BACKGROUND DOCUMENT

REPORT ON REVISIONS TO 5TH EDITION AP-42 CHAPTER 15 - ORDNANCE DETONATION

EMISSION FACTORS DEVELOPED BASED ON PHASE IX TESTING CONDUCTED AT DUGWAY PROVING GROUND, UTAH

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NOTICE

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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 four types of ordnance 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

DODIC	Ordnance Description	AP-42 Section
C449	M314 105-mm Illumination Cartridge (projectile only)	15.3.17
C454[a]	M60 105-mm White Phosphorus Smoke Cartridge (projectile only)	--
C484	M816 81-mm IR Illumination Cartridge (projectile only)	15.3.22
C790	M91 120-mm Illumination Cartridge (projectile only)	15.3.26

[a] During the testing of DODIC C454, the ordnance apparently partially detonated instead of just producing smoke, which caused a shock wave that irreparably damaged some of the sampling trains. Furthermore, the shock wave lifted the ventilation cover off of the test chamber and several pieces of the ordnance containing white phosphorous were scattered outside the test chamber. As a result, only one test run was conducted for this ordnance and no data are available for total suspended particulate, metals, semivolatile organic compounds, dioxins/furans, energetic materials, or perchlorate. Due to the limited test data available and the fact that part of the ordnance that was ejected from the test chamber, no emission factors were developed for DODIC C454.

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 USAEC Phase IX Emission Characterization of Exploding Ordnance and Smoke/Pyrotechnics*[1] and the document titled *Detailed Test Plan for Phase IX Emission Characterization of Burning Smoke/Pyrotechnics and Propellants.*[2] These documents were supplemented by additional data provided by USAEC.[3] One test run was conducted for DODIC C454 while two test runs were conducted for the other three ordnance. One item was detonated per run for all DODICs. 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 June 1 and 16, 2006.

The compounds that were measured included carbon monoxide (CO), carbon dioxide (CO_2), oxides of nitrogen (NO_x), sulfur dioxide (SO_2), 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 (Cl_2), ammonia (NH_3), volatile organic compounds (VOC), semivolatile organic compounds (SVOC), dioxins/furans (PCDD/PCDF), aldehydes and carbonyls, energetic materials, hydrogen cyanide, perchlorate, and sulfur hexafluoride (SF_6). 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

DODIC	Ordnance Description	NEW (lb/item)[a]
C449	M314 105-mm Illumination Cartridge (projectile only)	2.23
C484	M816 81-mm IR Illumination Cartridge (projectile only)	6.30 E-01
C790	M91 120-mm Illumination Cartridge (projectile only)	3.81

[a] NEW value obtained from References 1 and 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 three of the four 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 title *Procedures for Preparing Emission Factor Documents*[5] and *Draft Detailed Procedures for Preparing Emission Factors.*[6]

2.0 COMPOUNDS MEASURED AND EMISSION MEASUREMENT METHODS

The USAEC Phase IX series testing was conducted in the Open Detonation Open Burn Improved (ODOBi) test chamber located at Dugway Proving Ground, Utah. The ODOBi a capsule-shaped chamber with an interior volume of approximately 36 cubic meters. A removable stack is located at the top of the test chamber. The ODOBi test chamber and stack are made of 1-inch and 0.25-inch thick steel, respectively. An alternate configuration is to replace the stack with a ventilation cover. The ventilation cover is basically a framework of angle iron designed to keep shrapnel from the test within the chamber and prevent overpressure by releasing the gases at the time of deployment.

Test items are placed in the chamber or suspended in the center and remotely initiated. During sampling, fans inside the chamber keep the gases mixed while stainless steel probes extract gas samples from the chamber through 21 sample ports. The sample media is located immediately outside the

chamber. Gases extracted from the chamber are replaced by ambient air that enters the chamber through the partially open top anda tracer gas is used to estimate sample loss. An electrical firing circuit is used to remotely deploy 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 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 60 (40 CFR 60); and in *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*.[7] 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*[8] and the *National Institute for Occupational Safety and Health (NIOSH) Manual of Analytical Methods (NMAM), Fourth Edition*.[9] Where necessary, the test methods were adapted to reflect application to the unique testing of ordnance detonation in the ODOBi.

TABLE 3 SAMPLING AND ANALYTICAL METHODS USED

Compound	Test Method
CO	40 CFR 60, Appendix A, EPA Method 10 - *Determination of Carbon Monoxide Emissions from Stationary Sources* [sampling and analysis]
CO_2	40 CFR 60, Appendix A, EPA Method 3A - *Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)* [sampling and analysis]
NO_x	40 CFR 60, Appendix A, EPA Method 7E - *Determination of Nitrogen Oxides Emissions from Stationary Sources (Instrumental Analyzer Procedure)* [sampling and analysis]
SO_2	40 CFR 60, Appendix A, EPA Method 6C - *Determination of Sulfur Dioxide Emissions from Stationary Sources (Instrumental Analyzer Procedure)* [sampling and analysis]
TSP	40 CFR 60, Appendix A, EPA Method 5 - *Determination of Particulate Matter from Stationary Sources* [sampling and analysis]
PM-10 and PM-2.5	EPA Conditional Test Method 040 - *Method for the Determination of PM10 and PM2.5 Emissions (Constant Sampling Rate Procedures)* [sampling and analysis]
Metals	Metal sample was obtained from TSP sample [sampling]
	40 CFR 60, Appendix A, EPA Method 29 - *Determination of Metals Emissions from Stationary Sources* [analysis]
	SW-846 Method 6010A - *Inductively Coupled Plasma-Atomic Emission Spectrometry* [analysis for metals except mercury]
	SW-846 Method 7470 - *Mercury in Liquid Waste (Manual Cold-Vapor Technique)* [analysis for mercury]
HCl, Cl_2, and NH_3	40 CFR 60, Appendix A, EPA Method 26 - *Determination of Hydrogen Chloride Emissions from Stationary Sources* [sampling and analysis for HCl and Cl_2]
	EPA Conditional Test Method 027 - *Procedure for Collection and Analysis of Ammonia in Stationary Sources* [sampling and analysis for NH_3]

TABLE 3 (cont.)

Compound	Test Method
VOC	EPA Compendium Method TO-12 - *Method for the Determination of Non-Methane Organic Compounds (NMOC) in Ambient Air Using Cryogenic Preconcentration and Direct Flame Ionization Detection (FID)* [sampling and analysis]
Speciated VOC	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]
SVOC	SW-846 Method 0010 - Modified Method 5 Sampling Train [sampling]
	SW-846 Method 8270 - Semivolatile Organic Compounds by Gas Chromatography/ Mass Spectrometry (GC/MS) [analysis]
Dioxins and Furans	40 CFR 60, Appendix A, EPA Method 23 - *Determination of Polychlorinated Dibenzo-p-dioxins and Polychlorinated Dibenzofurans from Municipal Waste Combustors* [sampling and analysis]
Aldehydes and Carbonyls	EPA Compendium Method TO-11A - *Determination of Formaldehyde in Ambient Air Using Adsorbent Cartridge Followed by High Performance Liquid Chromatography (HPLC)* [sampling and analysis]
Energetic Materials	SW-846 Method 0010 - *Modified Method 5 Sampling Train* [sampling]
	SW-846 Method 8330 - *Nitroaromatics and Nitramines by High Performance Liquid Chromatography (HPLC)* [analysis]
	SW-846 Method 8332 - *Nitroglycerine by High Performance Liquid Chromatography* [analysis]
Hydrogen Cyanide	NIOSH Method 6010 - *Hydrogen Cyanide* [sampling and analysis]
Perchlorate	Perchlorate sample was obtained from TSP sample [sampling]
	EPA Method 314 - *Determination of Perchlorate in Drinking Water Using Ion Chromatography* [analysis]
Tracer Compound (SF_6)	Grab sample [sampling]
	Gas Chromatograph/Electron Capture Detector [analysis]

The following sections identify and briefly describe the test methods used to measure each compound or group of compounds. During each test run, sample data were collected for 20 to 30 mintues; target minimum sampling times are identified below. Additional information regarding the operation of the ODOBi and the test methods used is presented in Reference 1. EPA-approved methods were used by the laboratories that provided sampling and analysis data.

2.1 Carbon Monoxide, Carbon Dioxide, Oxides of Nitrogen, and Sulfur Dioxide

Real-time concentrations of CO, CO_2, NO_x, and SO_2 that resulted from the use of ordnance in the ODOBi 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*. CO_2 sampling and analysis was conducted in accordance with 40 CFR Part 60, Appendix A, Method 3A - *Determination of Oxygen and Carbon*

Dioxide Concentrations in Emissions from Stationary Sources. NO_x sampling and analysis was conducted in accordance with 40 CFR Part 60, Appendix A, Method 7E - *Determination of Nitrogen Oxides Emissions from Stationary Sources*. SO_2 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 ODOBi 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 ODOBi were determined using a modified sampling and analysis procedure based on EPA Conditional Test Method (CTM) 040 - *Method for the Determination of PM10 and PM2.5 Emissions (Constant Sampling Rate Procedures)*. The sample was collected two cyclones in series with a filter. 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 the 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 ODOBi were determined using particulate matter from one of the TSP samples collected as described in Section 2.2. After the TSP total weight gain was determined in the laboratory, 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 (Cl_2), and ammonia (NH_3) concentrations that resulted from the use of ordnance in the ODOBi were sampled in accordance with 40 CFR 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 hydoxide solutions. The HCl and NH_3 were absorbed in the sulfuric acid solution, while the Cl_2 passed through and was absorbed by the sodium hydroxide solution. HCl and Cl_2 were measured in accordance with 40 CFR 60, Appendix A, EPA Method 26. NH_3 was measured in accordance with EPA Conditional Test Method 027 - *Procedure for Collection and Analysis of Ammonia in Stationary Sources.* The concentrations of HCl, Cl_2, and NH_3 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 20 minutes.

2.6 Volatile Organic Compounds

VOC concentrations that resulted from the use of ordnance in the ODOBi 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 (Speciated VOC) - *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. Unknown compounds, if any, were tentatively identified using computerized mass spectral matching techniques of the highest non-target "peaks."

2.7 Semivolatile Organic Compounds

SVOC concentrations that resulted from the use of ordnance in the ODOBi 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 ODOBi 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 Method 5 sampling trains. The modified sampling trains used standard quartz filters, but the adsorbent cartridges contained XAD-2 polymeric resin beads. A minimum sampling time of 20 minutes was targeted. After sampling, the filters and adsorbent cartridges underwent extraction with toluene. The mass of dioxin and furan compounds collected was quantitatively determined by high-resolution gas chromatography/high-resolution mass spectrometry (HRGC/HRMS) following the procedures in EPA Method 23.

2.9 Aldehyde and Carbonyl Compounds

Aldehyde and carbonyl compound concentrations that resulted from the use of ordnance in the ODOBi 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. 2,4-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 ODOBi 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 two sections of XAD-2 polymeric resin beads separated by glass wool. 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 by HPLC-ultrviolet following the procedures outlined in SW-846 Method 8330 - *Nitroaromatics and Nitramines by High Performance Liquid Chromatography (HPLC*) and SW-846 Methods 8332 - *Nitroglycerine by High Performance Liquid Chromatography*.

2.11 Hydrogen Cyanide

Hydrogen cyanide (HCN) concentrations that resulted from the use of ordnance in the ODOBi were determined using NIOSH Method 6010 - *Hydrogen Cyanide*. The sample gas was drawn through tubes that contained two sections of granular soda lime sorbent. A minimum sampling time of 20 minutes was targeted. The tubes were then capped and analyzed using a spectrophotometer equipped with a visible absorption detector in accordance with NIOSH Method 6010.

2.12 Perchlorate

Perchlorate concentrations that resulted from the use of ordnance in the ODOBi were determined using particulate matter from one of the TSP samples collected as described in Section 2.2. After the TSP total weight gain was determined in the laboratory, 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 - *Determination of Perchlorate in Drinking Water Using Ion Chromatography*.

2.13 Tracer Compound

Sulfur hexafluoride (SF_6) 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 ODOBi during the run. Grab samples were collected five times during each run using evacuated 1-L 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[1] 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. With the exception of the adaptations discussed below that were made to facilitate testing in the test chamber, each ordnance that was tested was deployed in a manner similar to that which would occur in the field. All three ordnance were disassembled prior to testing so that only the projectiles were tested. DODICs C449 and C484 were initiated using a squib and a small quantity of black powder contained in a cotton sleeve. DODIC C790 was initiated using a blasting cap. The initiators were also used during the background runs so that emissions associated with the initiators could be subtracted from the total emissions associated with the initiators and ordnance. 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,[1] 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, CO_2, NO_x, and SO_2) 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

Eight 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.

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 SW8270 (SVOC) 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 SW8330 or SW8332 (energetics) methods, the SW8330 or SW8332 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 preferred method. These cases are noted in the footnotes to Table 4.

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

Compound	Selected Method	Other Method Employed
1,2-Dichlorobenzene	TO-14 (VOC)	SW8270 (SVOC)
1,3-Dichlorobenzene	TO-14 (VOC)	SW8270 (SVOC)
1,4-Dichlorobenzene	TO-14 (VOC)	SW8270 (SVOC)
2,4-Dinitrotoluene	SW8330 or SW8332 (Energetics)	SW8270 (SVOC)
2,6-Dinitrotoluene	SW8330 or SW8332 (Energetics)	SW8270 (SVOC)
Hexachlorobutadiene	TO-14 (VOC)	SW8270 (SVOC)
1,2,4-Trichlorobenzene	TO-14 (VOC)	SW8270 (SVOC)
Acetone[a]	TO-11A (Aldehydes)	TO-14 (VOC)

[a] For DODIC C790, data collected from the VOC sampling method were used to develop emission factors because this compound had a relative percent difference greater than 100 percent between aldehyde test samples.

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., ethylbenzene). 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 four to six 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 eight 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

Ordnances 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:

$$relative\ percent\ difference = \frac{test\ 1\ concentration - test\ 2\ concentration}{average\ of\ test\ 1\ and\ test\ 2\ concentrations}\ x\ 100\%$$

Due to the large relative percent differences between test runs or sample trains, 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

Compound	Applicable DODIC
Carbon dioxide	C790
Carbon monoxide	C790
Oxides of nitrogen	C790
Acetaldehyde	All DODICs
Acetonitrile	C790
Ammonia	C449, C790
1,3-Butadiene	C449
Caprolactam	C449
Carbon disulfide	C484, C790
Chloromethane	C449, C484
Chromium	C449, C790
Ethylbenzene	C449
Formaldehyde	C449, C790
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	C484
1,2,3,4,7,8,9-Heptachlorodibenzofuran	C449, C484
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	C484
1,2,3,4,7,8-Hexachlorodibenzofuran	C449, C484
1,2,3,6,7,8-Hexachlorodibenzofuran	C449
1,2,3,7,8,9-Hexachlorodibenzofuran	C449
2,3,4,6,7,8-Hexachlorodibenzofuran	C449
Hexane	C449
Isopropyl alcohol	C449
Methacrylonitrile	C449
Methylene chloride	C790
Naphthalene	C449
2-Nitrophenol	C449, C484
4-Nitrophenol	C484

TABLE 5 (cont.)

