DEPARTMENT OF THE AIR FORCE
HEADQUARTERS 27th FIGHTER WING (ACC)
CANNON AIR FORCE BASE, NEW MEXICO

15 SEP 1994

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Mr. Tom Tatkin
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Dear Mr. Tatkin

We would like to thank you for your support in completing and revising our permit application for the Open Detonation Unit at Melrose Air Force Range (MAFR). In reference to your recent telephone conversations with my Environmental Flight, Cannon AFB believes the air emissions associated with the Resource Conservation and Recovery Act, Subpart X permit application for Open Detonation at MAFR do not warrant air modeling. Our conclusions are based primarily upon the remoteness of MAFR to receptors, the small quantities of waste items to be treated (maximum 8,000 lbs per year), and the low levels of emissions observed from open detonation of munitions items.

Extracts from Section E of the permit application are located in Attachment 1. The nearest off-installation receptor is approximately 40,000 feet (7.58 mi) from the OD unit (source of emissions). Current ambient air quality is excellent and well within attainment of National Ambient Air Quality Standards. The emissions generated from OD operations will have an insignificant effect upon potential receptors or air quality. OD operations will only be conducted during conditions of low winds which will serve to decrease potential for emission migration. The nearest Class I sensitive ecological area is located at least 100 miles away from MAFR. A map depicting the Class I areas in relation to MAFR is located in Attachment 2.

Emissions from explosives and explosive components typical of those treated at MAFR have been studied with results contained in the "Characterization of Emissions Resulting From Thermal Treatment of Selected Explosive Munitions" ("Bang Box Study" Johnson Jan 94) and found to be nearly negligible. As shown in Attachment 3, the emissions from a sample of Tri-nitro-toluene (TNT) explosive are very low. When combined with the low annual maximum Net Explosive Weight (NEW) to be treated at the OD unit, air emissions

remain de-minimis. For example, in the TNT test at Attachment 3, the compound with the highest average emission is Methane (5.51E-04 wt/wt). With an annual maximum detonation of 8,000 pounds NEW per year, the maximum emission of Methane would be 4.408 pounds per year.

When combined with existing discussions in the permit application (Attachment 1), this information should fully address the requirements of 40 CFR part 264.601.

The support you have provided in preparing and reviewing our permit application has been invaluable. We greatly appreciate the time and effort you have put forth to support our mission. If you have any further questions, please contact Capt Greg Walters or Dr. Janice Stowell of my Environmental Flight at (505) 784-6022.

Sincerely

David A. Mitchell

DAVID A. MITCHELL, Colonel, USAF
Commander

Attachments:
1. Permit Application Extracts
2. Class I Areas Map
3. Bang Box Study Extracts

E. ENVIRONMENTAL PERFORMANCE STANDARDS

This section provides a detailed description of environmental, geological, and hydrogeological conditions at the Melrose AFR OD unit, in accordance with the requirements of various provisions specified under NMHWMR-7, Parts V and IX, and 40 CFR 264.601 and 270.14.

E-1 SUBSURFACE ASSESSMENT [NMHWMR-7, Part V; 40 CFR 264.601(a)]

The Melrose AFR is in the central portion of the Southern High Plains plateau. In the area of Melrose AFR, surface topography is characterized to some extent by the appearance of small, internally drained temporary lake basins known as playas. Due to the low annual rainfall, high lake evaporation rate, and minimal topographic relief, surface streams are generally poorly developed and exist as intermittent streams with no apparent receiving waters. Drainage patterns that do exist consist of long shallow valleys called draws that originate in areas of higher relief such as the mesas commonly found in the area.

Groundwater in the Melrose AFR area is found at an estimated depth of 94 to 100 ft below surface in a perched water zone, well above the Ogallala Aquifer. These hydrologic zones are not believed to be hydraulically connected (see the USGS Geologic Report in Appendix E).

E-1a Volume and Characteristic of the Waste [40 CFR 264.601(a)(1)]

The volume and characteristics of the waste to be thermally treated at the OD unit are described in Sect. C. Waste munitions are transported to the OD unit in their original containers or casings, which are designed for long-term stability and thus ensure that no wastes are inadvertently released to the environment prior to treatment.

The OD operations will be conducted within a single bermed area at the OD unit, as described in Sect. D. Contaminants released during treatment, usually limited to trace amounts of explosive compounds or toxic metals, should not adversely affect subsurface soils as a result of these activities. Past soil analyses have not shown any of these contaminants to be at levels that pose an actual or potential threat to human health or the environment. Furthermore, waste munitions are for the most part insoluble in water (see Table C-2), thus limiting the potential for wastes to migrate through soil or into surface or groundwater. The primary concern of releases of any contaminants would be gaseous and, therefore, affect air media rather than subsurface media.

E-1b Hydrogeologic Characterization [40 CFR 264.601(a)(2) and 270.14(c)]

The Ogallala Formation of Tertiary (Pliocene) age is the primary regional aquifer for both potable and irrigation water in the Southern High Plains of western Texas and eastern New Mexico. The Ogallala Formation consists of clay, silt, fine-to coarse-grained sand, gravel, and caliche. The lithology varies both vertically and horizontally within short distances, and individual beds or lenses are not continuous over wide areas. Although most of the Ogallala is unconsolidated, sediments near the top and locally within the formation have been cemented, mainly by calcium carbonate, to form resistent, impermeable beds of caliche. The formation ranges in thickness from 0 ft where the formation pinches out against older rocks to as much as 500 ft in east-central Curry County, New Mexico.

The Ogallala Aquifer is part of the High Plains aquifer that extends continuously from Wyoming and South Dakota into New Mexico and Texas. In east-central New Mexico, the Ogallala Aquifer rests on Dockum Group redbeds, which serve as the basal confining layer. It is believed that the Ogallala Formation and the Portales Valley Fill, which underlies the Melrose AFR, exist as a single hydrologic unit. The two underground basins that are part of the Ogallala Aquifer and extend beneath the currently expanded Melrose AFR are the Fort Sumner Basin and the Portales Basin. The State of New Mexico's Engineer's Office considers these to be the only designated or declared aquifer basins that extend into the area bounded by the range.

