DRAFT FINAL
OPEN BURNING/OPEN DETONATION
PERMITTING GUIDELINES

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ACRONYMS

AAQS	Ambient Air Quality Standards
ADNL	A-frequency Weighted DNL
AEGL	Acute Inhalation Exposure Guidelines
AHQ	Acute Hazard Quotient
AIEC	Acute Inhalation Exposure Criteria
APA	Air Pathway Assessment
ATEL	Acute Toxicity exposure Levels
BTAG	Biological Technical Assistance Group
BNA	Base, Neutral, and Acid Extractable
CBF	Confined Burn Facility
CDNL	C-frequency Weighted DNL
COPC	Chemical of Potential Concern
DNA	Defense Nuclear Agency
DNB	1,3-Dinitrobenzene
DNL	Day-Night Average Sound Level
DNT	Dinitrotoluene
DoD	Department of Defense
DOE	Department of Energy
DOT	Department of Transportation
DPG	Dugway Proving Ground
DRE	Destruction and Removal Efficiency
EGDN	Ethylene glycol dinitrate
EOD	Explosives Ordnance Disposal
EPA	U.S. Environmental Protection Agency
ERA	Ecological Risk Assessment
ERPG	Emergency Response Planning Guidelines
FRTR	Federal Remediation Technologies Round Tables
FT-IR	Fourier Transform Infrared
GPS	Global Positioning System
HCOC	Hazardous Constituents of Concern
HE	High Explosive
HHRA	Human Health Risk Assessment
HI	Hazard Index
HMX	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
HRTW	Hazardous, Toxic, and Radioactive Waste
HV	Hazard Value
ICUZ	Installation Compatible Use Zone
LC/MS	Liquid Chromatograph/Mass Spectrometry
MIDAS	Munitions Items Disposition Action System
MSDS	Material Safety Data Sheet
NAPS	Noise Assessment Prediction System
NB	Nitrobenzene
NEW	Net Explosive Weight

NG	Nitroglycerin
NT	Nitrotoluene
NWS	National Weather Service
OB	Open Burning
OBODM	Open Burn Open Detonation Model
OD	Open Detonation
ORNL	Oak Ridge National Laboratory
PA	Pascals Pressure Units
PEP	Propellants, Explosives, and Pyrotechnics
PETN	Pentaeiythritol tetranitrate
PGDN	Propylene Glycol Dinitrate
PICs	Products of Incomplete Combustion
PRG	Preliminary Remediation Goal
PTWMP	Post-Treatment Waste Management Plan
QA/QC	Quality Assurance/Quality Control
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Constituent and Recovery Act
RDX	Hexahydro-1,3,5-trinitro-1,3,5-triazine
REAMS	Remediation and Cleanup Using Health Based Standards, Risk Exposure, and Analysis Modeling System
RFI	RCRA Facility Investigation
SAP	Sampling and Analysis Plan
SCAPA	Subcommittee on Consequence Assessment and Protective Action
SCRAM	Support Center for Regulatory Air Models
SERDP	Strategic Environmental Research and Development Program
SIPS	Sound Intensity Prediction System
SOP	Standard Operating Procedure
T	Target Acceptable Risk
TCLP	Toxic Characteristic Leaching Procedures
TEEL	Temporary Emergency Exposure Limits
Tetryl	Methyl-2,4,6-trinitrophenylnitramine
TNB	1,3,5-Trinitrobenzene
TNT	2,4,6-Trinitrotoluene
TOC	Total Organic Content
TRV	Toxicity Reference Value
UV	Ultra Violet
UXO	Unexploded Ordnance
VAC	Virginia Administration Code
Virginia DEQ	Virginia Department of Environmental Quality
VHWMR	Virginia Hazardous Waste Management Regulations
VOC	Volatile Organic Compounds
WAP	Waste Analysis Plan
WMP	Waste Minimization Plan
WP	White Phosphorous

1. INTRODUCTION

Guidelines for the permitting, corrective action and closure of open burning (OB) and open detonation (OD) units that treat energetic wastes in the Commonwealth of Virginia have been prepared for the Virginia Department of Environmental Quality (VIRGINIA DEQ) with the contract support of the U.S. Environmental Protection Agency (EPA) Region III. The guidelines are intended for use by facility owner/operators to prepare complete and technically adequate permit applications as well as closure plans and corrective action plans for OB/OD units. Permit writers and other regulatory staff can use the guidelines to evaluate OB/OD unit documents and specify permit conditions.

The guidelines are to facilitate compliance with the requirements of Title 9 – Environment, Virginia Administrative Code (VAC) 20 – Virginia Waste Management, Chapter 60-Virginia Hazardous Waste Management Regulations (VHWMR) as applicable to miscellaneous units. Federal requirements for miscellaneous units are addressed by 40 CFR 264.600-603 (Subpart X) as adopted by reference based on 9VAC20-60-264. Other applicable general requirements are included in 9VAC20-60-10 through 1505.

The scope of the guidelines has been limited to addressing the specialized regulatory issues associated with OB/OD units pursuant to VIRGINIA DEQ. Thus, these guidelines are intended to be used in conjunction with other VIRGINIA DEQ and EPA guidance for developing general permit conditions and permit applications for hazardous waste management units. In addition, general guidelines for OB/OD units are included in *RCRA 40 CFR Part 264, Subpart X Permit Writers Technical Resource Document* (USEPA, June 1997).

An overview of OB/OD methods and criteria as defined in the regulations are set forth in Sect. 2. Sect. 3 provides a discussion of various significant OB/OD regulatory topics. The regulated community may use this guidance to evaluate the completeness of an OB/OD permit application, with the understanding that site-specific conditions may impose additional requirements or conditions. Sect. 4 addresses OB/OD environmental performance standards, and considerations for associated permit conditions are addressed in Sect. 5. (For expediency some permit writers may go directly to Sect. 5 for permit conditions guidance and refer to other sections that are cited for background information). The removal and remediation of energetic contaminated media is discussed in Sect. 6. References cited are listed in Sect. 7.

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2. OB/OD SOURCE OVERVIEW

Many waste propellants, explosives and pyrotechnics (PEP) and waste munition items are unsafe to treat by conventional methods of hazardous waste management. Open burning and open detonation (OB/OD) are major methods of treatment for these energetic wastes. Research is being conducted to develop alternative methods of treatment for waste munitions and other energetic wastes (USEPA, June 1997). However, because of safety hazards, as well as site-specific feasibility factors for alternative treatment technologies, there are certain circumstances and energetic wastes that necessitate the use of OB/OD treatment. Thus, OB/OD treatment is not expected to be totally replaced by alternative technologies in the near future.