Compound	Applicable DODIC
1,2,3,4,6,7,8,9-Octachlorodibenzofuran	C484
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	C484
2,3,4,7,8-Pentachlorodibenzofuran	C449, C484
Propionaldehyde	C449, C790
Propylene	C449
Pyridine	C449
Styrene	C449
Toluene	C449
1,1,1-Trichloroethane	C790
m-Xylene, p-Xylene	C449
Benzofuran	C449
Bicyclo[4.2.0]octa-1,3,5-triene	C449
n-Butane	C449
2-Butenal, (E)-	C790
1-Butene	C449
2-Butene, (E)-	C449
cis-2-Butene	C449
trans-2-Butene	C449, C790
Cyclobutane	C449, C484
Cyclohexene	C449
2-Cyclohexen-1-one	C790
Cyclopentanone	C449
1,3,5,7-Cyclooctatetraene	C484, C790
1,4:3,6-Dianhydro-.alpha.-d-glucopyranos	C449
Diethylphthalate	C449
Di-n-octylphthalate	C449, C790
13-Docosenamide, (Z)-	C790
Dodecane	C790
Ethane	C449, C484
Furan	C449, C484
2-Furancarboxaldehyde	C449
2-Furanmethanol	C449
Furan, 2-methyl-	C449

TABLE 5 (cont.)

Compound	Applicable DODIC
Furan, 3-methyl-	C790
n-Heptane	C449
1-Hexene	C449
2-Hexene, 5,5-dimethyl-.(Z)-	C790
Methyl ethyl ketone	C449
1-Pentene	C449
cis-2-Pentene	C449
trans-2-Pentene	C449
Perchlorate	C790
Propane	C449
1-Propyne	C449, C790
Tetrahydrofuran	C449
Thiophene	C484
o-Tolualdehyde	C449, C484

3.2.4 Analysis and Calculations

The test report,[1] detailed test plan,[2] and analytical data supporting the test report[3] 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. Several compounds met this criterion and are identified in Table 6. For these compounds, the test data were assigned a "B" rating.

TABLE 6 COMPOUNDS FOUND IN THE METHOD BLANK AT LEVELS BETWEEN 20 PERCENT AND 50 PERCENT OF BOTH TEST VALUES

Compound	Applicable DODIC
Antimony	C790
Barium	C790
Chromium	C449, C790
Copper	C449, C790
1,2,3,4,6,7,8-Heptachlorodibenzofuran	C449
Manganese	C484
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin	C449
Phosphorus	C790
Zinc	C484
Magnesium	C484
Methyl ethyl ketone	C449

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. The compounds that met this criterion are listed in Table 7.

TABLE 7 COMPOUNDS FOUND IN THE METHOD BLANK AT LEVELS GREATER THAN 50 PERCENT OF BOTH TEST VALUES

Compound	Applicable DODIC
Aluminum	All DODICs
Antimony	C445, C484
Chromium	C484
Copper	C484
1,2,3,4,6,7,8-Heptachlorodibenzofuran	C484
Nickel	All DODICs
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin	C484, C790
Phosphorus	C484
Selenium	All DODICs
Ethanol	C790

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 8 identifies the data quality ratings for all compounds that did not receive an “A” rating.

TABLE 8 DOWNGRADED DATA QUALITY RATINGS

Compound	Data Quality Rating	Applicable DODIC
Carbon dioxide	B	C449, C484
Carbon dioxide	C	C790
Carbon monoxide	B	C449, C484
Carbon monoxide	C	C790
Oxides of nitrogen	B	C449, C484
Oxides of nitrogen	C	C790
Sulfur dioxide	B	All DODICs
Acetaldehyde	C	All DODICs
Acetonitrile	C	C790
Ammonia	C	C449, C790
Antimony	B	C790
Barium	B	C790
1,3-Butadiene	C	C449
Caprolactam	C	C449
Carbon disulfide	C	C484, C790
Chloromethane	C	C449, C484
Chromium	C	C449, C790
Copper	B	C449, C790
Ethylbenzene	C	C449
Formaldehyde	C	C449, C790
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	C	C484
1,2,3,4,6,7,8-Heptachlorodibenzofuran	B	C449
1,2,3,4,7,8,9-Heptachlorodibenzofuran	C	C449, C484
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	C	C484
1,2,3,4,7,8-Hexachlorodibenzofuran	C	C449, C484
1,2,3,6,7,8-Hexachlorodibenzofuran	C	C449
1,2,3,7,8,9-Hexachlorodibenzofuran	C	C449
2,3,4,6,7,8-Hexachlorodibenzofuran	C	C449
Hexane	C	C449
Isopropyl alcohol	C	C449
Manganese	B	C484
Methacrylonitrile	C	C449
Methylene chloride	C	C790

TABLE 8 (cont.)

Compound	Data Quality Rating	Applicable DODIC
Naphthalene	C	C449
2-Nitrophenol	C	C449, C484
4-Nitrophenol	C	C484
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin	B	C449
1,2,3,4,6,7,8,9-Octachlorodibenzofuran	C	C484
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	C	C484
2,3,4,7,8-Pentachlorodibenzofuran	C	C449, C484
Phosphorus	B	C790
Propionaldehyde	C	C449, C790
Propylene	C	C449
Pyridine	C	C449
Styrene	C	C449
Toluene	C	C449
1,1,1-Trichloroethane	C	C790
m-Xylene, p-Xylene	C	C449
Zinc	B	C484
Benzofuran	C	C449
Bicyclo[4.2.0]octa-1,3,5-triene	C	C449
n-Butane	C	C449
2-Butenal, (E)-	C	C790
1-Butene	C	C449
2-Butene, (E)-	C	C449
cis-2-Butene	C	C449
trans-2-Butene	C	C449, C790
Cyclobutane	C	C449, C484
Cyclohexene	C	C449
2-Cyclohexen-1-one	C	C790
Cyclopentanone	C	C449
1,3,5,7-Cyclooctatetraene	C	C484, C790
1,4:3,6-Dianhydro-.alpha.-d-glucopyranos	C	C449
Diethylphthalate	C	C449
Di-n-octylphthalate	C	C449, C790
13-Docosenamide, (Z)-	C	C790

TABLE 8 (cont.)

Compound	Data Quality Rating	Applicable DODIC
Dodecane	C	C790
Ethane	C	C449, C484
Furan	C	All DODICs
2-Furancarboxaldehyde	C	C449
2-Furanmethanol	C	C449
Furan, 2-methyl-	C	C449
Furan, 3-methyl-	C	C790
n-Heptane	C	C449
1-Hexene	C	C449
2-Hexene, 5,5-dimethyl-.(Z)-	C	C790
Magnesium	B	C484
Methyl ethyl ketone	C	C449
9-Octadecenamide, (Z)-	C	C790
1-Pentene	C	C449
cis-2-Pentene	C	C449
trans-2-Pentene	C	C449
Perchlorate	C	C790
Propane	C	C449
1-Propyne	C	All DODICs
Tetrahydrofuran	C	C449
Thiophene	C	C484
o-Tolualdehyde	C	C449, C484

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, Cl_2, NH_3, 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 test 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., 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. As appropriate, ppmv and ppbv values were converted to mg/m^3. 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, Cl_2, NH_3, 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, Cl_2, NH_3, 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.
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:

$$DCC = \frac{BCC}{DCF}$$

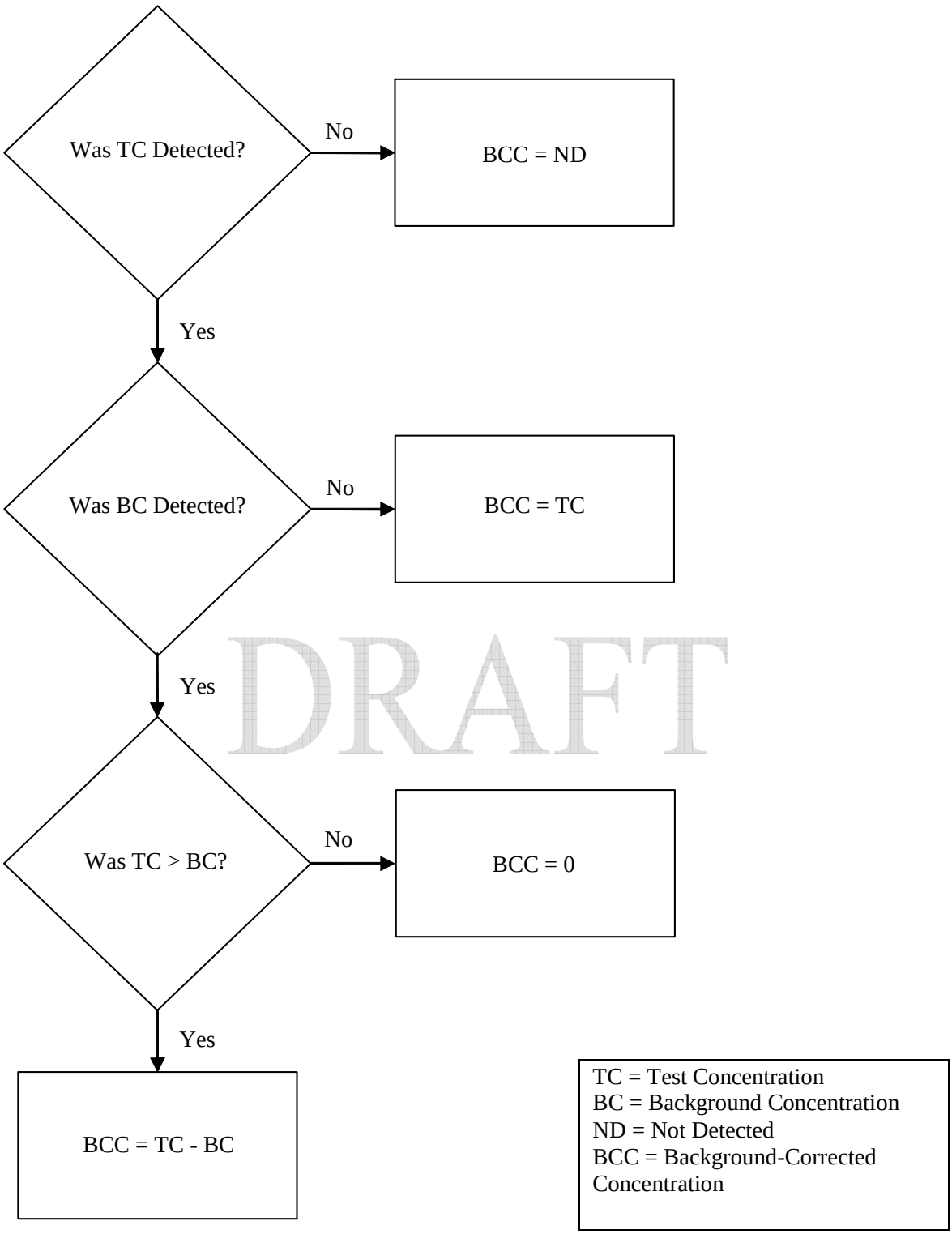

Figure 1 Calculation of background-corrected concentration (BCC).

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 test chamber. This calculation is illustrated by the following equation:

Mass compound released = DCC x Test 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 References 1 and 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. Only two tests were conducted 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 35 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 15 separate categories, depending upon the size and/or chemical composition of the ordnance. The ordnance and their respective categories are identified in Table 9 along with a comment field describing the number of data points.

Within each of the 15 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,[10] 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 15 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 4 to 70. Based upon information provided by EPA,[10] 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.

TABLE 9 ORDNANCE CATEGORIZATION FOR EMISSION FACTOR CORRELATION ASSESSMENT

Category	DODIC	Ordnance Description	Test Series	Comment
Demolition	G900	TH3 AN-M14 Incendiary Grenade	EO 5	20+ data points
	G911	MK3A2 Offensive Hand Grenade	EO 2	
	G911	MK3A2 Offensive Hand Grenade	EO 6	
	K010	M4 Field Incendiary Burster	EO 5	
	K145	M18A1 Antipersonnel Mine	EO 2	
	M023	M112 Demolition Block Charge	EO 1	
	M024[a]	M118 Demolition Block Charge	EO 16	
	M030	1/4-Pound Demolition Block Charge	EO 1	
	M030	1/4-Pound Demolition Block Charge	EO 3	
	M031	1/2-Pound Demolition Block Charge	DPG IV-A	
	M032	1-Pound Demolition Block Charge	EO 2	
	M032	1-Pound Demolition Block Charge	EO 3	
	M039[a]	40-Pound Demolition Cratering Charge	EO 15	
	M130	M6 Electric Blasting Cap	EO 7	
	M131	M7 Non-Electric Blasting Cap	EO 7	
	M241	M10 High Explosive Universal Destructor	DPG IV-B	
	M420	M2A4 15-Pound Demolition Shaped Charge	EO 13	
	M421[a]	M3A1 40-lb Demolition Shaped Charge	EO 14	
	M456	PETN Type 1 Detonating Cord	DPG IV-A	
	M500	M21 Cartridge Actuated Cutter	EO 10	
	M591	M1 Military Dynamite Demolition Block Charge	EO 1	
	M913	M58A3 Linear Demolition Charge	EO 3	
	ML05	MK24 Powder Actuated Cutter	EO 11	
	ML09	Linear Demolition Charge, Shaped 20 gr/ft	DPG IV-A	
	ML15	Linear Demolition Charge, Shaped 225 gr/ft	DPG IV-A	
	ML47	M11 Non-Electric Blasting Cap with 30-foot Shock Tube	EO 7	
	MM50	M221 Clipped Shaped Demolition Charge	EO 11	
	MN02	M11 Non-Electric Blasting Cap with 500-foot Shock Tube	EO 7	

TABLE 9 (cont.)

Category	DODIC	Ordnance Description	Test Series	Comment
Demolition, continued	MN03	M11 Non-Electric Blasting Cap with 1,000-foot Shock Tube	EO 7	20+ data points
	MN06	M14 Non-Electric Time Delay Blasting Cap	EO 7	
	MN07	M15 Non-Electric Time Delay Blasting Cap	EO 11	
	MN08	M81 Time Blasting Fuse Igniter	EO 9	
	MN68	M151 Booster Demolition Charge	DPG VIII	
	None	PAX-11, Granular Powder Burn	EO 4	
	None	PAX-11, Molded Pellet Detonation	EO 4	
Fuse	G878	M228 Practice Hand Grenade Fuse	DPG VI	10+ data points
	N278	M564 Mechanical Time and Super Quick (MTSQ) Fuse	EO 11	
	N285	M577A1 Mechanical Time and Super Quick (MTSQ) Fuse	EO 9	
	N286	M582 Mechanical Time and Super Quick (MTSQ) Fuse	EO 7	
	N335	M557 Point Detonating Fuse	EO 5	
	N340	M739A1 Point Detonating Fuse	EO 5	
	N464	M732 Proximity Fuse	EO 9	
Grenade	G881	M67 Fragmentation Grenade	EO 1	<10 data points
	GG09	M84 Non-Lethal Stun Hand Grenade	EO 12	
Illumination	B505	M662 40-mm Red Star Parachute Cartridge	DPG VIII	20+ data points
	B535	M583A1 40-mm White Star Parachute Cartridge	DPG IV-B	
	B536	M585 40-mm White Star Cluster Cartridge	DPG IV-B	
	B627	M83A3 60-mm Illuminating Cartridge (projectile only)	DPG V-B	
	C449	M314 105-mm Illumination Cartridge (projectile only)	DPG IX	
	C484	M816 81-mm IR Illumination Cartridge (projectile only)	DPG IX	
	C790	M91 120-mm Illumination Cartridge (projectile only)	DPG IX	
	D505	M485A2 155-mm Illumination Round (projectile only)	DPG I	

TABLE 9 (cont.)