The groundwater in the Ogallala Formation exists under unconfined conditions and is contained in the pore spaces of the unconsolidated or partially consolidated sediments, which are underlain in most of the area by relatively impermeable clays and shales. Groundwater flow has a northeasterly regional gradient of approximately 13 ft/mile. The saturated thickness of the Ogallala Aquifer ranges from less than 50 ft to more than 300 ft, although increased agricultural withdrawals for this groundwater have caused a significant decline in the water table since the 1930s and the overall reduction in the saturated thickness. At the Melrose Range, it is estimated to be less than 100 ft. As a result, well yields have likewise decreased over the years. Well yields vary from less than 1 gpm in thin silts and sands up to 1600 gpm in thick sands and gravels. Water quality is generally good, although the water is typically hard and has high concentrations of fluoride in many areas.

Exploratory holes drilled at the OD area as part of hydrogeologic investigations of the site were not advanced deep enough to intercept the Ogallala Aquifer. However, this investigation did confirm, as previously believed, the existence of a more shallow perched zone found at a depth ranging from 94 to 100 ft below surface grade (BSG). The areal extent of this perched zone has not been accurately determined. A more detailed description of hydrogeologic characterizations of the area is presented in the geologic report of Appendix E.

Table E-1 (continued)

Analyte	Concentration (μg/L)	Analyte	Concentration (μg/L)
4-Chlorotoluene	<0.3	Chloroform	<0.3
Chlorodibromomethane	<0.5	Bromodichloromethane	<0.4
Dibromomethane	<0.5	Chlorodibromomethane	<0.5
1,2-Dichlorobenzene	<0.5	Bromoform	<0.7
1,3-Dichlorobenzene	<0.5		
Inorganics (300 series methods)			
Ammonia	<0.2	Cyanide (total)	<0.005
Nitrate (as nitrogen)	1.44	Phenol	<10
Nitrite (as nitrogen)	<0.02	Sulfate	206

Source of Analytical Data: Samples were collected at the Melrose AFR on October 28, 1992.
Samples were analyzed at Armstrong Laboratory, Brooks AFB, Texas, between November 12 and December 4, 1992.

E-1f Assessment of Groundwater Migration Potential [40 CF4 264.601(a)(6) through (9)]

There are several factors, including site-specific conditions, distance to groundwater users, and other criteria that support the determination that (1) the potential for contamination of groundwater resulting from OD treatment operations is extremely low or improbable and (2) groundwater represents the pathway of least potential for migration of contaminants. Factors supporting this determination include the following:

- **Analytical data.** Although there are no groundwater data to directly support this conclusion, analytical data collected by the USGS during its 1993 site assessment study indicate conclusively that previous OD activities did not affect soils beneath the site. By proxy, the lack of any soil contamination from EOD operations strongly indicates that groundwater in the uppermost aquifer beneath the OD treatment area has not been affected.

- **Geology/Depth to uppermost groundwater.** Lithologic log from the deep hole boring installed in 1993 shows that depth to the first water-bearing zone is 95 BSG. The upper 55 ft of unconsolidated materials consist predominately of silts and clays. Below this, very fine-grained sandstone overlies a rather impermeable layer of mudstone and shale which is approximately 13 ft thick. The actual hydraulic conductivity of these materials has not been determined, but permeability values found in Table 2.2 of *Groundwater* (Freeze and Cherry, 1979) show a range of 10^{-9} to 10^{-6} cm/sec for these geologic materials. These conditions will inhibit recharge by retarding any downward percolating water or other liquids that may contain hazardous wastes or constituents.

- **Climate.** Climatological information shows that the OD unit is located in an arid region which receives only ~15 in. of rainfall annually. Evaporation rates for this area are high and are typical of those found at Clovis, New Mexico [the average rate, as recorded by the New Mexico State University Agricultural Center at Clovis between the months of April and September over a 26-year period (from 1954 to 1984) was 58.8 in.]. This combination results in a negative water balance, with negligible hydraulic head available to drive contaminants to any great depth.

- **Groundwater uses/receptors.** Although there are numerous groundwater withdrawal points on the Melrose range, the closest irrigation/stock well is nearly two miles away to the southwest. The only potable water well is approximately 12,000 ft north of the OD unit, and this well is believed to be completed in the deeper Ogallala Aquifer.

- **Other considerations.** There are no known sensitive environmental receptors (e.g., wetlands) that might be affected by groundwater contamination; OD operations are designed to maximize the effectiveness of the treatment process in a manner which renders all explosive materials to nonhazardous residue except for trace amounts of certain metals.

An identification of other potential sources of groundwater contamination at the Melrose AFR was accomplished during the performance of a RCRA Facility Assessment (RFA) by A. T. Kearney in 1987. The RFA identified seven potential solid waste management units (SWMUs) at the range, although none of these SWMUs are currently anticipated to require any remedial action. Information for these SWMUs is summarized in Table E-2. In addition, the operations and maintenance compound uses a septic tank/leach field for disposal of sanitary wastes.

study that was conducted for the OD unit. Figure B1-2 in Appendix B provides a map delineating the 100-year floodplain boundary relative to the unit.

E-2d Precipitation Patterns [40 CFR 264.601(b)(4)]

The climate at the Melrose AFR is classified as semiarid. The downslope warming of air from the mountains to the west tends to modify and temper the air masses coming from the west and northwest. Winds from northwesterly direction blow downslope and enhance atmospheric ventilation; Whereas winds from a southerly and easterly direction blow upslope and lead to increased cloud formation and can result in precipitation.

As recorded at Cannon AFB, which is 25 miles east of the Melrose AFR, the average rainfall in the area is 15.2 in., most of which occurs as thunderstorms during summer months. Thunderstorms occur approximately 47 to 50 days per year. Individual monthly averages vary from 0.4 in. during winter months to 2.5 to 2.7 in. during July and August. The greatest monthly rainfall intensity was 11.4 in. recorded in July. The greatest amount of rainfall recorded in 1 day was 4.8 in.