Specifically, 40 CFR 265.382 – Open Burning; Waste Explosives states:

> Open burning of hazardous waste is prohibited except for the open burning and detonation of waste explosives. Waste explosives include waste which has the potential to detonate and bulk military propellants which cannot be safely disposed of through other modes of treatment.

Source-specific factors associated with the permitting, operation and closure of OB/OD units include:

- Treatment of energetics and associated pretreatment, treatment, and post-treatment safety hazards.
- Potential for significant waste stream variability that may be difficult to predict and characterize.
- Intermittent/quasi-instantaneous releases that are challenges to monitor and model.
- Limited opportunities for engineering controls.
- Regulatory requirement for site-specific environmental performance standards.

The following sections provide an overview of OB/OD sources, including physical and process description (Sect. 2.1), criteria for burning and detonation (Sect. 2.2) potential emissions (Sect. 2.3), and best management practices (Sect. 2.4).

2.1 OB/OD PHYSICAL AND PROCESS DESCRIPTION

2.1.1 OB Physical and Process Description

Open burning has been used to treat energetic wastes by self-sustained combustion, which is ignited by an external source (such as a flame, heat, or detonation wave that does not result in an explosion) (USEPA, June 1997). Typical energetic wastes treated by OB include bulk propellants and energetic material items which are not reliably detonable and/or can be burned without causing an explosion. Occasionally, OB has been used for the treatment of solvents that contain energetic constituents or other energetic-contaminated wastes. Fig. 2-1 illustrates the various modes of OB treatment.

In the past, OB was frequently conducted on the ground surface or in burn trenches. Current best management practice for OB involves the use of burn pans to contain the energetic waste prior to treatment as well as the residue and ash from the burn. Burn pans typically range in size from 3 to 5 ft. wide by 5 to 20 ft. long and are 1 to 2 ft. deep (USEPA, June 1997). Based on field tests conducted by the U.S. Army, the OB ash/residue from the treatment of bulk propellants is approximately a factor of 10^{-3} of the original energetic waste mass (U.S. Army, January 1992).

Waste propellants to be treated by OB are often contained in bags that are placed directly into the unit. Dunnage (such as wood) and supplemental fuels (such as fuel oil or kerosene) have been used to aid the burning in certain circumstances. For example, dunnage can be used for the treatment of wet energetic wastes that may be generated during certain energetic manufacture operations. Burn cages and burn pans have been used for burns with dunnage.

Open burning and static firing have been used for the demilitarization of rocket and missile motors. In some cases involving very large items that would not fit in pans, the treatment of rocket/missile motors has involved OB directly on the ground or in trenches. In these cases, an explosive charge is used to break open the motor casing and the energetic motors will then burn. However, static firing (SF) is the preferred treatment method for these large rocket and missile motors. Mounting stands and missile silos have been used for the static firing of rocket and missile motors for demilitarization.

Burn pans with precipitation covers are illustrated in Fig. 2-2, respectively.

Burn rates and durations are a function of the depth of material in the pan as well as the type of energetic treated and the use of dunnage. (A maximum propellant depth of 3 in. is typical). For example, based on Army tests, the burn duration of a 3 in. layer of M-26 propellant is about 10 seconds. For flaked TNT the duration is 37 minutes (U.S. Army, March 1986). Typically, propellant burns last only seconds (i.e., less than one minute). The Army tests also indicate that burns of dunnage plus energetics may have durations for several hours (attributed solely to the burning/smoldering of the dunnage), but in the tests the burn duration for the energetics portion only of the dunnage/energetics combination was similar to those for energetics without dunnage.

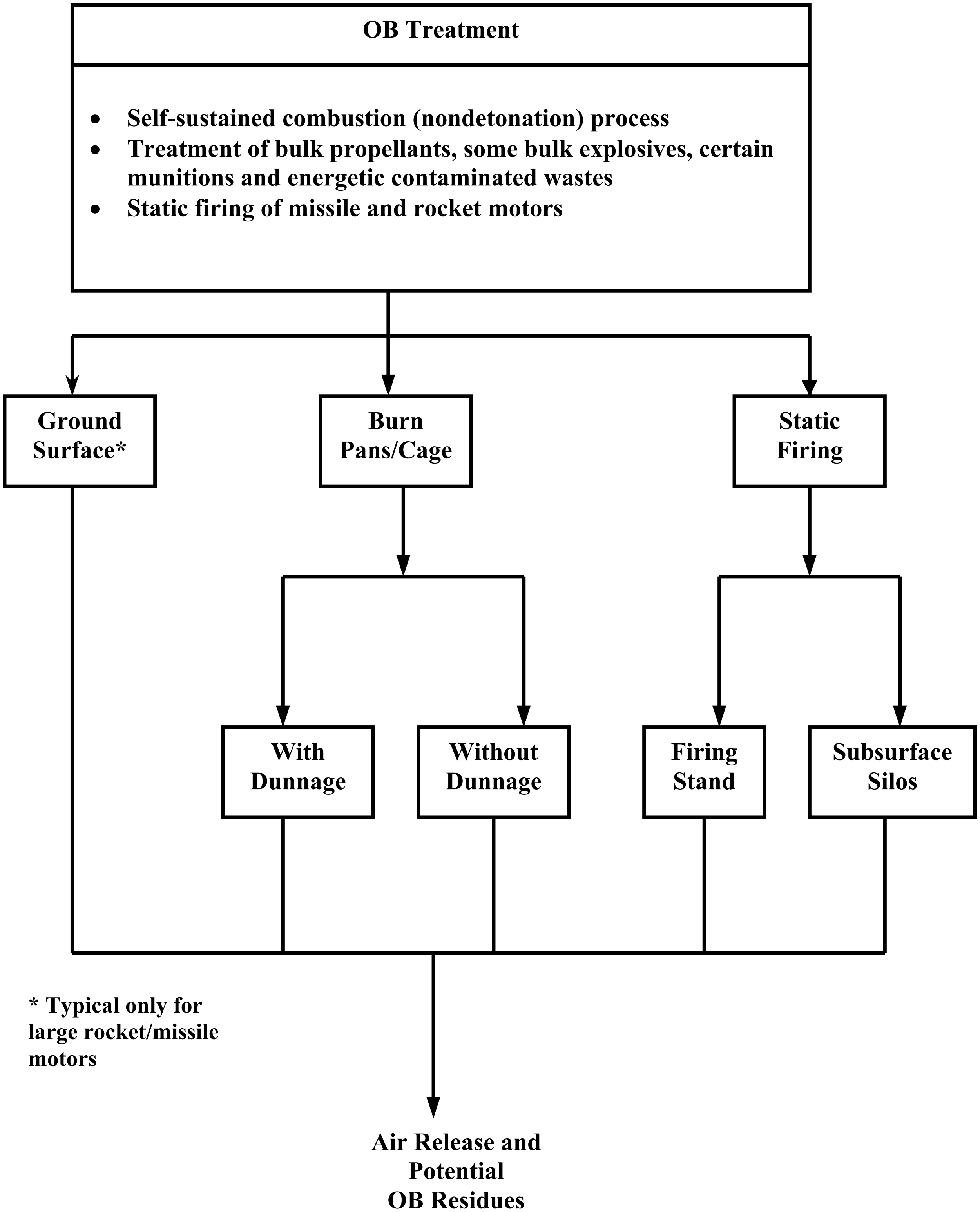


Fig. 2-1. Open burning (OB) overview (based on U.S. Army, March 2001)