Category	DODIC	Ordnance Description	Test Series	Comment
Illumination, continued	H180[a]	2.75-inch Rocket, MK40 Mod 3 Motor with M257 Illumination Warhead	EO 17	20+ data points
	L305	M195 Green Star Parachute Signal Flare	DPG I	
	L306	M158 Red Star Cluster Signal Illumination	DPG II	
	L307	M159 White Star Cluster Signal Illumination	DPG II	
	L311	M126A1 Red Star Parachute Signal Flare	DPG II	
	L312	M127A1 White Star Parachute Signal Flare	DPG I	
	L314	M125A1 Green Star Cluster Signal Flare	DPG I	
	L367	M22 Anti-Tank Guided Missile and Rocket Launching Simulator	DPG VI	
	L410	M206 Aircraft Countermeasure Flare	DPG VI	
Irritant	G963	M7A3 CS Riot Control Agent Hand Grenade	DPG VI	<10 data points
	K765	CS Riot Control Agent Capsule	DPG VI	
Large	C445	M1 105-mm High Explosive Cartridge (projectile only)	EO 13	20+ data points
	C473[a]	M760 105-mm High Explosive Cartridge (projectile only)	EO 16	
	C508[a]	M456A2 105-mm High Explosive Anti-Tank-Tracer-Multi-Purpose Cartridge (projectile only)	EO 15	
	C518[a]	M393 105-mm High Explosive Plastic Tracer Cartridge (projectile only)	EO 16	
	C546[a]	M913 105-mm High Explosive Rocket Assisted Cartridge (projectile only)	EO 16	
	C623	M933 120-mm High-Explosive Cartridge (projectile only)	EO 13	
	C787	M830 120-mm High Explosive Anti-Tank Cartridge (projectile only)	EO 13	
	C791[a]	M830A1 120-mm High Explosive Cartridge (projectile only)	EO 17	
	CA05[a]	M908 120-mm High Explosive Obstacle Reduction Tank Cartridge (projectile only)	EO 18	
	D510[a]	M712 155-mm High Explosive Anti-Tank Projectile	EO 15	
	D529[a]	M795 155-mm High Explosive Projectile	EO 15	
	D579[a]	M549 155-mm Rocket-Assisted Projectile	EO 14	

TABLE 9 (cont.)

Category	DODIC	Ordnance Description	Test Series	Comment
Medium	B129	M789 30-mm High Explosive Dual Purpose (HEDP) Cartridge (projectile only)	EO 9	<10 data points
	B542	M430 40-mm High Explosive Dual Purpose (HEDP) Cartridge (projectile only)	EO 3	
	B571	M383 40-mm High Explosive Cartridge (projectile only)	EO 3	
	BA11	M1001 40-mm High Velocity Canister Cartridge	EO 12	
Mine	K042	M88 Volcano Practice Canister Mine	DPG VIII	<10 data points
	K181[a]	M21 Anti-Tank High Explosive, Heavy Mine	EO 15	
Mortar	B632	M49A4 60-mm High Explosive Cartridge (projectile only)	EO 3	10+ data points
	B642	M720 60-mm High Explosive Cartridge (projectile only)	EO 6	
	B643	M888 60-mm High Explosive Cartridge (projectile only)	EO 11	
	C256	M374 81-mm High Explosive Cartridge (projectile only)	EO 13	
	C788	M57 120-mm High Explosive Cartridge (projectile only)	EO 13	
	C868[a]	M821 81-mm High Explosive Cartridge (projectile only)	EO 15	
	C869[a]	M889 81-mm High Explosive Cartridge (projectile only)	EO 16	
	None	M720 60-mm Mortar HE Cartridge with PAX-21 Charge (projectile only)	EO 8	
Projectile	C995	M136 AT4 Recoilless Rifle, 84-mm Cartridge (projectile only)	EO 3	<10 data points
	H557	M72A3 66-mm High Explosive Antitank Rocket (projectile only)	EO 1	
	H708	M73 35-mm Subcaliber Practice Rocket	DPG VIII	
	PJ02	FIM-92A Stinger-Basic Guided Missile (projectile only)	EO 6	
Propellant	A652	M220 20-mm Target Practice Tracer Cartridge	FP 9	20+ data points
	A940	M910 25-mm Target Practice Discarding Sabot Tracer Cartridge	FP 8	

TABLE 9 (cont.)

Category	DODIC	Ordnance Description	Test Series	Comment
Propellant, continued	A976	M793 25-mm Target Practice Tracer Cartridge	FP 8	20+ data points
	B519	M781 40-mm Practice Cartridge	FP 2	
	B584	M918 40-mm Practice Cartridge	FP 2	
	B627	M83A3 60-mm Illuminating Cartridge (propelling charge only)	FP 10	
	B642	M720 60-mm High Explosive Cartridge (propelling charge only)	FP 4	
	B645	M766 60-mm Short Range Practice Mortar Cartridge (propelling charge only)	FP 10	
	C226	M301A3 81-mm Illuminating Cartridge (propelling charge only)	FP 4	
	C379	M934 120-mm High Explosive Cartridge (Zone 1 - propelling charge only)	FP 8	
	C511	M490 105-mm Target Practice Tracer Cartridge (propelling charge only)	FP 5	
	C784	M831 120-mm Target Practice Tracer Cartridge (propelling charge only)	FP 5	
	C785	M865 120-mm Target Practice Discarding Sabot Tracer Cartridge (propelling charge only)	FP 5	
	C868	M821 81-mm High Explosive Cartridge (propelling charge only)	FP 4	
	C876	M880 81-mm Target Practice Short Range Cartridge (propelling charge only)	FP 4	
	CA09	M931 120-mm Full Range Practice Cartridge (Zone 1 - propelling charge only)	FP 8	
	CA09	M931 120-mm Full Range Practice Cartridge (Zone 4 - propelling charge)	FP 8	
	D533	M119A2 155-mm Propelling Charge (Zone 7)	FP 5	
	D540	M3 155-mm Propelling Charge (Zone 3, M199 Cannon)	FP 1	
	D540	M3 155-mm Propelling Charge (Zone 3, M199 Cannon)	FP 5	
	D540	M3 155-mm Propelling Charge (Zone 3, M284 Cannon)	FP 1	
	D540	M3 155-mm Propelling Charge (Zone 5, M199 Cannon)	FP 1	

TABLE 9 (cont.)

Category	DODIC	Ordnance Description	Test Series	Comment
Propellant, continued	D540	M3A1 155-mm Propelling Charge (Zone 3, M199 Cannon)	FP 1	20+ data points
	D540	M3A1 155-mm Propelling Charge (Zone 3, M284 Cannon)	FP 1	
	D541	M4A2 155-mm Propelling Charge (Zone 7)	FP 5	
	H459	Rocket, 2.75-inch Flechette, MK40 Mod 3 Motor (propelling rocket only)	FP 7	
	H557	M72A3 66-mm High Explosive Antitank Rocket (propelling rocket only)	FP 4	
	H557	M72A3 66-mm High Explosive Antitank Rocket (propelling rocket only)	FP 7	
	H708	M73 35-mm Subcaliber Practice Rocket (motor only)	FP 9	
	H974	Rocket, 2.75-inch M267 Practice Warhead, MK66 Mod 3 Motor (propelling rocket only)	FP 7	
	M174	.50 Caliber Blank Cartridge (Electrically Initiated)	EO 10	
	MD73	M796 Impulse Cartridge	EO 11	
	MN60	M79 Electric Match Igniter	EO 9	
	PJ02	FIM-92A Stinger-Basic Guided Missile (launch motor)	EO 5	
	PJ02	FIM-92A Stinger-Basic Guided Missile (flight motor)	FP 7	
Pyrotechnic	BA15	M769 60-mm Full Range Practice Cartridge (projectile only)	EO 12	20+ data points
	C511	M490 105-mm Target Practice Tracer Cartridge (M13 tracer only)	EO 6	
	C784	M831 120-mm Target Practice Tracer Cartridge (tracer only)	EO 12	
	C785	M865 120-mm Target Practice Discarding Sabot Tracer Cartridge (tracer only)	EO 12	
	C875[a]	M879 81-mm Full Range Practice Cartridge (projectile only)	EO 17	
	CA09[a]	M931 120-mm Full Range Practice Cartridge (projectile) only	EO 17	
	K051	M604 Anti-Tank Practice Mine Fuse	EO 6	
	L366	M74A1 Projectile Air Burst Simulator	DPG IV-B	

TABLE 9 (cont.)

Category	DODIC	Ordnance Description	Test Series	Comment
Pyrotechnic, continued	L495	M49A1 Surface Trip Flare	DPG II	20+ data points
	L508	M72 Red Railroad Warning Fusee	DPG VI	
	L592	TOW Blast Simulator	DPG V-A	
	L594	M115A2 Ground Burst Simulator	DPG I	
	L595	M9 Liquid Projectile Air Burst Simulator	EO 12	
	L596	M110 Flash Artillery Simulator	DPG I	
	L598	M117 Flash Booby Trap Simulator	DPG I	
	L599	M118 Illuminating Booby Trap Simulator	DPG II	
	L600	M119 Whistling Booby Trap Simulator	DPG II	
	L601	M116A1 Hand Grenade Simulator	DPG I	
	L602	M21 Artillery Flash Simulator	DPG IV-B	
	L709	M25 Target Hit Simulator	EO 2	
	L709	XM25 Target Hit Simulator	DPG V-B	
	L720	M26 Target Kill Simulator	EO 6	
	M327	Firing Device Coupling Base	EO 11	
	M448	M2A1 8-second Delay Percussion Detonator	EO 10	
	M626	M1 Pressure Type Demolition Firing Device	EO 9	
	M630	M1 Pull Type Demolition Firing Device	DPG V-A	
	M630	M1 Pull Type Demolition Firing Device	EO 9	
	M670	M700 Time Blasting Fuse	EO 11	
	M766	M60 Time Blasting Fuse Igniter	EO 9	
	ML03	M142 Multipurpose Demolition Firing Device	EO 10	
Rocket/Missile	H163	2.75-inch Rocket, MK66 Mod 3 Motor with M151 High Explosive Warhead	EO 13	10+ data points
	H534[a]	2.75-inch Rocket, MK40 Mod 3 Motor with M229 High Explosive Warhead	EO 14	
	H974[a]	2.75-inch Rocket, MK66 Mod 3 Motor with M267 Practice Warhead	EO 18	
	PA79[a]	AGM-114A Surface Attack Guided Missile (Hellfire)	EO 18	
	PB94[a]	BGM-71A-2 Surface Attack Guided Missile (TOW)	EO 14	

TABLE 9 (cont.)

Category	DODIC	Ordnance Description	Test Series	Comment
Rocket/Missile, continued	PD62[a]	BGM-71E Surface Attack Guided Missile (TOW)	EO 18	10+ data points
	PD68[a]	AGM-114C Surface Attack Guided Missile (Hellfire)	EO 17	
	Z219[a]	Rocket Propelled Grenade	EO 17	
Small Arm-FP	A010	M220 10 Gage Blank/Subcaliber Salute Cartridge	FP 9	20+ data points
	A011	12 Gage #00 Shot Cartridge	FP 9	
	A017	12 Gage #9 Shot Cartridge	FP 10	
	A059	M855 5.56-mm Ball Cartridge (fired from the M16A1 Rifle)	FP 3	
	A059	M855 5.56-mm Ball Cartridge (fired from the M16A2 Rifle)	FP 3	
	A059	M855 5.56-mm Ball Cartridge (No-Lead)	FP 4	
	A063	M856 5.56-mm Tracer Cartridge	FP 3	
	A065	M862 5.56-mm Practice Ball Cartridge	FP 3	
	A066	M193 5.56-mm Ball Cartridge	FP 6	
	A068	M196 5.56-mm Tracer Cartridge	FP 6	
	A080	M200 5.56-mm Blank Cartridge	FP 3	
	A086	.22 Caliber Long Rifle Ball Cartridge	FP 4	
	A106	.22 Caliber Standard Velocity Long Rifle Ball Cartridge	FP 4	
	A111	M82 7.62-mm Blank Cartridge	FP 3	
	A131	M62 7.62-mm Tracer Cartridge	FP 6	
	A136	M118 7.62-mm Ball Match Cartridge	FP 6	
	A143	M80 7.62-mm Ball Cartridge	FP 3	
	A171	M852 7.62-mm Ball Match Cartridge	FP 6	
	A182	M1 .30 Caliber Ball Cartridge	FP 6	
	A212	M2 .30 Caliber Ball Cartridge	FP 6	
	A218	M25 .30 Caliber Tracer Cartridge	FP 9	
	A247	M72 .30 Caliber Ball Match Cartridge	FP 6	
	A363	M882 9-mm Ball Cartridge	FP 3	
	A400	M41 .38 Caliber Special Ball Cartridge	FP 9	
	A403	.38 Caliber Special Blank Cartridge	FP 9	
	A475	M1911 .45 Caliber Ball Cartridge	FP 3	

TABLE 9 (cont.)

Category	DODIC	Ordnance Description	Test Series	Comment
Small Arm-FP, continued	A518	M903 .50 Caliber SLAP Cartridge	FP 9	20+ data points
	A518	M962 .50 Caliber SLAP-T Cartridge	FP 10	
	A525	M2 .50 Caliber Armor Piercing Cartridge	FP 8	
	A557	M17 .50 Caliber Tracer Cartridge	FP 3	
	A557	M33 .50 Caliber Ball Cartridge	FP 3	
	A598	M1A1 .50 Caliber Blank Cartridge	FP 3	
Smoke	A365	M181A1 14.5-mm Artillery Training Cartridge	DPG V-A	20+ data points
	C452[a]	M84 105-mm HC Smoke Cartridge (projectile only)	EO 18	
	C454	M60 105-mm White Phosphorus Smoke Cartridge (projectile only)	DPG IX	
	C870	M819 81-mm Red Phosphorus Smoke Cartridge	DPG VII	
	CA03	XM929 120-mm White Phosphorus Smoke Cartridge (projectile only)	DPG V-B	
	G815	L8A3 Red Phosphorus Smoke Screening Grenade Launcher (UK)	DPG VII	
	G930	AN-M8 Hexachloroethane (HC) Smoke Hand Grenade	DPG V-A	
	G940	M18 Green Smoke Hand Grenade	DPG III	
	G945	M18 Yellow Smoke Hand Grenade	DPG III	
	G950	M18 Red Smoke Hand Grenade	DPG III	
	G950	M18 Red Smoke Hand Grenade (new formulation)	DPG V-A	
	G955	M18 Violet Smoke Hand Grenade	DPG III	
	G955	M18 Violet Smoke Hand Grenade (new formulation)	DPG V-A	
	G978	M82 Smoke Simulant Screening Grenade Launcher	DPG V-B	
	G982	M83 Terephthalic Acid (TA) Smoke Practice Hand Grenade	DPG V-A	
	K866	ABC-M5 30-pound HC Smoke Pot	DPG VII	
	K867	M4A2 Floating Type HC Smoke Pot	DPG VII	

[a] 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 in the data 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 15 ordnance categories were reevaluated. This evaluation indicated that some of the emission factor ratings associated with ordnance included in ten categories could be elevated from a C or D rating to an A or B rating. These ten categories are:

1. Demolition
2. Fuse
3. Illumination
4. Large
5. Mortar
6. Propellant
7. Pyrotechnic
8. Rocket/Missile
9. Small Arm – Firing Point
10. Smoke

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.

Within the current test series, DODICs C449, C484, and C790 were included in the Illumination category, which includes more than 20 test data points. As a result, some emission factor ratings associated with these ordnance were elevated. The emission factor ratings assigned are presented in Appendix A.

6.0 REFERENCES

1. *Sampling Results for USAEC Phase IX Emission Characterization of Exploding Ordnance and Smoke/Pyrotechnics,* URS Group, Inc., Oak Ridge, TN, June 2008.