Occasional winter snows occur in this area from the upslope movement of moist air from the Gulf of Mexico. Over a 36-year period, annual snowfall amounts of 20 in. or more have been recorded on several occasions. The record snowfall for a single storm is 19 in. Snow can occur as early as October and as late as May.

E-2e Groundwater Data [40 CFR 264.601(b)(5)]

Information on groundwater was previously discussed in Sect. E-1.

E-2f Proximity to Surface Waters [40 CFR 264.601(b)(6)]

The surface waters nearest the OD unit is the intermittent stream discussed in Sect. E-2 that drains to the northeast of the OD unit. There are no permanent surface waters within the Melrose AFR. The nearest permanent surface water is the Pecos River, which flows generally south through much of New Mexico and is approximately 12 miles west of the Melrose AFR. Tule Lake is a relatively large body of water for the area and is approximately 10 miles northeast of the facility.

E-2g Water Quality Data [40 CFR 264.601(b)(7) and (8)]

Surface water occurs at the Melrose AFR only after periods of heavy rainfall. During this time, intermittent streams may flow for a short period, and there may be some ponding of water within three dirt embankments near the east range access road. However, it is not believed that any water samples have been collected for analysis from surface waters at the Melrose AFR.

E-2h Assessment of Surface Water Migration Potential [40 CFR 264.601(b)(9) through (11)]

The potential for contaminants from OD operations to migrate into and through surface waters is very low, and several factors support this conclusion.

- The only surface water in the vicinity of the EOD area is a small, intermittent stream located 700 to 800 ft from the OD unit.
- In general, the wastes to be treated at the EOD area are hazardous primarily because of their explosive properties. The OD treatment processes conducted at the unit effectively eliminate the explosive characteristics of waste munitions.
- The nature of the waste munitions and residues following treatment have only slight or no solubility in water (see Table C-2). Therefore, transport of these contaminants should be minimal.
- The OD unit is surrounded by an outer berm that protects it from any flooding that may occur. The berm will also prevent or minimize off-site transport of any waste munition residues that could occur during periods of heavy rainfall.
- Previous site investigations in soil media have indicated only the presence of beryllium, which may be attributable to naturally occurring metallic ions in soils, and no explosive compound residues.

E-3 AIR ASSESSMENT [NMHWMR-7, Part V; 40 CFR 264.601(c)]

Emissions to the air of trace quantities of contaminants from the OD unit are the major pathways of concern. The managerial procedures used in the operation of the unit will minimize, to the extent possible, the release of any contaminants other than through emission of smoke and gases from the unit and some minor releases into ambient soils. The OD operations do not normally produce any measurable amounts of contamination other than particulates. These can be monitored through the soil sampling program (see Sect. C-2 and Appendix C, "Sampling and Analysis Plan") to determine the quantities and distribution, if any, of particulates and fallout.

E-3a Volume and Characteristics of the Waste [40 CFR 264.601(c)(2)]

The volume and characteristics of wastes to be treated at the OD unit are discussed in detail in Sect. C. The maximum allowable amount of explosive wastes that will be allowed for OD is 1000 lb NEW per demilitarization episode while the average maximum detonating amount per quarter is expected to be 2000 lb NEW. However, this amount may need to be exceeded if some of the large live bombs (with 990 lb NEW) require detonation. If such a circumstance arises, approval from NMED will be requested prior to detonation. This quantitative limit helps ensure that no major sources of toxic emissions are released during OD operations. To fairly and accurately gauge the

potential impact to the environment of these operations, worst case conditions of OD of wastes are discussed in the following sections.

E-3b Reduction or Prevention of Emissions [40 CFR 264.601(c)(2)]

The detonation structure berm surrounding the OD unit will serve, to the extent possible, as a physical barrier for reducing emissions by limiting the projections of small debris and larger fragments that result from such operations. Typical detonations of ordnance items such as flares, 5.56mm ammunition, rocket motors, etc., produce only a very small amount of fragmentation because of the high intensity of the initiating charge. Thus, the proposed four-ft berm should be sufficient. However, a higher berm may be installed at a later date if a proper design can be achieved and funding is available.

E-3c Operating Characteristics [40 CFR 264.601(c)(3)]

The OD unit at the Melrose AFR currently operates on a quarterly or as-needed basis for the treatment of waste munitions. Almost all energetic materials are transformed into gaseous or particulate form in the OD treatment process. Operating procedures for OD activities are presented in Sect. D.

Emissions associated with the OD process are nearly instantaneous due to the nature of the treatment process. Total emissions and an analysis of potential receptor exposures are presented for typical treatment cases in Sect. E-3f. At this time, accurate emissions data are not available. The final report from emissions testing (i.e., Bang Box testing) conducted at the Dugway Proving Grounds in Utah is expected to become available in late 1993 or early 1994, at which time the emissions issue can be discussed with NMED. Until then, any air modeling to support air emissions characteristics would be premature and inaccurate.

OD operations will only be conducted under favorable meteorological conditions. As referenced under AFR TO 11A-1-42 in Appendix D and Sect. D, they will not be carried out during an electrical storm that approaches within 4 to 8 km (3 miles); during a sand, dust, or snow storm when OD uses an electrical firing system; or when wind velocity exceeds 15 mph.

E-3d Atmospheric, Meteorological, and Topographic Characteristics [40 CFR 264.601(c)(4)]

The OD unit at Melrose AFR is in relatively flat, gently sloping terrain. The topography at the OD area slopes to the northeast away from the 200-ft-high upland (the Mesa), which is approximately 1 mile to the south and west of the unit. The highest elevation within the range is approximately 4700 feet ($\pm$10 ft) NVGD, while the lowest elevation is approximately 4190 ft NVGD. There are no complex topographic features in the unit's vicinity.