Fig. 2-2. Example burn pans with precipitation covers

Initial OB flame temperatures associated with the thermal treatment of propellants can exceed 1,800K (2,322°F) for some materials. A typical OB source temperature is approximately 1,000K (1,341°F), and 700K (801°F) with dunnage (U.S. Army, March 1986).

2.1.2 OD PHYSICAL PROCESS DESCRIPTION

Open detonation to treat waste explosives and certain munition items typically has been conducted directly on the ground surface, in open pits or trenches, or via buried charges (i.e., subsurface detonations) (see Fig. 2--3). Figure 2-4 provides an example of OD treatment. Use of pits, trenches and subsurface detonations reduces the fragmentation hazard associated with the treatment of munition items, as well as minimizing noise.

Open pits typically range from 10 ft. to 30 ft. in diameter and from 5 ft. to 15 ft. deep (depending on the explosive weight to be treated). Trenches vary in size depending on the quantity to be tested and are usually 4 to 8 ft. wide by 6 to 15 ft. long (USEPA, June 1997). Subsurface detonations usually involve burial of charges with a 2 ft. to 10 ft. soil cover.

The maximum quantities to be OD treated are measured in terms of net explosive weight (NEW), the total weight of explosives in the munition. An explosive charge (donor charge) is used to initiate the detonation and increase treatment effectiveness. The donor charge is an explosive being used for its intended purpose, and therefore it is not RCRA regulated but should be accounted for in the charactization and impact assessment of OD operations. Military installations often use Composition C-4 (90 percent RDX and 10 percent plasticizer, such as polyisobutylene) as an explosive donor charge for OD operations. The quantity of donor charge used is frequently equal to the NEW of the munitions to be treated but may vary depending on the type of waste energetics/munitions treated (USEPA, June 1997).

The detonation process occurs at supersonic speeds and therefore is considered a quasi-instantaneous source. Typical OD source temperatures range from 800K (981°F) to 1,000K (1,341°F). Cloud heights (a function of the NEW) for OD tests were observed to stabilize approximately two minutes after the detonations (DNA, October 1981).

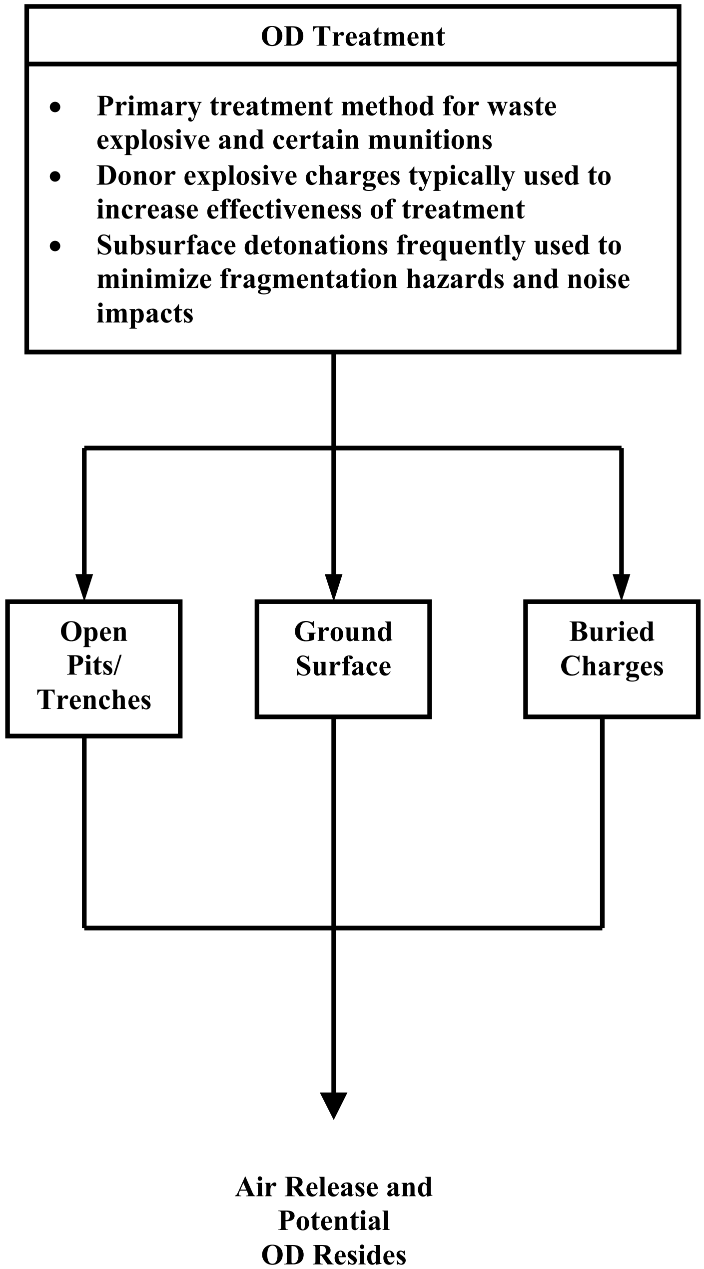


Fig. 2-3. Open detonation (OD) overview

Figure 2-4. Example OD treatment

2.2 CRITERIA FOR BURNING AND DETONATION

Wastes appropriate for OB/OD treatment are limited to certain reactive wastes, ignitable wastes and energetic contaminated wastes that cannot safely be disposed of through other modes of treatment based on site-specific considerations (e.g., hazard potential, environmental impact potential, technical feasibility, transportation).