2. *Detailed Test Plan for Phase IX Emission Characterization of Burning Smoke/Pyrotechnics and Propellants*, West Desert Test Center, U.S. Army Dugway Proving Ground, UT, April 2006.

3. Supporting information including Excel spreadsheets supplied upon request by the U.S. Army Environmental Command, Aberdeen Proving Ground, MD, January 2009.

4. *Munitions Items Disposition Action System (MIDAS)* website, https://midas.dac.army.mil/, U.S. Army Defense Ammunition Center, McAlester, OK, April 2009.

5. *Procedures for Preparing Emission Factor Documents*, EPA-454/R-95-015, U.S. Environmental Protection Agency, Research Triangle Park, NC, November 1997.

6. *Draft Detailed Procedures for Preparing Emission Factors*, U.S. Environmental Protection Agency, Research Triangle Park, NC, June 2006.

7. *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*, Second Supplement, EPA/600/4-89/018, U.S. Environmental Protection Agency, Research Triangle Park, NC, June 1988.

8. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846)*, U.S. Environmental Protection Agency, http://www.epa.gov/epaoswer/hazwaste/test/sw846.htm.

9. *National Institute for Occupational Safety and Health (NIOSH) Manual of Analytical Methods (NMAM), Fourth Edition*, National Institute for Occupational Safety and Health, Cincinnati, OH.

10. 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.

APPENDIX A

COMPOUNDS ANALYZED AND EMISSION FACTORS DEVELOPED FOR ORDNANCE INCLUDED IN PHASE IX TESTING AT DUGWAY PROVING GROUND, UTAH

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TABLE A1 COMPOUNDS ANALYZED AND EMISSION FACTORS DEVELOPED FOR DODIC C449, M314 105-MM ILLUMINATION CARTRIDGE (PROJECTILE ONLY)

CASRN[a]	Compound	Emission Factor[b,c]		Minimum Detection Level mg/m^3[e]
		lb per item	lb per lb NEW[d]	
Carbon Dioxide, Criteria Pollutants, Total Nonmethane Hydrocarbons, and Total Suspended Particulate				
124-38-9	Carbon dioxide[f]	4.3 E-01	1.9 E-01	--
630-08-0	Carbon monoxide[f]	1.6 E-02	7.3 E-03	--
7439-92-1	Lead	8.0 E-07	3.6 E-07	--
--	Oxides of nitrogen[g]	1.9 E-02	8.7 E-03	--
--	PM-2.5	1.1 E-01	4.9 E-02	--
--	PM-10	2.8 E-01	1.3 E-01	--
7446-09-5	Sulfur dioxide[g]	6.1 E-04	2.7 E-04	--
--	Total nonmethane hydrocarbons[g]	2.1 E-03	9.3 E-04	--
12789-66-1	Total suspended particulate[f]	4.8 E-01	2.1 E-01	--
Hazardous Air Pollutants and Toxic Chemicals				
83-32-9	Acenaphthene	ND	ND	1.9 E-03
208-96-8	Acenaphthylene	ND	ND	1.9 E-03
75-07-0	Acetaldehyde[h]	2.1 E-04	9.3 E-05	--
75-05-8	Acetonitrile	7.1 E-05	3.2 E-05	--
98-86-2	Acetophenone	ND	ND	8.9 E-03
53-96-3	2-Acetylaminofluorene	ND	ND	1.9 E-03
107-13-1	Acrylonitrile[g]	4.1 E-05	1.9 E-05	--
107-05-1	Allyl chloride	ND	ND	1.2 E-02
92-67-1	4-Aminobiphenyl	ND	ND	3.7 E-02
7664-41-7	Ammonia[h]	2.3 E-05	1.0 E-05	--
62-53-3	Aniline	ND	ND	2.7 E-02
120-12-7	Anthracene	ND	ND	1.9 E-03
7440-38-2	Arsenic	2.2 E-06	9.7 E-07	--
7440-39-3	Barium	3.0 E-04	1.4 E-04	--
71-43-2	Benzene[f]	9.1 E-05	4.1 E-05	--
92-87-5	Benzidine	ND	ND	1.9 E-01
56-55-3	Benzo[a]anthracene	ND	ND	2.1 E-03
205-99-2	Benzo[b]fluoranthene	ND	ND	4.1 E-03
207-08-9	Benzo[k]fluoranthene	ND	ND	2.3 E-03
191-24-2	Benzo[g,h,i]perylene	ND	ND	5.9 E-03
50-32-8	Benzo[a]pyrene	ND	ND	1.9 E-03
100-44-7	Benzyl chloride	ND	ND	5.3 E-03
7440-41-7	Beryllium	ND	ND	6.9 E-04

TABLE A1 (cont.)

CASRN[a]	Compound	Emission Factor[b,c]		Minimum Detection Level mg/m^3[e]
		lb per item	lb per lb NEW[d]	
75-25-2	Bromoform	ND	ND	1.1 E-02
74-83-9	Bromomethane	ND	ND	3.9 E-03
101-55-3	4-Bromophenylphenylether	ND	ND	1.9 E-03
106-99-0	1,3-Butadiene[i]	1.6 E-05	7.3 E-06	--
85-68-7	Butylbenzylphthalate	ND	ND	2.3 E-03
7440-43-9	Cadmium	ND	ND	1.9 E-03
86-74-8	Carbazole	ND	ND	2.4 E-03
75-15-0	Carbon disulfide[g]	1.2 E-05	5.4 E-06	--
56-23-5	Carbon tetrachloride[g]	ND	ND	6.4 E-03
7782-50-5	Chlorine	ND	ND	7.5 E-02
106-47-8	4-Chloroaniline	ND	ND	2.2 E-02
108-90-7	Chlorobenzene	ND	ND	4.7 E-03
75-00-3	Chloroethane	ND	ND	2.7 E-03
111-91-1	bis(2-Chloroethoxy)methane	ND	ND	1.9 E-03
111-44-4	bis(2-Chloroethyl)ether	ND	ND	2.1 E-03
67-66-3	Chloroform	ND	ND	5.0 E-03
108-60-1	bis(2-Chloroisopropyl)ether	ND	ND	2.8 E-03
74-87-3	Chloromethane[h]	4.1 E-06	1.8 E-06	--
91-58-7	2-Chloronaphthalene	ND	ND	1.9 E-03
7005-72-3	4-Chlorophenylphenyl ether	ND	ND	1.9 E-03
108-39-4 / 106-44-5	m-Cresol/p-Cresol	ND	ND	7.4 E-03
7440-47-3	Chromium[k]	3.4 E-06	1.5 E-06	--
218-01-9	Chrysene	ND	ND	2.4 E-03
7440-48-4	Cobalt[g]	ND	ND	1.9 E-03
7440-50-8	Copper[f]	1.2 E-05	5.2 E-06	--
4170-30-3	Crotonaldehyde	ND	ND	4.2 E-02
98-82-8	Cumene	ND	ND	5.0 E-03
110-82-7	Cyclohexane	ND	ND	3.5 E-03
53-70-3	Dibenz[a,h]anthracene	ND	ND	2.2 E-03
132-64-9	Dibenzofuran	ND	ND	1.9 E-03
106-93-4	1,2-Dibromoethane	ND	ND	7.8 E-03
84-74-2	Dibutylphthalate	ND	ND	3.7 E-02
95-50-1	1,2-Dichlorobenzene	ND	ND	6.1 E-03

TABLE A1 (cont.)

CASRN[a]	Compound	Emission Factor[b,c]		Minimum Detection Level mg/m^3[e]
		lb per item	lb per lb NEW[d]	
541-73-1	1,3-Dichlorobenzene	ND	ND	6.1 E-03
106-46-7	1,4-Dichlorobenzene	ND	ND	6.1 E-03
91-94-1	3,3'-Dichlorobenzidine	ND	ND	2.7 E-02
75-27-4	Dichlororobromomethane	ND	ND	6.8 E-03
75-71-8	Dichlorodifluoromethane	ND	ND	5.0 E-03
75-34-3	1,1-Dichloroethane	ND	ND	4.1 E-03
107-06-2	1,2-Dichloroethane	ND	ND	4.1 E-03
120-83-2	2,4-Dichlorophenol	ND	ND	1.9 E-03
78-87-5	1,2-Dichloropropane	ND	ND	4.7 E-03
10061-02-6	trans-1,3-Dichloro-1-propene	ND	ND	4.6 E-03
76-14-2	Dichlorotetrafluoroethane	ND	ND	7.1 E-03
60-11-7	p-Dimethylaminoazobenzene	ND	ND	1.9 E-03
57-97-6	7,12-Dimethylbenz[a]anthracene	ND	ND	1.9 E-03
119-93-7	3,3'-Dimethylbenzidine	ND	ND	1.9 E-01
105-67-9	2,4-Dimethylphenol	ND	ND	2.3 E-02
131-11-3	Dimethyl phthalate	ND	ND	1.9 E-03
99-65-0	1,3-Dinitrobenzene	ND	ND	1.9 E-03
534-52-1	4,6-Dinitro-o-cresol	ND	ND	3.2 E-02
51-28-5	2,4-Dinitrophenol	ND	ND	8.1 E-02
121-14-2	2,4-Dinitrotoluene	ND	ND	1.4 E-02
606-20-2	2,6-Dinitrotoluene	1.9 E-06	8.4 E-07	--
88-85-7	Dinoseb	ND	ND	3.7 E-03
123-91-1	1,4-Dioxane	ND	ND	1.4 E-02
--	Total dioxin/furan compounds	1.1 E-10	5.0 E-11	--
122-39-4	Diphenylamine	ND	ND	1.9 E-03
122-66-7	1,2-Diphenylhydrazine	ND	ND	1.9 E-03
100-41-4	Ethylbenzene[k]	1.5 E-06	6.8 E-07	--
74-85-1	Ethylene[f]	3.0 E-04	1.4 E-04	--
117-81-7	bis(2-Ethylhexyl)phthalate[g]	ND	ND	3.7 E-02
206-44-0	Fluoranthene	ND	ND	2.0 E-03
86-73-7	Fluorene	ND	ND	1.9 E-03
50-00-0	Formaldehyde[k]	9.4 E-05	4.2 E-05	--
76-13-1	Freon 113	ND	ND	7.8 E-03
35822-46-9	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	6.9 E-12	3.1 E-12	--

TABLE A1 (cont.)

CASRN[a]	Compound	Emission Factor[b,c]		Minimum Detection Level mg/m^3[3,e]
		lb per item	lb per lb NEW[d]	
67562-39-4	1,2,3,4,6,7,8-Heptachlorodibenzofuran	1.1 E-11	5.1 E-12	--
55673-89-7	1,2,3,4,7,8,9-Heptachlorodibenzofuran[h]	1.0 E-12	4.6 E-13	--
118-74-1	Hexachlorobenzene	ND	ND	1.9 E-03
87-68-3	Hexachlorobutadiene	ND	ND	4.2 E-02
77-47-4	Hexachlorocyclopentadiene	ND	ND	3.7 E-02
39227-28-6	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	ND	ND	1.0 E-08
57653-85-7	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	ND	ND	9.7 E-09
19408-74-3	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	ND	ND	9.8 E-09
70648-26-9	1,2,3,4,7,8-Hexachlorodibenzofuran[h]	1.3 E-12	5.8 E-13	--
57117-44-9	1,2,3,6,7,8-Hexachlorodibenzofuran[h]	1.4 E-12	6.1 E-13	--
72918-21-9	1,2,3,7,8,9-Hexachlorodibenzofuran[h]	3.0 E-12	1.3 E-12	--
60851-34-5	2,3,4,6,7,8-Hexachlorodibenzofuran[h]	3.3 E-12	1.5 E-12	--
67-72-1	Hexachloroethane	ND	ND	2.0 E-03
110-54-3	Hexane[h]	3.5 E-06	1.6 E-06	--
7647-01-0	Hydrochloric acid	ND	ND	7.5 E-02
74-90-8	Hydrogen cyanide	1.1 E-06	4.9 E-07	--
193-39-5	Indeno[1,2,3-cd]pyrene	ND	ND	2.0 E-03
78-59-1	Isophorone	ND	ND	1.9 E-03
67-63-0	Isopropyl alcohol[h]	6.6 E-06	3.0 E-06	--
120-58-1	Isosafrole	ND	ND	1.9 E-03
7439-92-1	Lead	8.0 E-07	3.6 E-07	7.4 E-03
7439-96-5	Manganese[g]	1.2 E-05	5.2 E-06	--
7439-97-6	Mercury[g]	ND	ND	2.3 E-04
126-98-7	Methacrylonitrile[h]	5.7 E-06	2.6 E-06	--
96-33-3	Methyl acrylate	ND	ND	1.5 E-02
56-49-5	3-Methylcholanthrene	ND	ND	1.9 E-03
75-09-2	Methylene chloride	ND	ND	3.5 E-03
108-10-1	Methyl isobutyl ketone	ND	ND	4.2 E-03
80-62-6	Methyl methacrylate	ND	ND	1.7 E-02
91-57-6	2-Methylnaphthalene[g]	4.1 E-07	1.8 E-07	--
95-48-7	2-Methylphenol	ND	ND	1.1 E-02

TABLE A1 (cont.)

CASRN[a]	Compound	Emission Factor[b,c]		Minimum Detection Level mg/m^3[e]
		lb per item	lb per lb NEW[d]	
1634-04-4	Methyl tert-butyl ether	ND	ND	3.7 E-03
91-20-3	Naphthalene[i]	1.8 E-06	8.2 E-07	--
134-32-7	1-Naphthylamine	ND	ND	3.7 E-02
91-59-8	2-Naphthylamine	ND	ND	3.7 E-02
100-01-6	4-Nitroaniline	ND	ND	7.4 E-03
98-95-3	Nitrobenzene	ND	ND	2.1 E-03
55-63-0	Nitroglycerin	ND	ND	5.5 E-02
88-75-5	2-Nitrophenol[h]	1.5 E-06	6.8 E-07	--
100-02-7	4-Nitrophenol	ND	ND	1.2 E-02
79-46-9	2-Nitropropane	ND	ND	1.6 E-02
924-16-3	N-Nitroso-di-n-butylamine	ND	ND	1.9 E-03
55-18-5	N-Nitrosodiethylamine	ND	ND	1.9 E-03
62-75-9	N-Nitrosodimethylamine	ND	ND	1.9 E-03
86-30-6	N-Nitrosodiphenylamine	ND	ND	3.2 E-03
621-64-7	N-Nitroso-di-n-propylamine	ND	ND	1.9 E-03
59-89-2	N-Nitrosomorpholine	ND	ND	1.9 E-03
100-75-4	N-Nitrosopiperidine	ND	ND	1.9 E-03
99-55-8	5-Nitro-o-toluidine	ND	ND	3.0 E-02
3268-87-9	1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin	4.1 E-11	1.8 E-11	--
39001-02-0	1,2,3,4,6,7,8,9-Octachlorodibenzofuran	3.4 E-11	1.5 E-11	--
608-93-5	Pentachlorobenzene	ND	ND	1.9 E-03
40321-76-4	1,2,3,7,8-Pentachlorodibenzo-p-dioxin	ND	ND	5.3 E-09
57117-41-6	1,2,3,7,8-Pentachlorodibenzofuran	2.7 E-12	1.2 E-12	--
57117-31-4	2,3,4,7,8-Pentachlorodibenzofuran[h]	3.6 E-12	1.6 E-12	--
76-01-7	Pentachloroethane	ND	ND	1.9 E-03
82-68-8	Pentachloronitrobenzene	ND	ND	1.9 E-03
87-86-5	Pentachlorophenol	ND	ND	9.3 E-02
85-01-8	Phenanthrene	ND	ND	1.9 E-03
108-95-2	Phenol[g]	1.1 E-06	5.1 E-07	--
7723-14-0	Phosphorus[g]	4.8 E-05	2.2 E-05	--
123-38-6	Propionaldehyde[h]	2.1 E-06	9.3 E-07	--
115-07-1	Propylene[i]	1.2 E-04	5.6 E-05	--
129-00-0	Pyrene	ND	ND	2.0 E-03

TABLE A1 (cont.)