No climatological data has been collected at the Melrose AFR. However, for a close comparison, data compiled at Cannon AFB (25 miles east of the range) can be substituted. The climate of the area is semiarid with hot, dry summers and mild winters. Average annual daily maximum temperatures for the area range from 47°F to 92°F with the average annual mean temperature of 60°F. Summer temperatures may reach above 100°F only occasionally, while minimum temperatures may be in the 20s during January.

The average lake evaporation rate for the Melrose AFR area is about 92 in./year.

Wind speed, frequency, and direction are important to air emission analysis. Based on meteorological data collected at Cannon AFB, winds in the east-central area of New Mexico are often gusty and can average 19 mph or higher. Based on a 10-year period, the prevailing surface wind direction at the range is from the west. These west winds occur mostly from October to May. During the warmer months, the winds tend to be from the south. The annual mean wind speed is approximately 7 knots (8 mph). Monthly wind averages from 5 knots (6 mph) to 9 knots (10 mph). The maximum recorded wind gust at the range is 73 knots (84 mph).

The atmosphere tends to be dispersive around the Melrose AFR area. The seasonal and annual average mixing heights can vary from 400 m in the morning to 4000 m in the afternoon. The afternoon mixing heights are typically greater during the spring and fall seasons. The morning mixing heights are generally low, due to nighttime heat loss from the ground producing surface-based temperature inversions. After sunrise, these inversions break up, and solar heating of the ground surface causes vertical mixing in the atmosphere.

E-3e Existing Air Quality [40 CFR 264.601(c)(5)]

Melrose AFR is in the Pecos-Permian Basin Interstate Air Quality Control Region. While there are no air monitoring sites positioned on or near the range, both Curry and Roosevelt counties meet the National Ambient Air Quality Standards (NAAQS). EPA reports that ambient concentrations of particulates and sulfur dioxides are lower than national standards, and that ozone, carbon monoxide, and nitrogen oxides (1) cannot be classified and (2) are better than promulgated standards. The area has not been designated as an Air Quality Maintenance Area for any of the criteria pollutants mentioned above.

Table E-3 shows the present pollution, listed by source, that originates on the Melrose AFR. These emissions have been occurring for the past few years and comprised a portion of the area's pollutant load when EPA ruled on the attainment status of the NAAQS. The air emissions released during OD operations consist primarily of organic and inorganic gases. Compared to the existing pollutants, emissions from the treatment of wastes munitions are negligible.

Table E-3. Current pollution emissions at the Melrose AFR, New Mexico

Source	Annual Hours	Fuel Flow (lb/hour)	Annual Fuel Consumption (X 1000 lb)	Pollutant Emission Rate lb/1000 lb fuel)					Pollutant Emisssions (lb/year)				
				CO	HC	NO_x	Part	SO_x	CO	HC	NO_x	Part	SO_x
Military Aircraft													
F-111D[a]	2,104	14,516	30,542	0.8	0.1	20.0	0.35	1.0	24,434	3,054	610,840	10,690	30,542
A-7[a]	527	8,419	4,437	1.8	0.2	21.0	0.67	1.0	7,987	887	93,177	2,973	4,437
F-4C[a]	23	17,859	411	2.2	0.2	8.9	2.2	1.0	904	82	3,658	904	411
HH-53BC[b]	19	2,856	54	2.4	0.9	23.3	2.9	1.0	130	49	1,258	157	54
F-111A[a]	7	14,516	102	0.8	0.1	20.0	0.35	1.0	82	10	2,040	136	102
Power Generating Sources													
60 kW Generator and power plant[c]	–	–	37	0.7	0.14	2.5	0.34	0.1	26	5	92	13	4
Vehicles[c]													
Gasoline-powered	–	–	21	64.0	7.86	9.1	1.1	0.23	1,340	165	191	23	5
Diesel-powered	–	–	119	6.3	1.0	4.62	0.33	0.62	752	120	550	39	74
Total									35,655	4,372	711,806	14,835	35,600

Reference sources:

[a]Aircraft Air Pollution Estimation, ACEE, CEEDO-TR-78-33, September 1978.

[b]Aircraft Engine Emissions catlog, R/S NAVAID WORK AC 13790-4, February 1976.

[c]Compilation of Air Pollutant Emission Factors, AP-42, 3rd Ed. August 1977.

are tabulated and found in Tables C1-1, C1-2, and C1-3 of Appendix C. The following discussion on detonation emissions is taken from EPA document AP-42.

Emissions from explosives detonation are influenced by factors such as explosive composition, product expansion, method of priming, length of charge, and confinement. These factors are difficult to measure and control in the field and are almost impossible to duplicate in a laboratory test facility. With the exception of a few studies in underground mines, most studies have been performed in laboratory test chambers that differ substantially from the actual environment. Estimates of emissions from explosives use must be regarded as approximations that cannot be made more precise because explosives are not used in a precise, reproducible manner.

Carbon monoxide (CO) is the pollutant produced in greatest quantity from explosives detonation. TNT, an oxygen-deficient explosive, produces more CO than most dynamites (which are oxygen balanced), but all explosives produce measurable amounts of CO. Particulates are produced as well, but such large quantities of particulates are generated in the shattering of the rock and earth by the explosive that the quantity of particulates from the explosive charge cannot be distinguished. Nitrogen oxides (both NO and NO_2) are formed, but only limited data are available on these emissions. Oxygen-deficient explosives are said to produce little or no NO_x; a small body of data exists to confirm this. Unburned hydrocarbons also result from explosions, but in most instances methane is the only species that has been reported.

By utilizing the estimated emissions rates in conjunction with the worst-case loading in the OD unit, worst-case emissions can be predicted. By inputting the emissions rates into the PUFF computer model, exposures of receptors can be calculated at various distances from the unit. The nearest off-site human receptor is greater than 40,000 ft from the OD unit.

E-4 POTENTIAL IMPACT ASSESSMENT [NMHWMR-7, Part V; 40 CFR 264.601(a),(b), and (c)]

E-4a Land Uses [40 CFR 264.301(a)(6)]

The OD range is within the central portion of the Melrose AFR impact area, which is itself centrally located within the entire range. The area is predominantly open grassland and is used mostly for cattle grazing and some crop raising. A land-use map of the Melrose AFR is presented in Fig. B-6.