2.2.1 RCRA Hazardous Waste Codes

Only hazardous wastes that have explosive characteristics of reactivity (i.e., a limited subset of EPA Hazardous Waste Code D003) are allowable for routine OB/OD treatment. Specifically, these explosive reactivity definitions are specified in 40 CFR 261.23(a)(6-8) of the Code of Federal Regulations, October 2001 as follows:

> It is capable of detonation or explosive reaction if it is subjected to a strong initiating source or if heated under confinement.
>
> It is readily capable of detonation or explosive decomposition or reaction at standard temperature and pressure.
>
> It is a forbidden explosive as defined in 49 CFR 173.51, or a Class A explosive as defined in 49 CFR 173.53 or a Class B explosive as defined in 49 CFR 173.88

These definitions therefore include propellants, explosives and pyrotechnics (PEP). In addition, most waste military munitions would be included pursuant to the Military Munitions Rule (40 CFR 260.10):

> . . . . the term military munitions includes: confined gaseous, liquids, and solid propellants, explosives, pyrotechnics, chemical and riot control agents, smokes, and incendiaries used by DoD components, including bulk explosives and chemical warfare agents, chemical munitions, rockets, guided and ballistic missiles, bombs, warheads, mortar rounds, artillery ammunition, small arms ammunition, grenades, mines, torpedoes, depth charges, cluster munitions and dispensers, demolition charges, and devices and components thereof. Military munitions do not include wholly inert items, improvised explosive devices, nuclear devices and nuclear components thereof. However, the term does include non-nuclear components of nuclear devices, managed under DOE's nuclear weapons program after all required sanitation operations under the Atomic Energy Act of 1954, as amended, have been completed.

Exceptions for routine OB/OD treatment from the above list would include small arms ammunition, (up to 50 caliber based on USEPA, November 1984) chemical warfare agents, and chemical munitions, although there may be circumstances that warrant emergency treatment pursuant to the Military Munitions Rule.

While the EPA Waste Code D003 is mandatory for OB/OD treatment, additional waste codes may also be applicable. For example, lead azide would have hazardous waste codes D003 and D008, and mercury fulminate would have D003 and D009 (P065 specific to mercury fulminate may also apply to limited circumstances). Another example is an aerial flare that could have hazardous waste codes D003 (since it is a "forbidden explosive" pursuant to 40 CFR 261.23(a)(8)) and D001 (since it has ignitability and rigorous burn characteristics pursuant to 40 CFR 261.21(a)(2)).

2.2.2 DOT Hazard Classification Codes

Hazard classification codes for explosives, as defined by the Department of Transportation (DOT), provide a basis for the selection of OB versus OD treatment of waste energetics. The hazard classification codes (49 CFR 173.52) for explosives are a combination of the DOT hazard class/division (49 CFR 173.50) and a compatibility group (49 CFR 173.52). A copy of these regulatory citations is provided in Appendix A. These explosive classification systems are also used by the Department of Defense (DoD) and included in the web-based Joint Hazard Classification System (DoD access authorization needed). A summary of Hazard Class 1 (Explosives) is provided in Table 2-1 and compatibility groups in Table 2-2. A matrix of hazard class/division versus compatibility group and the resulting hazard classification code is presented in Table 2-3.

Table 2-4 provides a summary of the appropriate treatment (OB, OD or OB/OD) as a function of hazard classification codes. However, there may be exceptions based on site-specific and item-specific hazard considerations and the judgment of UXO/EOD staff. A further discussion of energetic wastes appropriate for OB and OD treatment is provided in Sects. 2.2.3 and 2.2.4, respectively. A summary of typical energetic items that should be prohibited from routine OB/OD treatment is presented in Sect. 2.2.5.

2.2.3 Criteria for Open Burning

Open burning should be limited to the treatment of those waste energetics that would result in a subsonic chemical transformation process (i.e., no detonation). Typical candidates for OB treatment include the following:

- Bulk propellants
- Certain bulk explosives (e.g., TNT flakes) if detonation will not occur
- Class 1.3 explosive (mass deflagration hazard)
- Certain explosives (i.e., those that also are a vigorous combustion subset of EPA Waste code D001 pursuant to 40 CFR 261.21(b) and 49 CFR 173.151)

The selection and appropriateness of OB treatment must also be based on site-specific safety, transportation hazard potential, offsite treatment options and feasibility of alternative technology considerations.

Table 2-1. DOT hazard classes for explosives

1.1	Mass explosion
1.2	Nonmass explosion, fragment-producing
1.3	Mass Fire, minor blast or fragment
1.4	Moderate fire, no blast or fragment
1.5	Explosive substance, very insensitive (with a mass explosion hazard)
1.6	Explosive article, extremely insensitive

Table 2-2. Compatibility groups for explosives

Group A Bulk-initiating explosives that have the necessary sensitivity to friction, heat, or percussion (shock) to make them suitable for use as initiating elements in an explosive train (i.e., primary initiating explosives are lead azide, lead styphnate, mercury fulminate, and tetracene). Examples of nonprimary initiating explosives are dry forms of cyclotetramethylene tetranitramine (HMX), cyclotrimethylene trinitramine (RDX), and pentaerythritol tetranitrate (PETN)
Group B Detonators and similar initiating devices that do not contain two or more independent safety features (i.e., blasting caps, small arem primers, fuzes, and detonators of all types).
Group C Bulk propellants, propelling charges, and devices containing propellant with or without their own means of initiation (i.e., single, double and triple base propellants, composite propellants, rocket motors (solid propellant), and ammunition with inert projectiles).
Group D High explosives (HE) and devices containing HE without their own means of initiation and without a propelling charge (i.e., wet HMX, plastic-bonded explosives, TNT, and black powder).
Group E Explosives devices with their own means of initiation and with or without propelling charge (i.e., grenades, sounding devices, and similar items an in-line explosive train in the initiator).
Group G Pyrotechnic materials and devices containing pyrotechnic materials (i.e., devices that, when functioning, result in illumination, smoke, or an incendiary, lachrymatory, or sound effect).
Group H Ammunition containing both explosives and white phosphorus or other pyrophoric material (i.e., WP, plasticized WP, or other ammunition containing pyrophoric material).
Group J Ammunition containing both explosives and flammable liquids or gels (i.e., liquid and gel filled incendiary ammunition, fuel-air explosive devices, flammable liquid-fueled missiles, and torpedoes).
Group K Ammunition containing both explosives and toxic chemical agents (i.e., artillery or mortar ammunition [fuzed or unfuzed], grenades, and rockets or bombs filled with lethal or incapacitating chemical agent).
Group L Explosives or ammunition not included in other storage compatibility/hazard class groups (i.e., damaged or suspect explosive devices or containers, explosives that have undergone severe testing, fuel/air explosive devices, and water-activated devices, experimental explosives, newly synthesized compounds, new mixtures, and salvaged explosives until it is established they are compatible with the original materials).
Group N Hazard Division 1.6 ammunition containing only extremely insensitive detonating substances (i.e., bombs and warheads).
Group S Explosives, explosives devices, or ammunition presenting no significant hazard (i.e., thermal batteries, cable cutters, explosive actuators, and other ammunition items packaged to meet the criteria of this group).