CASRN[a]	Compound	Emission Factor[b,c]		Minimum Detection Level mg/m^3[,e]
		lb per item	lb per lb NEW[d]	
110-86-1	Pyridine[h]	1.4 E-06	6.3 E-07	--
94-59-7	Safrole	ND	ND	1.9 E-03
7440-22-4	Silver	ND	ND	3.7 E-03
100-42-5	Styrene[k]	2.2 E-06	9.7 E-07	--
1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin	ND	ND	6.5 E-09
51207-31-9	2,3,7,8-Tetrachlorodibenzofuran	1.9 E-12	8.7 E-13	--
79-34-5	1,1,2,2-Tetrachloroethane	ND	ND	7.0 E-03
127-18-4	Tetrachloroethylene	ND	ND	6.9 E-03
7440-28-0	Thallium	ND	ND	1.3 E-02
108-88-3	Toluene[k]	2.1 E-05	9.5 E-06	--
95-53-4	o-Toluidine	ND	ND	2.4 E-02
120-82-1	1,2,4-Trichlorobenzene	ND	ND	2.9 E-02
71-55-6	1,1,1-Trichloroethane	ND	ND	5.5 E-03
79-00-5	1,1,2-Trichloroethane	ND	ND	5.5 E-03
79-01-6	Trichloroethylene	ND	ND	5.5 E-03
75-69-4	Trichlorofluoromethane	ND	ND	5.7 E-03
95-95-4	2,4,5-Trichlorophenol	ND	ND	4.8 E-03
88-06-2	2,4,6-Trichlorophenol	ND	ND	2.8 E-03
95-63-6	1,2,4-Trimethylbenzene	ND	ND	5.0 E-03
540-84-1	2,2,4-Trimethylpentane	ND	ND	4.7 E-03
75-01-4	Vinyl chloride	ND	ND	2.6 E-03
75-35-4	Vinylidene chloride	ND	ND	4.0 E-03
106-42-3, 108-38-3	m-Xylene, p-Xylene[k]	1.4 E-06	6.4 E-07	--
95-47-6	o-Xylene	ND	ND	4.4 E-03
7440-66-6	Zinc	2.7 E-04	1.2 E-04	--
Other Pollutants				
67-64-1	Acetone[f]	1.8 E-05	7.9 E-06	--
74-86-2	Acetylene[g]	3.8 E-04	1.7 E-04	--
100-52-7	Benzaldehyde[f]	1.6 E-05	7.1 E-06	--
271-89-6	Benzofuran[j]	1.7 E-06	7.8 E-07	--
65-85-0	Benzoic acid	ND	ND	1.7 E-01
100-51-6	Benzyl alcohol	ND	ND	1.3 E-01
694-87-1	Bicyclo[4.2.0]octa-1,3,5-triene[j]	1.8 E-06	8.0 E-07	--
106-97-8	n-Butane[k]	1.7 E-05	7.5 E-06	--

TABLE A1 (cont.)

CASRN[a]	Compound	Emission Factor[b,c]		Minimum Detection Level mg/m^3[,e]
		lb per item	lb per lb NEW[d]	
106-98-9	1-Butene[i]	3.3 E-05	1.5 E-05	--
107-01-7	2-Butene, (E)-[j]	2.0 E-05	8.8 E-06	--
590-18-1	cis-2-Butene[i]	5.5 E-06	2.5 E-06	--
624-64-6	trans-2-Butene[i]	9.0 E-06	4.0 E-06	--
105-60-2	Caprolactam[j]	1.8 E-06	7.9 E-07	--
107-14-2	Chloroacetonitrile	ND	ND	3.5 E-02
2698-41-1	o-Chlorobenzalmalononitrile	ND	ND	3.7 E-03
109-69-3	1-Chlorobutane	ND	ND	4.2 E-02
59-50-7	4-Chloro-3-methylphenol	ND	ND	2.3 E-03
90-13-1	1-Chloronaphthalene	ND	ND	1.9 E-03
95-57-8	2-Chlorophenol	ND	ND	1.9 E-03
287-23-0	Cyclobutane[j]	4.7 E-05	2.1 E-05	--
110-83-8	Cyclohexene[j]	1.5 E-05	6.9 E-06	--
287-92-3	Cyclopentane	ND	ND	1.2 E-02
120-92-3	Cyclopentanone[j]	5.4 E-06	2.4 E-06	--
124-18-5	n-Decane	ND	ND	2.5 E-02
10000-98-14	1,4:3,6-Dianhydro-.alpha.-d-glucopyranos[j]	7.7 E-07	3.4 E-07	--
124-48-1	Dibromochloromethane	ND	ND	8.7 E-03
156-59-2	cis-1,2-Dichloroethene	ND	ND	4.0 E-03
156-60-5	trans-1,2-Dichloroethene	ND	ND	4.6 E-03
87-65-0	2,6-Dichlorophenol	ND	ND	1.9 E-03
10061-01-5	cis-1,3-Dichloropropene	ND	ND	4.6 E-03
141-93-5	1,3-Diethylbenzene	ND	ND	2.2 E-02
105-05-5	1,4-Diethylbenzene	ND	ND	2.2 E-02
84-66-2	Diethylphthalate[k]	1.5 E-06	6.8 E-07	--
5779-94-2	2,5-Dimethylbenzaldehyde	ND	ND	8.3 E-02
75-83-2	2,2-Dimethylbutane	ND	ND	1.5 E-02
79-29-8	2,3-Dimethylbutane	ND	ND	1.5 E-02
565-59-3	2,3-Dimethylpentane	ND	ND	1.7 E-02
108-08-7	2,4-Dimethylpentane	ND	ND	1.7 E-02
117-84-0	Di-n-octylphthalate[h]	8.1 E-07	3.6 E-07	--
74-84-0	Ethane[i]	1.3 E-04	5.7 E-05	--
64-17-5	Ethanol	5.6 E-06	2.5 E-06	--
60-29-7	Ethyl ether	ND	ND	1.3 E-02

TABLE A1 (cont.)

CASRN[a]	Compound	Emission Factor[b,c]		Minimum Detection Level mg/m^3[,e]
		lb per item	lb per lb NEW[d]	
97-63-2	Ethyl methacrylate	ND	ND	5.2 E-02
62-50-0	Ethyl methanesulfonate	ND	ND	1.9 E-03
620-14-4	m-Ethyltoluene[g]	ND	ND	2.1 E-02
611-14-3	o-Ethyltoluene[g]	ND	ND	2.1 E-02
622-96-8	p-Ethyltoluene[f]	ND	ND	5.0 E-03
100-00-9	Furan[l]	4.6 E-05	2.1 E-05	--
98-01-1	2-Furancarboxaldehyde[l]	3.0 E-05	1.4 E-05	--
98-00-0	2-Furanmethanol[j]	2.5 E-06	1.1 E-06	--
534-22-5	Furan, 2-methyl-[j]	2.9 E-05	1.3 E-05	--
142-82-5	n-Heptane[k]	2.7 E-06	1.2 E-06	--
1888-71-7	Hexachloropropene	ND	ND	2.7 E-03
66-25-1	Hexaldehyde	ND	ND	4.2 E-02
591-78-6	2-Hexanone	ND	ND	1.6 E-02
592-41-6	1-Hexene[i]	2.2 E-05	9.7 E-06	--
2691-41-0	HMX	ND	ND	1.4 E-02
75-28-5	Isobutane[g]	ND	ND	9.4 E-03
78-79-5	Isoprene	3.7 E-06	1.7 E-06	--
590-86-3	Isovaleraldehyde	ND	ND	4.2 E-02
7439-95-4	Magnesium[f]	1.5 E-01	6.8 E-02	--
108-87-2	Methylcyclohexane	ND	ND	1.7 E-02
96-37-7	Methylcyclopentane	ND	ND	1.5 E-02
78-93-3	Methyl ethyl ketone[i]	1.1 E-05	5.1 E-06	--
592-27-8	2-Methylheptane[g]	ND	ND	1.9 E-02
589-81-1	3-Methylheptane	ND	ND	2.0 E-02
591-76-4	2-Methylhexane	ND	ND	1.7 E-02
589-34-4	3-Methylhexane	ND	ND	1.7 E-02
66-27-3	Methyl methanesulfonate	ND	ND	2.0 E-03
107-83-5	2-Methylpentane	ND	ND	1.5 E-02
96-14-0	3-Methylpentane	ND	ND	1.5 E-02
88-74-4	2-Nitroaniline	ND	ND	1.9 E-03
99-09-2	3-Nitroaniline	ND	ND	7.4 E-03
10595-95-6	N-Nitrosomethylethylamine	ND	ND	3.1 E-03
930-55-2	N-Nitrosopyrrolidine	ND	ND	1.9 E-03
111-84-2	n-Nonane	ND	ND	2.2 E-02
111-65-9	n-Octane[g]	ND	ND	2.0 E-02

TABLE A1 (cont.)

CASRN[a]	Compound	Emission Factor[b,c]		Minimum Detection Level mg/m^3[,e]
		lb per item	lb per lb NEW[d]	
78-78-4	i-Pentane	ND	ND	1.3 E-02
109-66-0	n-Pentane [g]	ND	ND	1.3 E-02
109-67-1	1-Pentene [i]	1.4 E-05	6.2 E-06	--
627-20-3	cis-2-Pentene [k]	3.1 E-06	1.4 E-06	--
646-04-8	trans-2-Pentene [k]	4.5 E-06	2.0 E-06	--
14797-73-0	Perchlorate	ND	ND	3.1 E-03
62-44-2	Phenacetin	ND	ND	1.9 E-03
74-98-6	Propane [i]	3.4 E-05	1.5 E-05	--
103-65-1	n-Propylbenzene [g]	ND	ND	5.0 E-03
74-99-7	1-Propyne [j]	1.2 E-05	5.5 E-06	--
121-82-4	RDX	ND	ND	1.4 E-02
95-94-3	1,2,4,5-Tetrachlorobenzene	ND	ND	1.9 E-03
58-90-2	2,3,4,6-Tetrachlorophenol	ND	ND	2.4 E-03
109-99-9	Tetrahydrofuran [h]	1.3 E-06	6.0 E-07	--
620-23-5 / 104-87-0	m,p-Tolualdehyde	ND	ND	4.2 E-02
529-20-4	o-Tolualdehyde [h]	1.8 E-05	8.2 E-06	--
526-73-8	1,2,3-Trimethylbenzene	ND	ND	2.1 E-02
108-67-8	1,3,5-Trimethylbenzene	ND	ND	5.0 E-03
565-75-3	2,3,4-Trimethylpentane	ND	ND	2.0 E-02
99-35-4	1,3,5-Trinitrobenzene	ND	ND	1.9 E-03
118-96-7	2,4,6-Trinitrotoluene	1.8 E-06	8.1 E-07	--
1120-21-4	Undecane	ND	ND	2.7 E-02
110-62-3	Valeraldehyde [f]	1.4 E-05	6.2 E-06	--

TABLE A1 (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 compound is 2.23 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 based upon C-rated test data, but because of correlation with emission factors for similar ordnance and number of data points the factor was upgraded from a D rating to a B rating.
[j] Emission factor rated D because the factor is for a tentatively identified compound, and the factor is based upon C-rated test data.
[k] Emission factor based upon C-rated test data, but because of correlation with emission factors for similar ordnance and number of data points the factor was upgraded from a D rating to a C rating.
[l] Emission factor based upon C-rated test data and the factor is a tentatively identified compound, but because of correlation with emission factors for similar ordnance and number of data points the factor was upgraded from a D rating to a C rating.

TABLE A2 COMPOUNDS ANALYZED AND EMISSION FACTORS DEVELOPED FOR DODIC C484, M816 81-MM IR ILLUMINATION CARTRIDGE (PROJECTILE ONLY)

CASRN[a]	Compound	Emission Factor[b,c]		Minimum Detection Level mg/m^3[e]
		lb per item	lb per lb NEW[d]	
Carbon Dioxide, Criteria Pollutants, Total Nonmethane Hydrocarbons, and Total Suspended Particulate				
124-38-9	Carbon dioxide[f]	2.8 E-01	4.4 E-01	--
630-08-0	Carbon monoxide[f]	5.0 E-03	8.0 E-03	--
7439-92-1	Lead	0	0	--
--	Oxides of nitrogen[g]	3.2 E-03	5.1 E-03	--
--	PM-2.5	8.3 E-02	1.3 E-01	--
--	PM-10	1.1 E-01	1.7 E-01	--
7446-09-5	Sulfur dioxide[g]	5.6 E-05	8.9 E-05	--
--	Total nonmethane hydrocarbons[g]	2.2 E-04	3.5 E-04	--
12789-66-1	Total suspended particulate[f]	1.1 E-01	1.8 E-01	--
Hazardous Air Pollutants and Toxic Chemicals				
83-32-9	Acenaphthene	ND	ND	1.9 E-03
208-96-8	Acenaphthylene	ND	ND	1.9 E-03
75-07-0	Acetaldehyde[h]	3.3 E-05	5.2 E-05	--
75-05-8	Acetonitrile	1.2 E-05	1.9 E-05	--
98-86-2	Acetophenone	ND	ND	8.9 E-03
53-96-3	2-Acetylaminofluorene	ND	ND	1.9 E-03
107-13-1	Acrylonitrile[g]	3.6 E-06	5.7 E-06	--
107-05-1	Allyl chloride	ND	ND	1.2 E-02
92-67-1	4-Aminobiphenyl	ND	ND	3.7 E-02
7664-41-7	Ammonia	1.6 E-05	2.5 E-05	--
62-53-3	Aniline	ND	ND	2.7 E-02
120-12-7	Anthracene	ND	ND	1.9 E-03
7440-38-2	Arsenic	1.3 E-07	2.1 E-07	--
7440-39-3	Barium	3.8 E-04	6.1 E-04	--
71-43-2	Benzene[f]	3.0 E-05	4.7 E-05	--
92-87-5	Benzidine	ND	ND	1.9 E-01
56-55-3	Benzo[a]anthracene	ND	ND	2.1 E-03
205-99-2	Benzo[b]fluoranthene	ND	ND	4.1 E-03
207-08-9	Benzo[k]fluoranthene	ND	ND	2.3 E-03
191-24-2	Benzo[g,h,i]perylene	ND	ND	5.9 E-03
50-32-8	Benzo[a]pyrene	ND	ND	1.9 E-03
100-44-7	Benzyl chloride	ND	ND	5.3 E-03
7440-41-7	Beryllium	ND	ND	6.9 E-04

TABLE A2 (cont.)