E-4b Human Health [40 CFR 264.601(a)(8), 264.601(b)(10), and 264.601(c)(6)]

Due to the nature of the treatment operation, nearly all contaminant exposures will be due to atmospheric transport of gaseous and particulate compounds. Little or no health impacts from emissions are anticipated to occur either during the transportation, unloading, and stacking of waste munitions or during the actual treatment (detonation) of the waste ordnance. All concentrations at the facility boundary are estimated to be well below the NAAQS standards. These standards are established as health-based criteria.

EOD personnel will wear personal protective equipment (PPE) including Occupational Safety and Health Administration (OSHA)-approved air purifying respirators during residue removal. Therefore, no impacts stemming from this activity are expected.

E-4c Vegetation and Wildlife [40 CFR 264.601(a)(9), 264.601(b)(11), and 264.601(c)(7)]

The Melrose AFR does include some agricultural use of lands for both cattle grazing and crop growing, and there are several species of wildlife that frequent the range, including pronghorn, prairie dogs, and others (see Fig. B-6). Prairie grass is the only vegetation that grows within the facility. However, no domestic animals (livestock) and cultivated crops are permitted within the range impact area where the OD unit is situated. Thus, no noticeable effects are anticipated on either plants or animals (both domestic and wild). There are no known endangered species in permanent residence at Melrose AFR.

As noted in Air Quality Criteria for Particulate Matter, most research has been performed on gaseous pollutants, with little done on particulates. Thus, the levels at which toxic response occurs from these materials are not well defined. However, predicted levels are less than 3% of documented levels needed to produce noticeable plant effects (i.e., soot-clogged stomata).

Plants are relatively insensitive to CO at the lower levels of concentrations that have been found to be toxic for animals. In experiments over 100 plant species were exposed to CO concentration ranging from 115,000 to 575,000 $\mu g/m^3$. Exposure time varied from 7 to 23 days. Concentrations of 115,000 $\mu g/m^3$ caused practically no growth retardation, suggesting that concentrations of CO needed to affect plant growth are considerably higher than those normally encountered in ambient air. Therefore, no vegetation damage should occur as a result of predicted CO emissions.

Experimental results indicate that a minimum NO_x concentration of between 4000 to 9000 $\mu g/m^3$ for an 8-hour period is necessary to cause a 5% injury level for the most sensitive plants. This level is much greater than the peak ambient NO_x concentration projected for the EOD boundary. Therefore, no adverse impacts are anticipated as a result of NO_x emissions.

E-4d Other Environmental Impacts

E-4d(1) Airblast Limitations (30 CFR 816.67)

The OD area contained within the Melrose AFR is approximately 48,000 ft (~9 miles) west of the nearest public highway (New Mexico State Highway 267); 55,000 ft (~10.5 miles) south of the nearest railway (the Atkinson Topeka and Santa Fe Railway, which parallels U.S Route 60/84); and approximately 38,000 ft (7 miles) southwest of the nearest believed off-site inhabited building (the Hart Ranch, which is just north of Little Tule lake) (Fig. B-2). These distances exceed the recommended distances for OD of explosives on the ground as presented in Table E-4. This table gives the separation distances required to ensure that air blasts (also referred to as overpressures) to buildings will be less than 0.03 psig (140 dB) for detonations at the ground surface.

Table E-4 covers detonations up to 500 lb NEW, which is half the maximum amount (1000 lb NEW) that will be permitted for OD treatment during a single episode. Since OD operations will be performed in an open, excavated trench representing unconfined conditions, such activity will present a considerably lesser hazard, particularly ground motion, and thus they should be well within the air blast and ground motion limitations prescribed for blasting operations by the Office of Surface Mining Reclamation and Enforcement (OSMRE). Under no conditions will air blast limits be allowed to exceed the maximum limits listed in Table E-5 at the location of any dwelling, public building, school, church, or community or institutional building outside the OD area. Given the remote location of the OD unit and the great distance to the nearest inhabited building, it is very unlikely that such limits would ever be exceeded. To ensure that these standards are met, periodic monitoring will be conducted at locations outside the OD area. The measuring system used will have an upper-end flat frequency response of at least 200 Hz.

E-4d(2) Ground Motion Limitations [30 CFR 816.67(d)]

OD operations will be performed in an open, excavated trench and will also conform to OSMRE regulations for ground vibrations. Structures in the vicinity of the OD area will be protected from damage by complying with maximum allowable limits on the ground vibration. Table E-5 lists the maximum allowable ground vibration limits, which are not to be exceeded at the location of any dwelling, public school, church, or community or institutional building outside the OD area. These limits are expressed as the peak particle velocity at specified distances from a detonation or blasting area. Peak particle velocity, as measured by a seismograph, is the maximum velocity at which a particle of ground vibrates when excited by a seismic valve. A seismograph record made for periodic detonations will be maintained at the facility.

Table E-4. Distances for the OD of explosives on the ground[a]

Quantity of explosives (not over)	Inhabited buildings		Public highways Class A to D		Passenger railway and public highways with traffic volume more than 3,000 vehicles/day		Separation from other OB units	
Pounds	No missile hazard	Missile hazard without barricade	No missile hazard	Missile hazard without barricade	No missile hazard	Missile hazard without barricade	No missile hazard	Missile hazard without barricade
1	730	730	325	325	480	480	6	12
2	920	920	410	410	600	600	6	12
5	1250	1250	550	550	820	820	6	12
10	1600	1600	695	695	1030	1030	8	16
20	1990	1990	875	875	1295	1295	10	20
50	2700	2700	1190	1190	1760	1760	14	28
75	3080	3080	1360	1360	2015	2015	15	30
100	3400	3400	1500	1500	2220	2220	16	32
150	3900	3900	1715	1715	2535	2535	19	38
200	4275	4275	1890	1890	2795	2795	21	42
400	5400	5400	2380	2380	3520	3520	27	54
500	5800	5800	2560	2560	3790	3790	29	58

Source: RCRA Guidance Manual for Permitting Commercial Explosives Industry Open Burning/Open Detonation Units, Institute of Makers of Explosives, 1989.