Table 2-3. Hazard classification codes for explosives

Hazard Class/ Division	A	B	C	D	E	F	G	H	J	K	L	N	S
1.1	1.1 A	1.1 B	1.1 C	1.1 D	1.1 E	1.1 F	1.1 G	…	1.1 J	…	1.1 L	…	…
1.2	…	1.2 B	1.2 C	1.2 D	1.2 E	1.2 F	1.2 G	1.2 H	1.2 J	1.2 K	1.2 L	…	…
1.3	…	…	1.3 C	…	…	1.3 F	1.3 G	1.3 H	1.3 J	1.3 K	1.3 L	…	…
1.4	…	1.4 B	1.4 C	1.4 D	1.4 E	1.4 F	1.4 G	…	…	…	…	…	1.4 S
1.5	…	…	…	1.5 D	…	…	…	…	…	…	…	…	…
1.6	…	…	…	…	…	…	…	…	…	…	…	1.6 N	…

Table 2-4. OB/OD appropriate treatment summary

Compatibility Groups	Hazard Classification Code	Typically OB	Typically OD	Candidate for OB or OD
A	1.1 A		X	
B	1.1 B		X	X
	1.2 B		X	
	1.4 B	X		
C	1.1 C	X		X
	1.2 C		X	X
	1.3 C	X		X
	1.4 C	X		
D	1.1 D		X	
	1.2 D		X	X
	1.4 D	X		
	1.5 D		X	
E	1.1 E		X	
	1.2 E		X	
	1.4 E	X		
F	1.1 F		X	
	1.2 F		X	
	1.3 F	X		X
	1.4 F	X		X
G	1.1 G		X	
	1.2 G		X	
	1.3 G	X		X
	1.4 G	X		X
H	1.2 H		X	X
	1.3 H	X		X
J	1.1 J		X	
	1.2 J		X	
	1.3 J	X		X
K	1.2 K		X	
	1.3 K	X		X
L	1.1 L		X	
	1.2 L		X	
	1.3 L	X		X
N	1.6 N		X	
S	1.4 S	X		

2.2.4 Criteria for Open Detonation

Open detonation should be limited to the treatment of those waste energetics that would result in a supersonic chemical transformation process. Typical candidates for OD treatment include the following:

- Bulk explosives
- Class 1.1 explosives (detonates almost instantaneously)
- Class 1.2 explosives (principal hazards of blast and/or fragmentation)
- Most other munition items

The selection and appropriateness of OD treatment must also be based on site-specific safety, transportation hazard potential, offsite treatment options, and feasibility of alternative technology considerations.

2.2.5 Prohibited Energetic Wastes for Routine OB/OD Treatment

Certain energetic wastes should be excluded from routine OB/OD treatment because of the potential for extremely toxic releases or availability of alternative treatment technologies. Examples of these prohibited items include the following:

- Small arms ammunition up to 50 caliber (since this is not considered to have RCRA explosive reactivity characteristics based on EPA policy (USEPA, November 1984) and alternative treatment technologies are available)

- Chemical agent munitions

- Riot-control munitions

- White/red phosphorous

- Incendiaries (e.g., napalm)

- Colored smokes

- Depleted uranium (DU) munitions

The items listed above may be prohibited from routine OB/OD operations, but there may be site-specific need for emergency treatment to mitigate safety hazards.

2.3 OB/OD TREATMENT EMISSIONS AND CONCEPTUAL SITE MODEL

The evaluation of OB/OD treatment emissions involve consideration of the following factors:

- OB/OD air emissions
- Casings and other munition components (OD)
- OB/OD ejecta
- Unexploded ordnance (UXO) hazards
- Soil explosives hazard
- Historical operations
- OB/OD conceptual site model

These factors are discussed in Sects. 2.3.1 through 2.3.7, respectively.

2.3.1 OB/OD Air Emissions

Energetic compounds are composed mainly of carbon, hydrogen, nitrogen, and oxygen. The primary air emissions are products of combustion that typically include the following:

- Carbon monoxide
- Carbon dioxide
- Nitrogen and nitrogen oxides
- Water
- Sulfur dioxide
- Methane

Secondary air emissions include various products of incomplete combustion that can include energetics, other organics, and inorganics such as metals, cyanides, and sulfides. There is also a potential for the release of dioxins and furans if chlorinated energetics are treated. Air emissions from OB/OD treatment include inhalable size particles that can remain airborne for large travel distances.

2.3.2 Casings and Other Munition Components

Studies conducted by the U.S. Navy have indicated that metal casings and other unit munition components treated by OD become shrapnel (U.S. Navy, March 2001). Therefore, these components are not considered a primary source of OD air emissions or residues that would rapidly migrate in the environment.

2.3.3 OB/OD Ejecta

Soil ejecta from OD operations can be a source of airborne soil particulates that include OD residues. The inhalable size particles from OD soil ejecta can remain airborne for large travel distances. However, most of the ejecta from the crater are deposited within about 3 to 5 crater radii of the detonation location. Sample crater radii as a function of NEW treated are provided in Table 2-5. Guidance for the estimation of crater radii is provided in *High Explosives Field Tests* (DNA, October 1981).

Open detonation field tests conducted at Dugway Proving Ground (DPG), Utah, indicated that 97-98% of the measured OD residue constituents in soil occurred within the crater. The remainder (2-3%) was within a 125-m radius for a 2,000 lb NEW detonation (U.S. Army, January 1992).

Maximum OD residue concentrations are expected to occur within the detonation crater. Typical crater depths as a function of NEW treatment quantities are provided in Table 2-5. Guidance for the estimation of crater depths is provided in *High Explosives Field Tests* (DNA, October 1981).

Open burn field tests conducted at DPG have indicated that residues were generally limited to within 10-20 m of the burn pans. Potential OB residue constituents in the soil may occur in the immediate vicinity of the pans because of spillage (loading the burn pans with propellant and/or unloading the post-burn residue and ash). Ejecta and "pop outs" from the burns are another potential source of contamination (U.S. Army, January 1992).

2.3.4 UXO Hazards

The potential for unexploded ordnance exists at OD units and OB units which have been used to treat munitions. UXO is also a concern for all OB/OD units located within military impacts ranges. When live ordnance items and/or debris have been buried by natural processes it may be necessary to conduct a UXO survey and subsequent UXO clearance based on site-specific conditions and/or closure requirements.