CASRN[a]	Compound	Emission Factor[b,c]		Minimum Detection Level mg/m^3[e]
		lb per item	lb per lb NEW[d]	
75-25-2	Bromoform	ND	ND	1.1 E-02
74-83-9	Bromomethane	ND	ND	3.9 E-03
101-55-3	4-Bromophenylphenylether	ND	ND	1.9 E-03
106-99-0	1,3-Butadiene[f]	1.0 E-06	1.6 E-06	--
85-68-7	Butylbenzylphthalate	ND	ND	2.3 E-03
7440-43-9	Cadmium	2.6 E-04	4.1 E-04	--
86-74-8	Carbazole	ND	ND	2.4 E-03
75-15-0	Carbon disulfide[i]	0	0	--
56-23-5	Carbon tetrachloride[g]	ND	ND	6.4 E-03
7782-50-5	Chlorine	ND	ND	7.0 E-02
106-47-8	4-Chloroaniline	ND	ND	2.2 E-02
108-90-7	Chlorobenzene	ND	ND	4.7 E-03
75-00-3	Chloroethane	ND	ND	2.7 E-03
111-91-1	bis(2-Chloroethoxy)methane	ND	ND	1.9 E-03
111-44-4	bis(2-Chloroethyl)ether	ND	ND	2.1 E-03
67-66-3	Chloroform	ND	ND	5.0 E-03
108-60-1	bis(2-Chloroisopropyl)ether	ND	ND	2.8 E-03
74-87-3	Chloromethane[h]	1.5 E-06	2.4 E-06	--
91-58-7	2-Chloronaphthalene	ND	ND	1.9 E-03
7005-72-3	4-Chlorophenylphenyl ether	ND	ND	1.9 E-03
108-39-4 / 106-44-5	m-Cresol/p-Cresol	ND	ND	7.4 E-03
218-01-9	Chrysene	ND	ND	2.4 E-03
7440-48-4	Cobalt[g]	ND	ND	1.9 E-03
4170-30-3	Crotonaldehyde	ND	ND	5.0 E-02
98-82-8	Cumene	ND	ND	5.0 E-03
110-82-7	Cyclohexane	ND	ND	3.5 E-03
53-70-3	Dibenz[a,h]anthracene	ND	ND	2.2 E-03
132-64-9	Dibenzofuran	ND	ND	1.9 E-03
106-93-4	1,2-Dibromoethane	ND	ND	7.8 E-03
84-74-2	Dibutylphthalate	ND	ND	3.7 E-02
95-50-1	1,2-Dichlorobenzene	ND	ND	6.1 E-03
541-73-1	1,3-Dichlorobenzene	ND	ND	6.1 E-03
106-46-7	1,4-Dichlorobenzene	ND	ND	6.1 E-03
91-94-1	3,3'-Dichlorobenzidine	ND	ND	2.7 E-02

TABLE A2 (cont.)

CASRN[a]	Compound	Emission Factor[b,c]		Minimum Detection Level mg/m^3[e]
		lb per item	lb per lb NEW[d]	
75-27-4	Dichlororobromomethane	ND	ND	6.8 E-03
75-71-8	Dichlorodifluoromethane	ND	ND	5.0 E-03
75-34-3	1,1-Dichloroethane	ND	ND	4.1 E-03
107-06-2	1,2-Dichloroethane	ND	ND	4.1 E-03
120-83-2	2,4-Dichlorophenol	ND	ND	1.9 E-03
78-87-5	1,2-Dichloropropane	ND	ND	4.7 E-03
10061-02-6	trans-1,3-Dichloro-1-propene	ND	ND	4.6 E-03
76-14-2	Dichlorotetrafluoroethane	ND	ND	7.1 E-03
60-11-7	p-Dimethylaminoazobenzene	ND	ND	1.9 E-03
57-97-6	7,12-Dimethylbenz[a]anthracene	ND	ND	1.9 E-03
119-93-7	3,3'-Dimethylbenzidine	ND	ND	1.9 E-01
105-67-9	2,4-Dimethylphenol	ND	ND	2.3 E-02
131-11-3	Dimethyl phthalate	ND	ND	1.9 E-03
99-65-0	1,3-Dinitrobenzene	ND	ND	1.9 E-03
534-52-1	4,6-Dinitro-o-cresol	ND	ND	3.2 E-02
51-28-5	2,4-Dinitrophenol	ND	ND	8.1 E-02
121-14-2	2,4-Dinitrotoluene	ND	ND	1.4 E-02
606-20-2	2,6-Dinitrotoluene	ND	ND	1.4 E-02
88-85-7	Dinoseb	ND	ND	3.7 E-03
123-91-1	1,4-Dioxane	ND	ND	1.4 E-02
--	Total dioxin/furan compounds	7.4 E-11	1.2 E-10	--
122-39-4	Diphenylamine	ND	ND	1.9 E-03
122-66-7	1,2-Diphenylhydrazine	ND	ND	1.9 E-03
100-41-4	Ethylbenzene[g]	ND	ND	4.4 E-03
74-85-1	Ethylene[f]	8.8 E-05	1.4 E-04	--
117-81-7	bis(2-Ethylhexyl)phthalate[g]	ND	ND	3.7 E-02
206-44-0	Fluoranthene	ND	ND	2.0 E-03
86-73-7	Fluorene	ND	ND	1.9 E-03
50-00-0	Formaldehyde[g]	1.7 E-05	2.6 E-05	--
76-13-1	Freon 113	ND	ND	7.8 E-03
35822-46-9	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin[h]	1.9 E-11	3.1 E-11	--
55673-89-7	1,2,3,4,7,8,9-Heptachlorodibenzofuran[h]	1.1 E-12	1.8 E-12	--
118-74-1	Hexachlorobenzene	ND	ND	1.9 E-03

TABLE A2 (cont.)

CASRN[a]	Compound	Emission Factor[b,c]		Minimum Detection Level mg/m^3[e]
		lb per item	lb per lb NEW[d]	
87-68-3	Hexachlorobutadiene	ND	ND	4.2 E-02
77-47-4	Hexachlorocyclopentadiene	ND	ND	3.7 E-02
39227-28-6	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	ND	ND	8.6 E-09
57653-85-7	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin[h]	1.4 E-12	2.2 E-12	--
19408-74-3	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	ND	ND	8.2 E-09
70648-26-9	1,2,3,4,7,8-Hexachlorodibenzofuran[h]	1.7 E-12	2.8 E-12	--
57117-44-9	1,2,3,6,7,8-Hexachlorodibenzofuran	7.7 E-13	1.2 E-12	--
72918-21-9	1,2,3,7,8,9-Hexachlorodibenzofuran	8.7 E-13	1.4 E-12	--
60851-34-5	2,3,4,6,7,8-Hexachlorodibenzofuran	ND	ND	4.8 E-09
67-72-1	Hexachloroethane	ND	ND	2.0 E-03
110-54-3	Hexane	ND	ND	3.6 E-03
7647-01-0	Hydrochloric acid	ND	ND	7.5 E-02
74-90-8	Hydrogen cyanide	3.5 E-05	5.5 E-05	--
193-39-5	Indeno[1,2,3-cd]pyrene	ND	ND	2.0 E-03
78-59-1	Isophorone	ND	ND	1.9 E-03
67-63-0	Isopropyl alcohol	ND	ND	9.7 E-03
120-58-1	Isosafrole	ND	ND	1.9 E-03
7439-92-1	Lead	0	0	7.4 E-03
7439-96-5	Manganese[g]	3.8 E-07	6.0 E-07	--
7439-97-6	Mercury[g]	ND	ND	2.3 E-04
126-98-7	Methacrylonitrile	ND	ND	1.1 E-02
96-33-3	Methyl acrylate	ND	ND	1.4 E-02
56-49-5	3-Methylcholanthrene	ND	ND	1.9 E-03
75-09-2	Methylene chloride	ND	ND	3.5 E-03
108-10-1	Methyl isobutyl ketone	ND	ND	4.2 E-03
80-62-6	Methyl methacrylate	ND	ND	1.6 E-02
91-57-6	2-Methylnaphthalene[g]	ND	ND	1.9 E-03
95-48-7	2-Methylphenol	ND	ND	1.1 E-02
1634-04-4	Methyl tert-butyl ether	ND	ND	3.7 E-03
91-20-3	Naphthalene[f]	8.9 E-07	1.4 E-06	--
134-32-7	1-Naphthylamine	ND	ND	3.7 E-02
91-59-8	2-Naphthylamine	ND	ND	3.7 E-02
100-01-6	4-Nitroaniline	ND	ND	7.4 E-03

TABLE A2 (cont.)

CASRN[a]	Compound	Emission Factor[b,c]		Minimum Detection Level mg/m^3[e]
		lb per item	lb per lb NEW[d]	
98-95-3	Nitrobenzene	ND	ND	2.1 E-03
55-63-0	Nitroglycerin	2.8 E-06	4.4 E-06	--
88-75-5	2-Nitrophenol[h]	2.2 E-06	3.5 E-06	--
100-02-7	4-Nitrophenol[h]	1.9 E-06	3.0 E-06	--
79-46-9	2-Nitropropane	ND	ND	1.4 E-02
924-16-3	N-Nitroso-di-n-butylamine	ND	ND	1.9 E-03
55-18-5	N-Nitrosodiethylamine	ND	ND	1.9 E-03
62-75-9	N-Nitrosodimethylamine	ND	ND	1.9 E-03
86-30-6	N-Nitrosodiphenylamine	ND	ND	3.2 E-03
621-64-7	N-Nitroso-di-n-propylamine	ND	ND	1.9 E-03
59-89-2	N-Nitrosomorpholine	ND	ND	1.9 E-03
100-75-4	N-Nitrosopiperidine	ND	ND	1.9 E-03
99-55-8	5-Nitro-o-toluidine	ND	ND	3.0 E-02
39001-02-0	1,2,3,4,6,7,8,9-Octachlorodibenzofuran[h]	4.6 E-11	7.3 E-11	--
608-93-5	Pentachlorobenzene	ND	ND	1.9 E-03
40321-76-4	1,2,3,7,8-Pentachlorodibenzo-p-dioxin[h]	7.2 E-13	1.1 E-12	--
57117-41-6	1,2,3,7,8-Pentachlorodibenzofuran	ND	ND	5.8 E-09
57117-31-4	2,3,4,7,8-Pentachlorodibenzofuran[h]	1.2 E-12	1.9 E-12	--
76-01-7	Pentachloroethane	ND	ND	1.9 E-03
82-68-8	Pentachloronitrobenzene	ND	ND	1.9 E-03
87-86-5	Pentachlorophenol	ND	ND	9.3 E-04
85-01-8	Phenanthrene	ND	ND	1.9 E-03
108-95-2	Phenol[g]	ND	ND	3.3 E-03
123-38-6	Propionaldehyde	9.7 E-07	1.5 E-06	--
115-07-1	Propylene[f]	1.5 E-05	2.4 E-05	--
129-00-0	Pyrene	ND	ND	2.0 E-03
110-86-1	Pyridine	ND	ND	2.7 E-03
94-59-7	Safrole	ND	ND	1.9 E-03
7440-22-4	Silver	0	0	--
100-42-5	Styrene[g]	ND	ND	4.3 E-03
1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin	4.5 E-13	7.1 E-13	--
51207-31-9	2,3,7,8-Tetrachlorodibenzofuran	ND	ND	4.1 E-09
79-34-5	1,1,2,2-Tetrachloroethane	ND	ND	7.0 E-03

TABLE A2 (cont.)

CASRN[a]	Compound	Emission Factor[b,c]		Minimum Detection Level mg/m^3[,e]
		lb per item	lb per lb NEW[d]	
127-18-4	Tetrachloroethylene	ND	ND	6.9 E-03
7440-28-0	Thallium	ND	ND	1.3 E-02
108-88-3	Toluene[g]	3.1 E-06	4.9 E-06	--
95-53-4	o-Toluidine	ND	ND	2.4 E-02
120-82-1	1,2,4-Trichlorobenzene	ND	ND	2.9 E-02
71-55-6	1,1,1-Trichloroethane	ND	ND	5.5 E-03
79-00-5	1,1,2-Trichloroethane	ND	ND	5.5 E-03
79-01-6	Trichloroethylene	ND	ND	5.5 E-03
75-69-4	Trichlorofluoromethane	ND	ND	5.7 E-03
95-95-4	2,4,5-Trichlorophenol	ND	ND	4.8 E-03
88-06-2	2,4,6-Trichlorophenol	ND	ND	2.8 E-03
95-63-6	1,2,4-Trimethylbenzene	ND	ND	5.0 E-03
540-84-1	2,2,4-Trimethylpentane	ND	ND	4.7 E-03
75-01-4	Vinyl chloride	ND	ND	2.6 E-03
75-35-4	Vinylidene chloride	ND	ND	4.0 E-03
106-42-3, 108-38-3	m-Xylene, p-Xylene[g]	ND	ND	4.4 E-03
95-47-6	o-Xylene	ND	ND	4.4 E-03
7440-66-6	Zinc	4.3 E-06	6.8 E-06	--
Other Pollutants				
67-64-1	Acetone[f]	6.3 E-06	9.9 E-06	--
74-86-2	Acetylene[g]	4.6 E-05	7.3 E-05	--
100-52-7	Benzaldehyde[f]	ND	ND	5.0 E-02
65-85-0	Benzoic acid	ND	ND	1.7 E-01
100-51-6	Benzyl alcohol	ND	ND	1.3 E-01
106-97-8	n-Butane[g]	ND	ND	2.4 E-02
106-98-9	1-Butene[f]	3.5 E-06	5.5 E-06	--
590-18-1	cis-2-Butene[f]	ND	ND	9.1 E-03
624-64-6	trans-2-Butene[f]	9.4 E-07	1.5 E-06	--
107-14-2	Chloroacetonitrile	ND	ND	3.1 E-02
2698-41-1	o-Chlorobenzalmalononitrile	ND	ND	3.7 E-03
109-69-3	1-Chlorobutane	ND	ND	3.8 E-02
59-50-7	4-Chloro-3-methylphenol	ND	ND	2.3 E-03
90-13-1	1-Chloronaphthalene	ND	ND	1.9 E-03
95-57-8	2-Chlorophenol	ND	ND	1.9 E-03

TABLE A2 (cont.)

CASRN[a]	Compound	Emission Factor[b,c]		Minimum Detection Level mg/m^3[,e]
		lb per item	lb per lb NEW[d]	
287-23-0	Cyclobutane[j]	6.3 E-06	1.0 E-05	--
629-20-9	1,3,5,7-Cyclooctatetraene[j]	2.4 E-06	3.8 E-06	--
287-92-3	Cyclopentane	ND	ND	1.1 E-02
124-18-5	n-Decane	ND	ND	2.3 E-02
124-48-1	Dibromochloromethane	ND	ND	8.7 E-03
156-59-2	cis-1,2-Dichloroethene	ND	ND	4.0 E-03
156-60-5	trans-1,2-Dichloroethene	ND	ND	4.6 E-03
87-65-0	2,6-Dichlorophenol	ND	ND	1.9 E-03
10061-01-5	cis-1,3-Dichloropropene	ND	ND	4.6 E-03
141-93-5	1,3-Diethylbenzene	ND	ND	2.2 E-02
105-05-5	1,4-Diethylbenzene	ND	ND	2.2 E-02
84-66-2	Diethylphthalate[g]	ND	ND	2.7 E-03
5779-94-2	2,5-Dimethylbenzaldehyde	ND	ND	1.0 E-01
75-83-2	2,2-Dimethylbutane	ND	ND	1.4 E-02
79-29-8	2,3-Dimethylbutane	ND	ND	1.4 E-02
565-59-3	2,3-Dimethylpentane	ND	ND	1.6 E-02
108-08-7	2,4-Dimethylpentane	ND	ND	1.6 E-02
117-84-0	Di-n-octylphthalate	ND	ND	2.1 E-03
74-84-0	Ethane[k]	1.5 E-05	2.3 E-05	--
64-17-5	Ethanol	1.6 E-06	2.6 E-06	--
60-29-7	Ethyl ether	ND	ND	1.2 E-02
97-63-2	Ethyl methacrylate	ND	ND	4.7 E-02
62-50-0	Ethyl methanesulfonate	ND	ND	1.9 E-03
620-14-4	m-Ethyltoluene[g]	ND	ND	2.0 E-02
611-14-3	o-Ethyltoluene[g]	ND	ND	2.0 E-02
622-96-8	p-Ethyltoluene[f]	ND	ND	5.0 E-03
110-00-9	Furan[l]	7.8 E-06	1.2 E-05	--
142-82-5	n-Heptane[g]	ND	ND	4.2 E-03
1888-71-7	Hexachloropropene	ND	ND	2.7 E-03
66-25-1	Hexaldehyde	ND	ND	5.0 E-02
591-78-6	2-Hexanone	ND	ND	1.6 E-02
592-41-6	1-Hexene[f]	ND	ND	1.4 E-02
2691-41-0	HMX	ND	ND	1.4 E-02
75-28-5	Isobutane[g]	ND	ND	9.4 E-03
78-79-5	Isoprene	ND	ND	1.1 E-02

TABLE A2 (cont.)