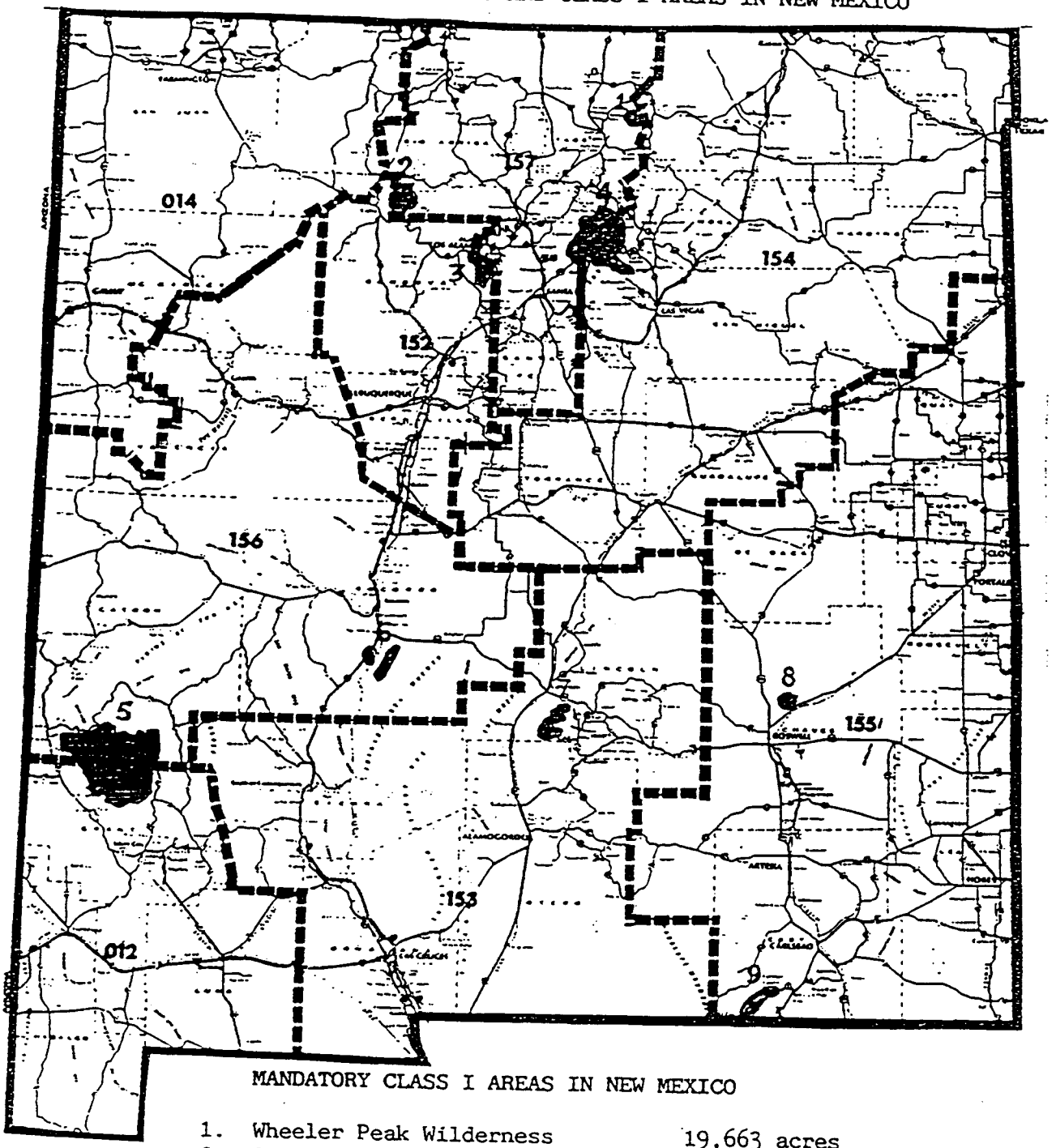
[a]This table is intended only for application to open detonation of commercial explosive materials. The distances stated in this table should be measured from the center of the unit, except for separations from other open detonation units, which are measured from the edge of the unit. Distances are in feet.

Table E-5. Maximum ground vibration (peak particle velocity)

Distance (D) from the blasting site, in feet	Maximum allowable peak particle velocity (Vmax) for ground vibration, in inches/second[a]	Scaled distance factor to be applied without seismic monitoring[b] (Ds)
0 to 300	1.25	50
301 to 5000	1.00	55
5001 and beyond	0.75	65

[a]Ground vibration shall be measured as the particle velocity. Particle velocity shall be recorded in three mutually perpendicular directions. The maximum allowable peak particle velocity shall apply to each of the three measurements.
[b]Applicable to the scaled-distance equation of Paragraph (d)(3)(1) of 30 CFR 816.67(d).

AIR QUALITY CONTROL REGIONS AND CLASS I AREAS IN NEW MEXICO



MANDATORY CLASS I AREAS IN NEW MEXICO

1.	Wheeler Peak Wilderness	19,663 acres
2.	San Pedro Parks Wilderness	41,132
3.	Bandelier Wilderness	23,267
4.	Pecos Wilderness	223,333
5.	Gila Wilderness	569,792
6.	Bosque Del Apache Wilderness	40,948
7.	White Mountains Wilderness	48,873
8.	Salt Creek Wilderness	9,621
9.	Carlsbad Caverns National Park	46,435

U.S. AIR FORCE
AIR COMBAT COMMAND

REPORT
ON

Characterization of Emissions Resulting from Thermal Treatment of Selected Explosive Munitions

A Dugway Proving Ground
BangBox Study

By

MacDonald B. Johnson
Douglass Bacon
Cecil Eckard
William Mitchell

January 1994

HQ, Air Combat Command
Langley Air Force Base, Virginia

DRAFT COPY 1025 14 December 1993

4.5.3 Untargeted SFC/MS and SFC/TEA Analytes

Composite filter extracts were analyzed for untargeted nitro- and nitroso-compounds, nitramines, and nitrate esters. Some unknown compound peaks were found in the SFC/TEA chromatograms, while others were selected for analysis by SFC/CI/SIM/MS. New compounds detected by these method are listed in Appendix E of AWL Report Appendix E.