UXO associated with OB/OD treatment operations is expected to occur on the ground surface and at depths commensurate with OD pits and craters. However, UXO can occur at greater depths at OB/OD sites located within military ranges associated with range operations.

Additional UXO guidance and information are available from the *Handbook on the Management of Ordnance and Explosives at Closed, Transferred, and Transferring Ranges.* (USEPA, June 2001).

2.3.5 Soil Explosives Hazard

The U.S. Army collected surface soil samples at OB/OD sites at 36 installations (U.S. Army, February 1986). About 99% of the analytical results for energetics were below 1,000 μg/g. Soils with a 12 percent or greater concentration of secondary explosives, such as TNT and RDX, are capable of propagating through soil if initiated by flame. Soils containing more than 15 percent secondary explosives by weight are susceptible to initiation by shock. In addition, chunks of bulk explosives in soils will detonate if initiated, but will not propagate through the soil without a minimum explosive concentration of 12 percent. To be safe, the U.S. Army Environmental Center considers all soils containing 10 percent or more of secondary

Table 2-5. Typical sample OD crater dimensions[a,b]

Soil Geology	Total NEW (lb)	Crater Radius (ft)	Ejecta Fallout Zone 3-5 Crater Radii (ft)	Crater Depth (ft)
Wet Soil/Clay	1	1.5	5-8	0.6
Wet Soil/Clay	10	3.3	10-17	1.4
Wet Soil/Clay	100	7.0	21-35	2.9
Wet Soil/Clay	1,000	15.1	45-76	6.3
Dry Soil/Clay	1	1.0	3-5	0.4
Dry Soil/Clay	10	2.1	6-11	0.9
Dry Soil/Clay	100	4.4	13-22	1.8
Dry Soil/Clay	1,000	9.5	29-48	4.0

[a]Based on DNA, October 1981

[b]Crater dimensions based on surface detonations. Crater dimensions expected to be greater for shallow-buried charges. Crater dimension may also vary based on site-specific subsurface soil conditions and geology.

explosives or mixtures of secondary explosives to be explosive soil (U.S. Navy, March 2001,USEPA, June 2001). Therefore, soil explosion hazards at OB/OD site are generally low although there is the potential for "hot spots."

2.3.6 Historical Operations

In addition to the RCRA-regulated OB/OD treatment operations described in this section, other earlier hazardous waste activities may have contributed to the quality of soils and groundwater at a unit. Especially for sites operated prior to 1980, historical operations may be a major cause of hazardous constituents in soils and groundwater. For site-specific regulatory guidance applicable to these situations adequate historical operations information and available site characterization data should be provided to the lead regulatory agency.

2.3.7 OB/OD Conceptual Site Model

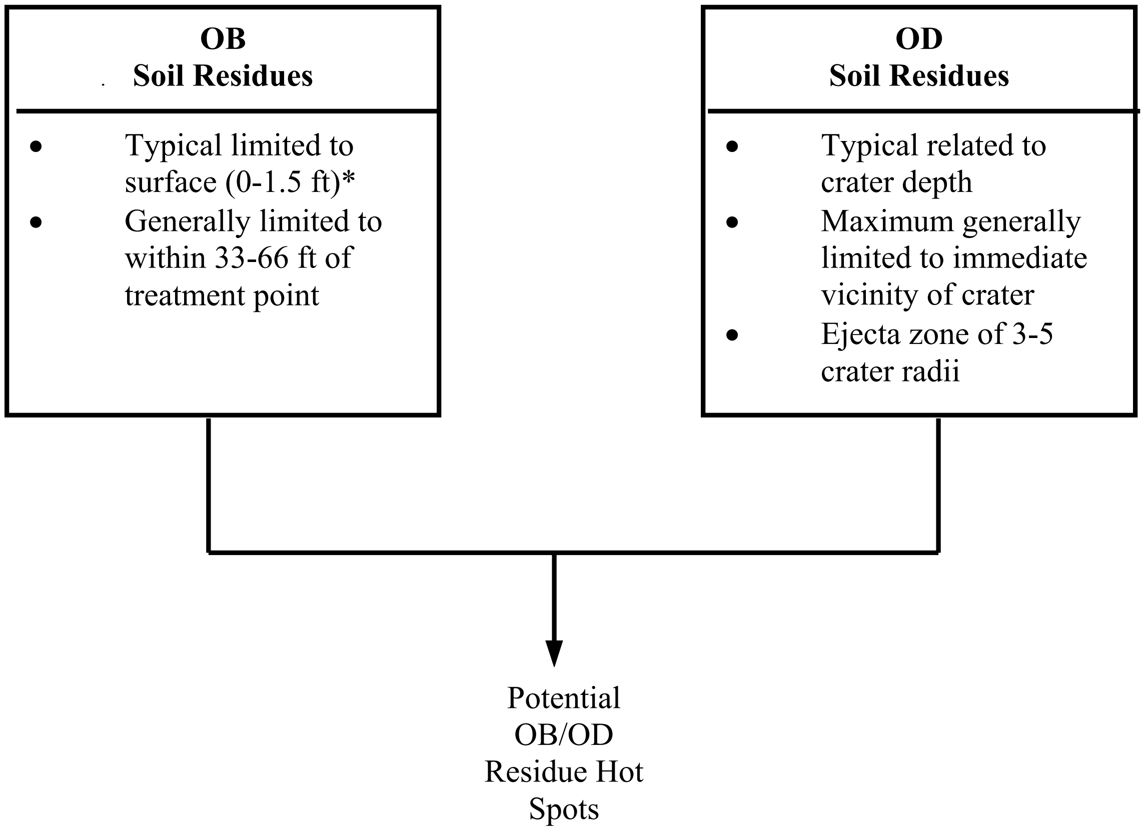
A generic OB/OD site model involves the following components:

- Contamination source (Sect. 2.3.1-2.3.6)
  - + Treatment location
  - + Ejecta zone
  - + Other hot spots

- Transport pathways (to be discussed in Sect. 4)
  - + Atmospheric dispersion (inhalation)
  - + Atmospheric deposition (air to soil and/or surface water)
  - + Overland runoff (soil to surface water)
  - + Infiltration (soil to groundwater)
  - + Wind erosion (soil to air)
  - + Fugitive dust (soil to air)

- Potential receptors (to be discussed in Sect. 4)
  - + Points of compliance
  - + Maximum exposures

The potential for soil residue hot spots at an OB/OD are summarized in Fig. 2-5. A generic OB/OD unit conceptual site model is illustrated in Fig. 2-6. And a preliminary basis to evaluate the potential for leaching of OB/OD residues from the soil to groundwater is depicted in Fig. 2-7. These figures illustrate the process for identifying potential contamination sources, migration pathways, and receptors. This process should be implemented on a site-specific basis and documented in the permit application (or corrective action/closure plans) and used for the determination of environmental performance standards and permit (or corrective action/closure) conditions.