CASRN[a]	Compound	Emission Factor[b,c]		Minimum Detection Level mg/m^3[e]
		lb per item	lb per lb NEW[d]	
590-86-3	Isovaleraldehyde	ND	ND	5.0 E-02
7439-95-4	Magnesium[f]	1.6 E-05	2.5 E-05	--
108-87-2	Methylcyclohexane	ND	ND	1.6 E-02
96-37-7	Methylcyclopentane	ND	ND	1.4 E-02
78-93-3	Methyl ethyl ketone[k]	1.5 E-06	2.3 E-06	--
592-27-8	2-Methylheptane[g]	ND	ND	1.8 E-02
589-81-1	3-Methylheptane	ND	ND	1.9 E-02
591-76-4	2-Methylhexane	ND	ND	1.6 E-02
589-34-4	3-Methylhexane	ND	ND	1.6 E-02
66-27-3	Methyl methanesulfonate	ND	ND	2.0 E-03
107-83-5	2-Methylpentane	ND	ND	1.4 E-02
96-14-0	3-Methylpentane	ND	ND	1.4 E-02
88-74-4	2-Nitroaniline	ND	ND	1.9 E-03
99-09-2	3-Nitroaniline	ND	ND	7.4 E-03
10595-95-6	N-Nitrosomethylethylamine	ND	ND	3.1 E-03
930-55-2	N-Nitrosopyrrolidine	ND	ND	1.9 E-03
111-84-2	n-Nonane	ND	ND	2.1 E-02
111-65-9	n-Octane[g]	ND	ND	1.8 E-02
78-78-4	i-Pentane	ND	ND	1.2 E-02
109-66-0	n-Pentane[g]	ND	ND	1.2 E-02
109-67-1	1-Pentene[f]	1.2 E-06	1.9 E-06	--
627-20-3	cis-2-Pentene[g]	ND	ND	1.1 E-02
646-04-8	trans-2-Pentene[g]	ND	ND	1.1 E-02
14797-73-0	Perchlorate	ND	ND	4.6 E-03
62-44-2	Phenacetin	ND	ND	1.9 E-03
74-98-6	Propane[f]	ND	ND	1.8 E-02
103-65-1	n-Propylbenzene[g]	ND	ND	5.0 E-03
74-99-7	1-Propyne[m]	7.9 E-06	1.3 E-05	--
121-82-4	RDX	ND	ND	1.4 E-02
95-94-3	1,2,4,5-Tetrachlorobenzene	ND	ND	1.9 E-03
58-90-2	2,3,4,6-Tetrachlorophenol	ND	ND	2.4 E-03
109-99-9	Tetrahydrofuran	ND	ND	3.0 E-03
110-02-1	Thiophene[l]	1.2 E-06	1.8 E-06	--
620-23-5 / 104-87-0	m,p-Tolualdehyde	ND	ND	5.0 E-02

TABLE A2 (cont.)

CASRN[a]	Compound	Emission Factor[b,c]		Minimum Detection Level mg/m^3[e]
		lb per item	lb per lb NEW[d]	
529-20-4	o-Tolualdehyde[h]	1.1 E-05	1.8 E-05	--
526-73-8	1,2,3-Trimethylbenzene	ND	ND	1.9 E-02
108-67-8	1,3,5-Trimethylbenzene	ND	ND	5.0 E-03
565-75-3	2,3,4-Trimethylpentane	ND	ND	1.8 E-02
99-35-4	1,3,5-Trinitrobenzene	ND	ND	1.9 E-03
118-96-7	2,4,6-Trinitrotoluene	ND	ND	1.4 E-02
1120-21-4	Undecane	ND	ND	2.5 E-02
110-62-3	Valeraldehyde[f]	5.6 E-06	8.9 E-06	--

[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 compound is 6.30 E-01 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 based upon C-rated test data, but because of correlation with emission factors for similar ordnance and number of data points the factor was upgraded from a D rating to a C rating.
[j] Emission factor rated D because the factor is for a tentatively identified compound, and the factor is based upon C-rated test data.
[k] Emission factor based upon C-rated test data, but because of correlation with emission factors for similar ordnance and number of data points the factor was upgraded from a D rating to a B rating.
[l] Emission factor based upon C-rated test data and the factor is a tentatively identified compound, but because of correlation with emission factors for similar ordnance and number of data points the factor was upgraded from a D rating to a C rating.
[m] Emission factor rated D because the factor is for a tentatively identified compound.

TABLE A3 COMPOUNDS ANALYZED AND EMISSION FACTORS DEVELOPED FOR DODIC C790, M91 120-MM ILLUMINATION CARTRIDGE (PROJECTILE ONLY)

CASRN[a]	Compound	Emission Factor[b,c]		Minimum Detection Level mg/m^3[e]
		lb per item	lb per lb NEW[d]	
Carbon Dioxide, Criteria Pollutants, Total Nonmethane Hydrocarbons, and Total Suspended Particulate				
124-38-9	Carbon dioxide[f]	4.2 E-01	1.1 E-01	--
630-08-0	Carbon monoxide[f]	1.0 E-02	2.6 E-03	--
7439-92-1	Lead	7.3 E-06	1.9 E-06	--
--	Oxides of nitrogen[g]	2.9 E-02	7.7 E-03	--
--	PM-2.5	1.6 E-01	4.2 E-02	--
--	PM-10	3.6 E-01	9.4 E-02	--
7446-09-5	Sulfur dioxide[h]	7.8 E-04	2.0 E-04	--
--	Total nonmethane hydrocarbons[h]	2.1 E-03	5.6 E-04	--
12789-66-1	Total suspended particulate[i]	6.4 E-01	1.7 E-01	--
Hazardous Air Pollutants and Toxic Chemicals				
83-32-9	Acenaphthene	ND	ND	1.8 E-03
208-96-8	Acenaphthylene	ND	ND	1.8 E-03
75-07-0	Acetaldehyde[j]	6.7 E-05	1.8 E-05	--
75-05-8	Acetonitrile[j]	5.9 E-06	1.6 E-06	--
98-86-2	Acetophenone	2.4 E-06	6.3 E-07	--
53-96-3	2-Acetylaminofluorene	ND	ND	1.8 E-03
107-13-1	Acrylonitrile[h]	ND	ND	8.2 E-03
107-05-1	Allyl chloride	ND	ND	1.2 E-02
92-67-1	4-Aminobiphenyl	ND	ND	3.6 E-02
7664-41-7	Ammonia[j]	3.3 E-05	8.6 E-06	--
62-53-3	Aniline	ND	ND	2.6 E-02
120-12-7	Anthracene	ND	ND	1.8 E-03
7440-36-0	Antimony	3.3 E-05	8.7 E-06	--
7440-38-2	Arsenic	7.6 E-07	2.0 E-07	--
7440-39-3	Barium	2.9 E-05	7.5 E-06	--
71-43-2	Benzene[i]	7.8 E-05	2.0 E-05	--
92-87-5	Benzidine	ND	ND	1.8 E-01
56-55-3	Benzo[a]anthracene	ND	ND	2.1 E-03
205-99-2	Benzo[b]fluoranthene	ND	ND	3.9 E-03
207-08-9	Benzo[k]fluoranthene	ND	ND	2.2 E-03
191-24-2	Benzo[g,h,i]perylene	ND	ND	5.7 E-03
50-32-8	Benzo[a]pyrene	ND	ND	1.8 E-03
100-44-7	Benzyl chloride	ND	ND	4.7 E-03

TABLE A3 (cont.)

CASRN[a]	Compound	Emission Factor[b,c]		Minimum Detection Level mg/m^3[,e]
		lb per item	lb per lb NEW[d]	
7440-41-7	Beryllium	2.1 E-07	5.5 E-08	--
75-25-2	Bromoform	ND	ND	9.5 E-03
74-83-9	Bromomethane	ND	ND	3.6 E-03
101-55-3	4-Bromophenylphenylether	ND	ND	1.8 E-03
106-99-0	1,3-Butadiene[i]	ND	ND	2.0 E-03
85-68-7	Butylbenzylphthalate	ND	ND	2.2 E-03
7440-43-9	Cadmium	5.1 E-04	1.3 E-04	--
86-74-8	Carbazole	ND	ND	2.3 E-03
75-15-0	Carbon disulfide[g]	8.1 E-06	2.1 E-06	--
56-23-5	Carbon tetrachloride[h]	ND	ND	5.8 E-03
7782-50-5	Chlorine	ND	ND	7.2 E-02
106-47-8	4-Chloroaniline	ND	ND	2.1 E-02
108-90-7	Chlorobenzene	ND	ND	4.2 E-03
75-00-3	Chloroethane	ND	ND	2.4 E-03
111-91-1	bis(2-Chloroethoxy)methane	ND	ND	1.8 E-03
111-44-4	bis(2-Chloroethyl)ether	ND	ND	2.0 E-03
67-66-3	Chloroform	ND	ND	4.5 E-03
108-60-1	bis(2-Chloroisopropyl)ether	ND	ND	2.7 E-03
74-87-3	Chloromethane	4.8 E-06	1.3 E-06	--
91-58-7	2-Chloronaphthalene	ND	ND	1.8 E-03
7005-72-3	4-Chlorophenylphenyl ether	ND	ND	1.8 E-03
108-39-4 / 106-44-5	m-Cresol/p-Cresol	ND	ND	7.1 E-03
7440-47-3	Chromium[g]	1.7 E-05	4.6 E-06	--
218-01-9	Chrysene	ND	ND	2.3 E-03
7440-48-4	Cobalt[h]	6.3 E-06	1.6 E-06	--
7440-50-8	Copper	1.4 E-05	3.7 E-06	--
4170-30-3	Crotonaldehyde	ND	ND	3.6 E-02
98-82-8	Cumene	ND	ND	4.5 E-03
110-82-7	Cyclohexane	ND	ND	3.1 E-03
53-70-3	Dibenz[a,h]anthracene	ND	ND	2.1 E-03
132-64-9	Dibenzofuran	ND	ND	1.8 E-03
106-93-4	1,2-Dibromoethane	ND	ND	7.0 E-03
84-74-2	Dibutylphthalate	ND	ND	3.6 E-02
95-50-1	1,2-Dichlorobenzene	ND	ND	5.5 E-03

TABLE A3 (cont.)

CASRN[a]	Compound	Emission Factor[b,c]		Minimum Detection Level mg/m^3[e]
		lb per item	lb per lb NEW[d]	
541-73-1	1,3-Dichlorobenzene	ND	ND	5.5 E-03
106-46-7	1,4-Dichlorobenzene	ND	ND	5.5 E-03
91-94-1	3,3'-Dichlorobenzidine	ND	ND	2.6 E-02
75-27-4	Dichlororobromomethane	ND	ND	6.1 E-03
75-71-8	Dichlorodifluoromethane	ND	ND	4.5 E-03
75-34-3	1,1-Dichloroethane	ND	ND	3.7 E-03
107-06-2	1,2-Dichloroethane	ND	ND	3.7 E-03
120-83-2	2,4-Dichlorophenol	ND	ND	1.8 E-03
78-87-5	1,2-Dichloropropane	ND	ND	4.2 E-03
10061-02-6	trans-1,3-Dichloro-1-propene	ND	ND	4.2 E-03
76-14-2	Dichlorotetrafluoroethane	ND	ND	6.4 E-03
60-11-7	p-Dimethylaminoazobenzene	ND	ND	1.8 E-03
57-97-6	7,12-Dimethylbenz[a]anthracene	ND	ND	1.8 E-03
119-93-7	3,3'-Dimethylbenzidine	ND	ND	1.8 E-01
105-67-9	2,4-Dimethylphenol	ND	ND	2.3 E-02
131-11-3	Dimethyl phthalate	ND	ND	1.8 E-03
99-65-0	1,3-Dinitrobenzene	ND	ND	1.9 E-03
534-52-1	4,6-Dinitro-o-cresol	ND	ND	3.1 E-02
51-28-5	2,4-Dinitrophenol	ND	ND	7.9 E-02
121-14-2	2,4-Dinitrotoluene	ND	ND	1.3 E-02
606-20-2	2,6-Dinitrotoluene	ND	ND	1.3 E-02
88-85-7	Dinoseb	ND	ND	3.5 E-03
123-91-1	1,4-Dioxane	ND	ND	1.4 E-02
--	Total dioxin/furan compounds	1.5 E-11	4.0 E-12	--
122-39-4	Diphenylamine	ND	ND	1.8 E-03
122-66-7	1,2-Diphenylhydrazine	ND	ND	1.8 E-03
100-41-4	Ethylbenzene[h]	5.4 E-06	1.4 E-06	--
74-85-1	Ethylene[i]	2.2 E-04	5.7 E-05	--
117-81-7	bis(2-Ethylhexyl)phthalate[h]	ND	ND	3.6 E-02
206-44-0	Fluoranthene	ND	ND	1.9 E-03
86-73-7	Fluorene	ND	ND	1.8 E-03
50-00-0	Formaldehyde[g]	3.2 E-05	8.3 E-06	--
76-13-1	Freon 113	ND	ND	7.0 E-03
35822-46-9	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	0	0	--

TABLE A3 (cont.)

CASRN[a]	Compound	Emission Factor[b,c]		Minimum Detection Level mg/m^3[,e]
		lb per item	lb per lb NEW[d]	
67562-39-4	1,2,3,4,6,7,8-Heptachlorodibenzofuran	ND	ND	8.2 E-09
55673-89-7	1,2,3,4,7,8,9-Heptachlorodibenzofuran	ND	ND	7.3 E-09
118-74-1	Hexachlorobenzene	ND	ND	1.8 E-03
87-68-3	Hexachlorobutadiene	ND	ND	4.0 E-02
77-47-4	Hexachlorocyclopentadiene	ND	ND	3.6 E-02
39227-28-6	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	ND	ND	8.5 E-09
57653-85-7	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	ND	ND	8.0 E-09
19408-74-3	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	ND	ND	8.1 E-09
70648-26-9	1,2,3,4,7,8-Hexachlorodibenzofuran	ND	ND	3.5 E-09
57117-44-9	1,2,3,6,7,8-Hexachlorodibenzofuran	ND	ND	2.8 E-09
72918-21-9	1,2,3,7,8,9-Hexachlorodibenzofuran	ND	ND	3.4 E-09
60851-34-5	2,3,4,6,7,8-Hexachlorodibenzofuran	ND	ND	4.1 E-09
67-72-1	Hexachloroethane	ND	ND	1.9 E-03
110-54-3	Hexane	ND	ND	3.2 E-03
7647-01-0	Hydrochloric acid	ND	ND	7.4 E-02
74-90-8	Hydrogen cyanide	ND	ND	5.0 E-02
193-39-5	Indeno[1,2,3-cd]pyrene	ND	ND	1.9 E-03
78-59-1	Isophorone	ND	ND	1.8 E-03
67-63-0	Isopropyl alcohol	ND	ND	9.2 E-03
120-58-1	Isosafrole	ND	ND	1.8 E-03
7439-92-1	Lead	7.3 E-06	1.9 E-06	7.1 E-03
7439-96-5	Manganese[h]	1.4 E-04	3.6 E-05	--
7439-97-6	Mercury[h]	ND	ND	2.3 E-04
126-98-7	Methacrylonitrile	ND	ND	1.0 E-02
96-33-3	Methyl acrylate	ND	ND	1.3 E-02
56-49-5	3-Methylcholanthrene	ND	ND	1.8 E-03
75-09-2	Methylene chloride[j]	3.7 E-05	9.6 E-06	--
108-10-1	Methyl isobutyl ketone	ND	ND	3.7 E-03
80-62-6	Methyl methacrylate	ND	ND	1.5 E-02
91-57-6	2-Methylnaphthalene[h]	6.8 E-07	1.8 E-07	--
95-48-7	2-Methylphenol	ND	ND	1.1 E-02

TABLE A3 (cont.)