4.5.4 GC/MS of New Compounds of Potential Interest

An extensive library search of compounds found by GC/MS was conducted. Sixty-four compounds were found in the background sample with 53 peaks tentatively identified from library spectra. One hundred twenty-five to 153 compounds were found in the T45E7 adapter booster trial samples with 76 to 92 tentatively identified from library spectra (three samples were analyzed). The complete list of compounds with analyte concentrations are in Appendix 4, pages 133-170 of the AWL Report.

4.5.5 Metals

The energetic material in the T45E7 adapter booster contained tetryl. The EFs for the elements found are given in Table 4.21.

4.5.6 Emission Factors for PM10

The EFs for the PM10 produced by the open detonation of the T45E7 adapter-booster were 0.243, 0.270, and 0.271. The mean and standard deviation from these estimates are 0.262 and 0.01623, respectively.

4.5.7 Emission Factors for Hydrogen Cyanide

The EFs for the HCN produced by the open detonation of the T45E7 adapter-booster were 0.00232, 0.00232, and 0.00246. The mean and standard deviation from these estimates are 0.00237 and 0.0000831, respectively.

4.6 TNT EMISSION FACTORS

4.6.1 Volatile Organic Compounds

Table 4.21 Emission Factors for the Elements Found During Open Detonation of T45E7 Adapter Booster, as Sampled by Hi-Vol.

AWL[a] NO:	AF072 (wt/wt)
Aluminum	9.48E-03
Arsenic	2.23E-05
Barium	9.77E-04
Cadmium	5.77E-03
Calcium	5.10E-03
Chromium	9.43E-05
Copper	3.13E-03
Lead	7.73E-04
Nickel	4.E-05
Potassium	5.68E-04
Sodium	8.79E-04
Titanium	2.67E-04
Zinc	3.24E-03

[a]Alpine West Laboratories.

The EFs for individual and groups of volatile compounds for the T54E7 adapter-booster are listed in Table 4.22. The complete volatile data package from the assay of the SUMMA™ canisters is included in Appendix F.

4.6.2 Semivolatile Organic Compounds

The semivolatiles were assayed from two collection media; (1) hi-vol samplers using 20.3 x 25.4 cm quartz fiber filters and PS-1 samplers using 100 mm diameter quartz fiber filters followed by a 60 mm i.d. x 125 mm borosilicate glass cylinder containing XAD-2® resin. Extraction of the hi-vol media were done by AWL using the method described in LOI 3. Analyses of hi-vol media extracts were done according to USEPA Method 8270 using GC/MS, and by SFC/MS using the method described in LOI 7. Extractions of the PS-1 media were done by Radian Corp., with assay of the extract by USEPA Method 8270 using GC\MS, LOI 18.

4.6.2.1 Emission Factors from Hi-Vol Samplers Using the SFC/MS Method

Table 4.23 lists the EFs for the semivolatiles found from the SFC/MS analyses. The phthalates which were in the sample were not quantified or reported. The analysis was

Table 4.22 Emission Factors for Volatile Organic Compounds Found During Open Detonation of Bulk TNT.

OGI[a] NO: Analyte	DU-21&22 (wt/wt)	DU-23&24 (wt/wt)	DU-25&26 (wt/wt)	Average (wt/wt)	Standard Deviation (wt/wt)
Methane	5.49E-04	5.52E-04	5.52E-04	5.51E-04	2.03E-06
1,3-Butadiene	3.37E-06	9.62E-07	9.62E-07	1.76E-06	1.39E-06
Benzene	4.81E-06	4.81E-06	2.89E-06	4.17E-06	1.11E-06
Alkenes (Olefins)[b]	8.04E-05	6.54E-05	3.90E-05	6.16E-05	2.10E-05
Aromatics	1.78E-05	1.49E-05	BD[c]	1.64E-05	2.04E-06
TNMHC	BD	2.79E-05	BD	NA[d]	NA
TO-12 (NMOC)	1.11E-04	4.93E-04	BD	3.02E-04	2.70E-04

[a]Oregon Graduate Institute of Science and Technology.
[b]See table 3.9 for list of alkenes, and aromatics.
[c]Below detection limit.
[d]Not applicable.

confined to the 18 target compounds on the list. This method is the only one that reports on the parent explosive, RDX. Additionally, this method can detect and differentiate between diphenylamine and N-nitrosodiphenylamine. The phenols and naphthalenes were probably during the extraction of the samples.

4.6.2.2 Emission Factors from Hi-Vol Samplers Using USEPA Method 8270 (GC/MS)

Table 4.24 shows the EFs for the semivolatiles found when using USEPA Method 8270. Five phthalates were reported as found. These very persistent, highly inert substances are routinely found at low levels in the environment and are added to the formulation of most plastics. These assays were accomplished using an aliquot of the same extraction fluid as the SFC analyses and thus could also show reduced levels of phenol and naphthalene.

4.6.2.3 Emission Factors from PS-1 Samplers Using USEPA Method 8270 (GC/MS)

Table 4.25 shows the EFs for the semivolatiles found when using USEPA Method 8270.

Table 4.23 Emission Factors for Semivolatile Organic Compounds Produced During Open Detonation of Bulk Trinitrotoluene, as Sampled by Hi-Vol[a] and Assayed Using SFC/MS[b].