* Greater depths for historical treatment that used liquid fuels directly on the ground or site conditions with high infiltration potential.

Fig. 2-5. Potential OB/OD residue hot spots.

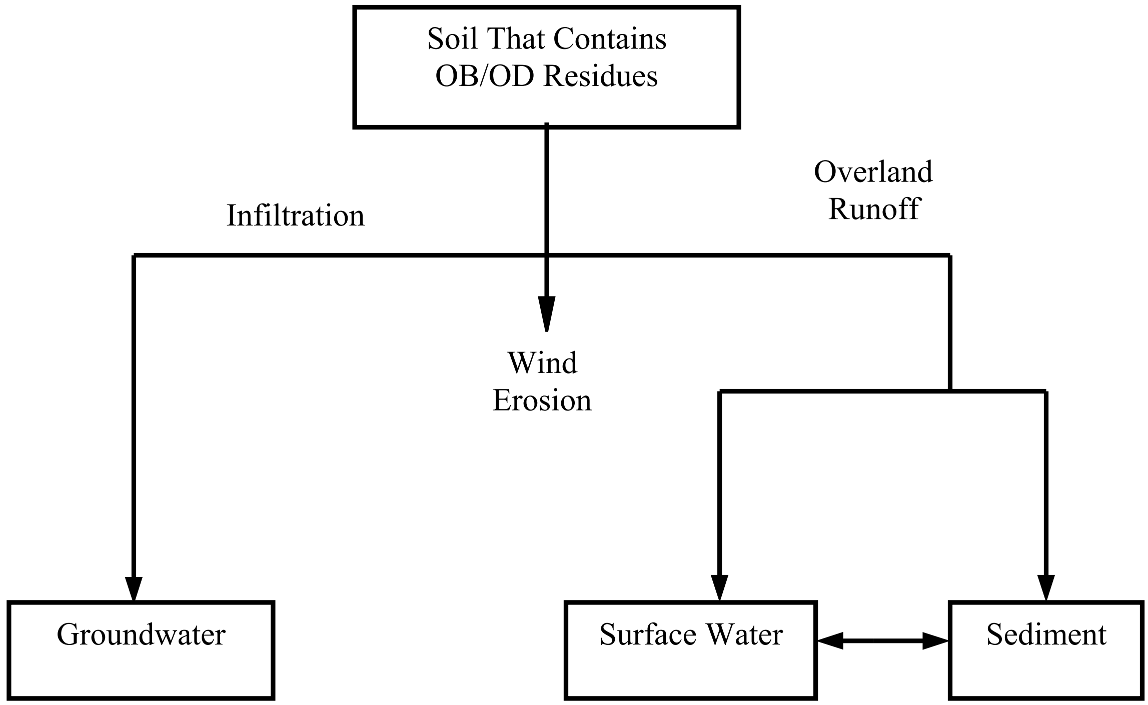


Fig. 2-6. Potential environmental transport pathways of concern at OB/OD units.

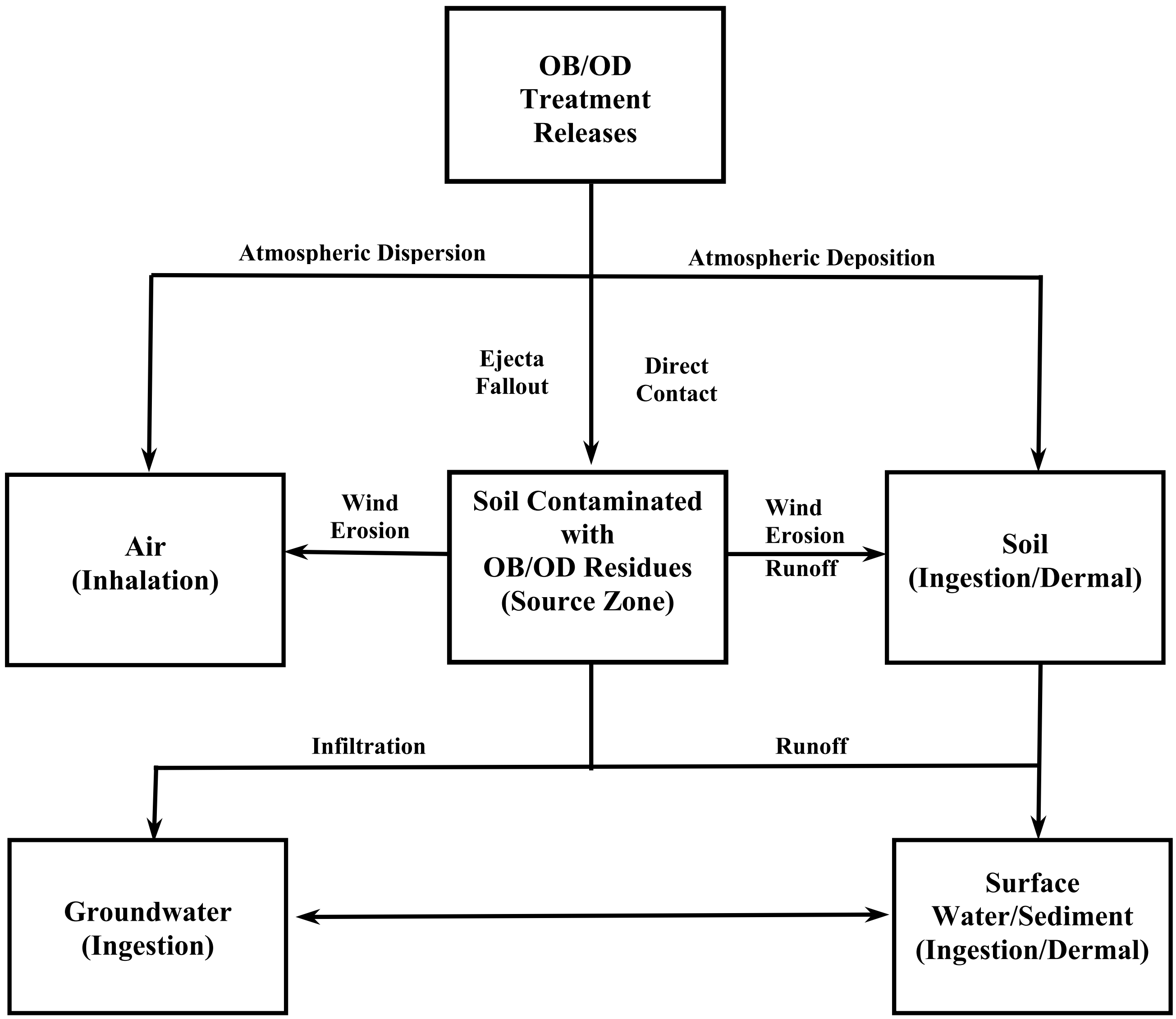


Fig. 2-7. Generic OB/OD conceptual site model

2.4 OB/OD BEST MANAGEMENT PRACTICES

Applicable best management practices for OB/OD unit should be specified as permit conditions. Following is a list of generic OB/OD best management practices that should be considered on as case-by-case basis:

- Run-on and run-off controls for the OB/OD unit. Typical control measures that could be taken include:

  + Berms or ditches of sufficient size upgradient of the OB/OD unit to prevent run-on.