CASRN[a]	Compound	Emission Factor[b,c]		Minimum Detection Level mg/m^3[e]
		lb per item	lb per lb NEW[d]	
1634-04-4	Methyl tert-butyl ether	ND	ND	3.3 E-03
91-20-3	Naphthalene[i]	6.0 E-06	1.6 E-06	--
134-32-7	1-Naphthylamine	ND	ND	3.6 E-02
91-59-8	2-Naphthylamine	ND	ND	3.6 E-02
100-01-6	4-Nitroaniline	ND	ND	7.1 E-03
98-95-3	Nitrobenzene	ND	ND	2.0 E-03
55-63-0	Nitroglycerin	1.2 E-05	3.1 E-06	--
88-75-5	2-Nitrophenol	ND	ND	1.8 E-03
100-02-7	4-Nitrophenol	ND	ND	1.2 E-02
79-46-9	2-Nitropropane	ND	ND	1.4 E-02
924-16-3	N-Nitroso-di-n-butylamine	ND	ND	1.8 E-03
55-18-5	N-Nitrosodiethylamine	ND	ND	1.8 E-03
62-75-9	N-Nitrosodimethylamine	ND	ND	1.8 E-03
86-30-6	N-Nitrosodiphenylamine	ND	ND	3.1 E-03
621-64-7	N-Nitroso-di-n-propylamine	ND	ND	1.8 E-03
59-89-2	N-Nitrosomorpholine	ND	ND	1.8 E-03
100-75-4	N-Nitrosopiperidine	ND	ND	1.8 E-03
99-55-8	5-Nitro-o-toluidine	ND	ND	2.9 E-02
39001-02-0	1,2,3,4,6,7,8,9-Octachlorodibenzofuran	1.5 E-11	4.0 E-12	--
608-93-5	Pentachlorobenzene	ND	ND	1.8 E-03
40321-76-4	1,2,3,7,8-Pentachlorodibenzo-p-dioxin	ND	ND	4.8 E-09
57117-41-6	1,2,3,7,8-Pentachlorodibenzofuran	ND	ND	6.6 E-09
57117-31-4	2,3,4,7,8-Pentachlorodibenzofuran	ND	ND	6.1 E-09
76-01-7	Pentachloroethane	ND	ND	1.8 E-03
82-68-8	Pentachloronitrobenzene	ND	ND	1.8 E-03
87-86-5	Pentachlorophenol	ND	ND	8.9 E-02
85-01-8	Phenanthrene	ND	ND	1.8 E-03
108-95-2	Phenol[h]	9.0 E-07	2.4 E-07	--
7723-14-0	Phosphorus[h]	8.5 E-05	2.2 E-05	--
123-38-6	Propionaldehyde[j]	3.3 E-05	8.6 E-06	--
115-07-1	Propylene[i]	4.3 E-05	1.1 E-05	--
129-00-0	Pyrene	ND	ND	1.9 E-03
110-86-1	Pyridine	ND	ND	2.6 E-03

TABLE A3 (cont.)

CASRN[a]	Compound	Emission Factor[b,c]		Minimum Detection Level mg/m^3[3,e]
		lb per item	lb per lb NEW[d]	
94-59-7	Safrole	ND	ND	1.8 E-03
7440-22-4	Silver	ND	ND	3.7 E-03
100-42-5	Styrene[h]	ND	ND	3.9 E-03
1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin	ND	ND	6.9 E-09
51207-31-9	2,3,7,8-Tetrachlorodibenzofuran	ND	ND	5.4 E-09
79-34-5	1,1,2,2-Tetrachloroethane	ND	ND	6.3 E-03
127-18-4	Tetrachloroethylene	ND	ND	6.2 E-03
7440-28-0	Thallium	ND	ND	1.3 E-02
108-88-3	Toluene[h]	2.3 E-05	6.1 E-06	--
95-53-4	o-Toluidine	ND	ND	2.3 E-02
120-82-1	1,2,4-Trichlorobenzene	ND	ND	2.8 E-02
71-55-6	1,1,1-Trichloroethane[j]	4.4 E-06	1.1 E-06	--
79-00-5	1,1,2-Trichloroethane	ND	ND	5.0 E-03
79-01-6	Trichloroethylene	ND	ND	4.9 E-03
75-69-4	Trichlorofluoromethane	ND	ND	5.1 E-03
95-95-4	2,4,5-Trichlorophenol	ND	ND	4.6 E-03
88-06-2	2,4,6-Trichlorophenol	ND	ND	2.7 E-03
95-63-6	1,2,4-Trimethylbenzene	ND	ND	4.5 E-03
540-84-1	2,2,4-Trimethylpentane	ND	ND	4.3 E-03
75-01-4	Vinyl chloride	ND	ND	2.3 E-03
75-35-4	Vinylidene chloride	ND	ND	3.6 E-03
106-42-3, 108-38-3	m-Xylene, p-Xylene[h]	2.0 E-06	5.3 E-07	--
95-47-6	o-Xylene	ND	ND	4.0 E-03
7440-66-6	Zinc	2.6 E-04	6.8 E-05	--
Other Pollutants				
67-64-1	Acetone[i]	0	0	--
74-86-2	Acetylene[h]	6.5 E-03	1.7 E-03	--
100-52-7	Benzaldehyde[i]	1.8 E-05	4.8 E-06	--
65-85-0	Benzoic acid	ND	ND	1.6 E-01
100-51-6	Benzyl alcohol	ND	ND	1.3 E-01
106-97-8	n-Butane[h]	ND	ND	2.2 E-02
123-73-9	2-Butenal, (E)-[k]	5.3 E-06	1.4 E-06	--
106-98-9	1-Butene[i]	8.4 E-06	2.2 E-06	--
590-18-1	cis-2-Butene[i]	2.4 E-06	6.4 E-07	--

TABLE A3 (cont.)

CASRN[a]	Compound	Emission Factor[b,c]		Minimum Detection Level mg/m^3[e]
		lb per item	lb per lb NEW[d]	
624-64-6	trans-2-Butene[f]	2.7 E-06	7.2 E-07	--
107-14-2	Chloroacetonitrile	ND	ND	2.9 E-02
2698-41-1	o-chlorobenzalmalononitrile	ND	ND	3.6 E-03
109-69-3	1-Chlorobutane	ND	ND	3.5 E-02
59-50-7	4-Chloro-3-methylphenol	ND	ND	2.2 E-03
90-13-1	1-Chloronaphthalene	ND	ND	1.8 E-03
95-57-8	2-Chlorophenol	ND	ND	1.8 E-03
930-68-7	2-Cyclohexen-1-one[k]	7.3 E-06	1.9 E-06	--
629-20-9	1,3,5,7-Cyclooctatetraene[k]	8.7 E-06	2.3 E-06	--
287-92-3	Cyclopentane	ND	ND	1.1 E-02
124-18-5	n-Decane	ND	ND	2.2 E-02
124-48-1	Dibromochloromethane	ND	ND	7.8 E-03
156-59-2	cis-1,2-Dichloroethene	ND	ND	3.6 E-03
156-60-5	trans-1,2-Dichloroethene	ND	ND	4.2 E-03
87-65-0	2,6-Dichlorophenol	ND	ND	1.8 E-03
10061-01-5	cis-1,3-Dichloropropene	ND	ND	4.2 E-03
141-93-5	1,3-Diethylbenzene	ND	ND	2.1 E-02
105-05-5	1,4-Diethylbenzene	ND	ND	2.1 E-02
84-66-2	Diethylphthalate[h]	2.1 E-06	5.6 E-07	--
5779-94-2	2,5-Dimethylbenzaldehyde	ND	ND	7.1 E-02
75-83-2	2,2-Dimethylbutane	ND	ND	1.3 E-02
79-29-8	2,3-Dimethylbutane	ND	ND	1.3 E-02
565-59-3	2,3-Dimethylpentane	ND	ND	1.5 E-02
108-08-7	2,4-Dimethylpentane	ND	ND	1.5 E-02
117-84-0	Di-n-octylphthalate[j]	2.2 E-06	5.7 E-07	--
112-84-5	13-Docosenamide, (Z)-[k]	8.1 E-05	2.1 E-05	--
112-40-3	Dodecane[k]	4.3 E-06	1.1 E-06	--
74-84-0	Ethane[i]	7.0 E-05	1.8 E-05	--
60-29-7	Ethyl ether	ND	ND	1.1 E-02
97-63-2	Ethyl methacrylate	ND	ND	4.4 E-02
62-50-0	Ethyl methanesulfonate	ND	ND	1.8 E-03
620-14-4	m-Ethyltoluene[h]	ND	ND	1.9 E-02
611-14-3	o-Ethyltoluene[h]	ND	ND	1.9 E-02
622-96-8	p-Ethyltoluene[i]	ND	ND	4.5 E-03
110-00-9	Furan[l]	1.6 E-05	4.2 E-06	--

TABLE A3 (cont.)

CASRN[a]	Compound	Emission Factor[b,c]		Minimum Detection Level mg/m^3[e]
		lb per item	lb per lb NEW[d]	
930-27-8	Furan, 3-methyl-[k]	2.9 E-06	7.5 E-07	--
142-82-5	n-Heptane[h]	ND	ND	3.7 E-03
1888-71-7	Hexachloropropene	ND	ND	2.6 E-03
66-25-1	Hexaldehyde	1.3 E-05	3.3 E-06	--
591-78-6	2-Hexanone	ND	ND	1.5 E-02
592-41-6	1-Hexene[i]	ND	ND	1.3 E-02
39761-61-0	2-Hexene, 5,5-dimethyl-.(Z)-[k]	1.2 E-05	3.2 E-06	--
2691-41-0	HMX	ND	ND	1.3 E-02
75-28-5	Isobutane[h]	ND	ND	8.9 E-03
78-79-5	Isoprene	ND	ND	1.0 E-02
590-86-3	Isovaleraldehyde	ND	ND	3.6 E-02
7439-95-4	Magnesium[i]	2.5 E-01	6.5 E-02	--
108-87-2	Methylcyclohexane	ND	ND	1.5 E-02
96-37-7	Methylcyclopentane	ND	ND	1.3 E-02
78-93-3	Methyl ethyl ketone[i]	1.1 E-05	2.8 E-06	--
592-27-8	2-Methylheptane[h]	ND	ND	1.7 E-02
589-81-1	3-Methylheptane	ND	ND	1.8 E-02
591-76-4	2-Methylhexane	ND	ND	1.5 E-02
589-34-4	3-Methylhexane	ND	ND	1.5 E-02
66-27-3	Methyl methanesulfonate	ND	ND	2.0 E-03
107-83-5	2-Methylpentane	ND	ND	1.3 E-02
96-14-0	3-Methylpentane	ND	ND	1.3 E-02
88-74-4	2-Nitroaniline	ND	ND	1.8 E-03
99-09-2	3-Nitroaniline	ND	ND	7.1 E-03
10595-95-6	N-Nitrosomethylethylamine	ND	ND	3.0 E-03
930-55-2	N-Nitrosopyrrolidine	ND	ND	1.8 E-03
111-84-2	n-Nonane	ND	ND	2.0 E-02
301-02-0	9-Octadecenamide, (Z)-[m]	4.6 E-06	1.2 E-06	--
111-65-9	n-Octane[h]	ND	ND	1.8 E-02
78-78-4	i-Pentane	ND	ND	1.1 E-02
109-66-0	n-Pentane[h]	ND	ND	1.1 E-02
109-67-1	1-Pentene	ND	ND	1.1 E-02
627-20-3	cis-2-Pentene[h]	ND	ND	1.1 E-02
646-04-8	trans-2-Pentene[h]	ND	ND	1.1 E-02
14797-73-0	Perchlorate[j]	1.2 E-06	3.2 E-07	--

TABLE A3 (cont.)

CASRN[a]	Compound	Emission Factor[b,c]		Minimum Detection Level mg/m^3[e]
		lb per item	lb per lb NEW[d]	
62-44-2	Phenacetin	ND	ND	1.8 E-03
74-98-6	Propane[i]	ND	ND	1.7 E-02
103-65-1	n-Propylbenzene[h]	ND	ND	4.5 E-03
74-99-7	1-Propyne[k]	3.4 E-05	8.8 E-06	--
121-82-4	RDX	ND	ND	1.3 E-02
95-94-3	1,2,4,5-Tetrachlorobenzene	ND	ND	1.8 E-03
58-90-2	2,3,4,6-Tetrachlorophenol	ND	ND	2.3 E-03
109-99-9	Tetrahydrofuran	ND	ND	2.7 E-03
620-23-5 / 104-87-0	m,p-Tolualdehyde	ND	ND	3.6 E-02
529-20-4	o-Tolualdehyde	ND	ND	3.6 E-02
526-73-8	1,2,3-Trimethylbenzene	ND	ND	1.8 E-02
108-67-8	1,3,5-Trimethylbenzene	ND	ND	4.5 E-03
565-75-3	2,3,4-Trimethylpentane	ND	ND	1.8 E-02
99-35-4	1,3,5-Trinitrobenzene	ND	ND	1.8 E-03
118-96-7	2,4,6-Trinitrotoluene	ND	ND	1.3 E-02
1120-21-4	Undecane	ND	ND	2.4 E-02
110-62-3	Valeraldehyde[i]	1.8 E-05	4.6 E-06	--

[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 compound is 3.81 pounds per item.
[e] Data provided for compounds that were not detected.
[f] Emission factor based upon C-rated test data, but because of correlation with emission factors for similar ordnance and number of data points the factor was upgraded from a D rating to a B rating.
[g] Emission factor based upon C-rated test data, but because of correlation with emission factors for similar ordnance and number of data points the factor was upgraded from a D rating to a C rating.
[h] Emission factor rated B because of correlation with emission factors for similar ordnance and number of test data points.
[i] Emission factor rated A because of correlation with emission factors for similar ordnance and number of test data points.
[j] Emission factor rated D because the factor is based upon C-rated test data.
[k] Emission factor rated D because the factor is for a tentatively identified compound, and the factor is based upon C-rated test data.
[l] Emission factor is for a tentatively identified compound, but because of correlation with emission factors for similar ordnance and number of data points the factor was upgraded from a D rating to a C rating.
[m] Emission factor rated D because the factor is for a tentatively identified compound.

APPENDIX B

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

Electronic versions of the new AP-42 sections for ordnance included in Phase IX 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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