AWL[c] NO: Target Analytes	AF0212529 Sample 1 (wt/wt)	AF0222630 Sample 2 (wt/wt)	AF0232731 Sample 3 (wt/wt)	Average (wt/wt)	Standard Deviation (wt/wt)
2,4-Dinitrotoluene	1.47E-07	6.02E-08	5.56E-08	8.74E-08	5.12E-08
2,4,6-Trinitrotoluene	8.55E-06	1.02E-05	5.80E-06	8.18E-06	2.21E-06
1,3,5-Trinitrobenzene	1.97E-06	1.23E-06	1.21E-06	1.47E-06	4.33E-07
Hexahydro-1,3,5-trinitro-1,3,5-triazine[d]	1.37E-06	1.29E-06	9.73E-07	1.21E-06	2.11E-07
1-Nitropyrene	BD[e]	BD	1.81E-09	NA[f]	NA
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine[g]	BD	6.10E-08	1.91E-08	4.01E-08	2.97E-08
Naphthalene	4.88E-08	2.81E-07	5.66E-08	1.29E-07	1.32E-07
Phenol	9.66E-08	6.27E-08	3.37E-07	1.65E-07	1.50E-07
Dibenzofuran	BD	2.90E-08	1.40E-09	1.52E-08	1.95E-08
Diphenylamine	1.07E-08	BD	1.76E-08	1.42E-08	4.83E-09

[a]High-volume sampler.
[b]Supercritical fluid chromatography/mass spectrometry.
[c]Alpine West Laboratories.
[d]RDX.
[e]Below detection limit.
[f]Not applicable.
[g]HMX.

Table 4.24 Emission factors for Semivolatile Organic Compounds Produced During Open Detonation of Bulk Trinitrotoluene, as Sampled by Hi-Vol[a] and Assayed Using USEPA Method 8270.

AWL[b] NO:	AF0212529	AF0222630	AF0232731		Standard
	Sample 1	Sample 2	Sample 3	Average	Deviation
Analyte	(wt/wt)	(wt/wt)	(wt/wt)	(wt/wt)	(wt/wt)
2-Methylnaphthalene	7.26E-07	9.07E-07	7.20E-07	7.85E-07	1.06E-07
Acetophenone	1.20E-07	1.77E-07	BD[c]	1.49E-07	4.00E-08
Benzyl alcohol	1.36E-07	2.08E-07	7.91E-08	1.41E-07	6.44E-08
bis(2-Ethylhexyl) phthalate	9.62E-07	1.19E-06	9.95E-07	1.05E-06	1.21E-07
Butylbenzyl phthalate	1.93E-07	2.51E-07	1.81E-07	2.08E-07	3.77E-08
Diethyl phthalate	2.40E-07	2.09E-07	1.26E-07	1.91E-07	5.92E-08
Dimethyl phthalate	8.19E-08	1.17E-07	6.56E-08	8.81E-08	2.62E-08
Di-n-butyl phthalate	BD	8.28E-08	4.32E-09	4.36E-08	5.55E-08
Di-n-octyl phthalate	2.63E-07	3.42E-07	2.18E-07	2.74E-07	6.25E-08
Naphthalene	3.54E-07	4.24E-07	3.14E-07	3.64E-07	5.55E-08
Phenanthrene	1.72E-08	4.81E-08	BD	3.26E-08	2.18E-08
Phenol	BD	BD	8.95E-08	NA[d]	NA

[a]High-volume sampler.
[b]Alpine West Laboratories.
[c]Below detection limit.
[d]Not applicable.

Table 4.25 Emission Factors for Semivolatile Organic Compounds Produced During Open Detonation of Bulk Trinitrotoluene, as Sampled by PS-1 and Assayed Using USEPA Method 8270.

Radian Field ID[a]	SVOC-4-2	SVOC-4-4	SVOC-4-5		Standard
Analyte	(wt/wt)	(wt/wt)	(wt/wt)	Average (wt/wt)	Deviation (wt/wt)
4-Methyl phenol	BD[b]	BD	5.68E-07	NA[c]	NA
Phenanthrene	BD	1.41E-07	BD	NA	NA
Fluoranthene	6.16E-08	BD	BD	NA	NA
di-n-Octyl phthalate	3.08E-07	3.45E-07	3.14E-07	3.22E-07	1.E-08

[a]Identification number.
[b]Below detection limit.
[c]Not applicable.

4.6.3 Untargeted SFC/MS and SFC/TEA Analytes

Composite filter extracts were analyzed for untargeted nitro- and nitroso-compounds, nitramines, and nitrate esters. Some unknown compound peaks were found in the SFC/TEA chromatograms, while others were selected for analysis by SFC/CI/SIM/MS. New compounds detected by these method are listed in Appendix E of AWL Report Appendix E.

4.6.4 GC/MS of New Compounds of Potential Interest

An extensive library search of compounds found by GC/MS was conducted. Sixty-seven compounds were found in the background sample with 41 peaks tentatively identified from library spectra. Eighty to 148 compounds were found in the bulk TNT samples with 50 to 75 tentatively identified from library spectra (three samples were analyzed). The complete list of compounds with analyte concentrations are in Appendix 4, pages 1-30 of the AWL Report.

4.6.5 Metals

For bulk TNT the EFs for the elements found are given in Table 26.

Table 4.26 Emission Factors for Elementals Produced During Open Detonation of Bulk Trinitrotoluene, as Sampled by Hi-Vol.

AWL[a] NO:	AF023 (wt/wt)
Aluminum	3.61E-04
Barium	4.81E-04
Cadmium	7.74E-06
Calcium	1.19E-03
Chromium	1.12E-06
Copper	7.76E-04
Lead	4.10E-04
Mercury	1.64E-07
Nickel	7.39E-06
Potassium	1.64E-04
Titanium	5.51E-05
Zinc	4.81E-05

[a]Alpine West Laboratories.

4.6.6 Emission Factors for PM10

The EFs for the PM10 produced by the open detonation of bulk TNT were 0.0717, 0.0729, and 0.0745. The mean and standard deviation from these estimates are 0.0730 and 0.001441, respectively.

4.6.7 Emission Factors for Hydrogen Cyanide

The EFs for the HCN produced by the open detonation of bulk TNT were 0.0009, 0.00106, and 0.000959. The mean and standard deviation from these estimates are 0.000973 and 0.0000808, respectively.