h)</td>
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<td>Valeraldehyde</td>
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TABLE A5  (cont.)

a CASRN = Chemical Abstracts Service Registry Number.
b ND = nondetected.
c Emission factors rated C unless otherwise noted.
d NEW = net explosive weight. The NEW for this ordnance is 5.70 E-05 pounds per item.
e Data provided for compounds that were not detected.
f Emission factor rated A because of correlation with emission factors for similar ordnance and number of test data points.
g Emission factor rated B because of correlation with emission factors for similar ordnance and number of test data points.
h Emission factor rated D because the factor is based upon C-rated test data.
i Emission factor rated D because the factor is for a tentatively identified compound.
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DRAFT
APPENDIX B

NEW AP-42 SECTIONS FOR ORDNANCE INCLUDED IN PHASE V-A TESTING
AT DUGWAY PROVING GROUND, UTAH

Electronic versions of the new AP-42 sections for ordnance included in Phase V-A testing at Dugway Proving Ground, Utah, are located on the EPA web site at: http://www.epa.gov/ttn/chief/ap42/index.html.
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