  + Covers to prevent precipitation from contacting contamination (thus preventing contaminated run-off)

  + Berms or ditches of sufficient size downgradient of the OB/OD unit to capture run-off.

  + Run-off collection system.

  + Analysis of collected run-off of determine if it can be released or must be treated.

- Operations only during daylight hours (i.e., from 1-hr after sunrise to 1-hr before sunset)

- Operation only within a wind speed range of 3-15 mph (a 20 mph maximum is also frequently used for OD units)

- No operations during electrical storms within 3 miles

- No operations during precipitation/inclement weather or planned if storms are forecasted within a 4-hr period.

- No operations during a weather inversion, nor planned if an inversion is forecasted.

- A minimum radius of 200 ft from the OB/OD treatment location should be cleared of combustible material as a fire prevention measure.

- Waste energetics should only be placed in the OB/OD unit if treatment is planned within 4 hours.

- Preferable to conduct OB/OD at a fixed location(s) within the unit boundaries to minimize the operational "footprint".

Sects. 2.4.1 and 2.4.2 provide OB-specific and OD-specific best management practices for OB and OD units, respectively.

2.4.1 <u>OB Best Management Practices</u>

Best management practices for OB units include the following:

- Use of burn pans (or the other containment devices) to avoid contact with the soil surface.

- Pans should be made of material sufficient to withstand the burning process and be of sufficient size and depth to contain residues.

- The depth of energetics to be treated should be 3 in. or less (to avoid the potential for detonation and facilitate effective treatment).

- The pans should be elevated to enhance cooling and to facilitate routine inspections.

- The pans should be covered when not in use to prevent entry of precipitation.

- Pans may be equipped with ports/valves for draining collected precipitation or cleaning solutions (collected precipitation should not be discharged into the ground unless the pan was decontaminated after its last use, or unless determined not to contain hazardous constituents based on sampling and analysis).

- Metal screening or cages may be helpful to minimize the ejection of residue from the pans/device.

- Burn pans should be situated parallel to each other, oriented length wise along the prevailing wind direction, (i.e., ignition train and explosions burn in direction of prevailing wind) separated by 150 ft and limited to a maximum treatment quantity of 1,000 lbs NEW. This approach is based on Army Material Command Regulation AMC-R 385-100 (U.S. Army, September, 1985).

- The use of dunnage (and liquid fuel igniters) should only be used for special circumstances (e.g., treatment of net energetics or energetic-contaminated materials)

- Generally lined pans (e.g., bricks, clay, etc.) should not be used since this makes residue collection more difficult (however, pans may need to be lined for some cases when burning wet energetics)

- A 24-hour wait time typically is observed between OB events for pan reuse to allow the burn pan surface to cool.

- After each OB treatment event the containment devices should be cleaned of any residue and managed as a hazardous waste until determined otherwise based on waste analyses.

- Ground cover around and beneath the pans should be prepared to facilitate ease of recovery of ejected treatment residue and for prevention of fire hazards (maintenance of packed dirt or clay at a minimum but use of a concrete pad is preferred and use of a gravel bed is discouraged).

- For some OB units it may be warranted to install a subsurface liner system to collect leachate.

Additional OB best management practices may be appropriate on a case-by-case basis.

2.4.2 <u>OD Best Management Practices</u>

Best management practices for OD units include the following:

- Fill sand can be useful to minimize PM10 particulate emissions from OD soil ejecta.

- OD pits, trenches, and/or craters should be filled in (or alternative protective measure) after each use to prevent the accumulation of precipitation and runon (i.e., potential sources for migration to groundwater).

- Search surrounding area for UXO after each treatment day (retreat as necessary)

- A donor to waste energetic NEW ratio of 1 or less (so as not to transform shrapnel to small particles that have a high environmental mobility potential) as appropriate (but may vary depending on the type of waste energetics munitions treated)

- For subsurface detonations the minimal charge burial depth needed to mitigate fragmentation hazards and noise impacts should be used (since burial depth may adversely impact treatment effectiveness)

- An elevated detonation pad (i.e., mound) with clay and/or membrane layers may be practical for small detonation quantities to mitigate residue transport by soil erosion and infiltration.

- Routine housekeeping of the OD unit (i.e., collection and removal of shrapnel from the unit) should be conducted.

Additional OD best management practices may be practical on a case-by-case basis.

3. OB/OD PERMIT APPLICATION

An overview of specific topics regarding the permitting, corrective action, and closure of OB/OD units is presented here for use in preparing permit applications and corrective action and closure plans for OB/OD units. These guidelines will also aid permit writers and other regulatory staff in evaluating applications. However, to ensure completeness of regulatory submittals, the following additional references should be consulted:

- 40 CFR 264.600-603 (Subpart X)
- *RCRA 40 CFR Part 264, Subpart X Permit Writers Technical Resource Document (Subpart X Technical Resource Document)* including the "Subpart X Checklist for Part B Permit Applications" *(Subpart X Checklist)* (USEPA June, 1997)
- 9VAC20-60-10 through 1505 requirements as applicable (including Part B contents specified in 9VAC20-60-1010)

Additional technical resources and guidance are cited throughout this chapter.

Specific topics covered in this section are:

3.1 OB/OD Checklist
3.2 Waste Description
3.3 Waste Analysis Plan
3.4 Waste Minimization Plan
3.5 Treatment Effectiveness Demonstration
3.6 OB/OD Treatment Justification
3.7 OB/OD Unit Location, Design and Operations
3.8 Post-Treatment Waste Management Plan
3.9 Closure Plan
3.10 Additional Site Factors
3.11 Submission Instructions

The objective of this section is to ensure that information provided in the permit applications for OB/OD units is complete and adequate to support the determination of site-specific environmental performance standards (to be discussed in Sect. 4) and of associated permit conditions (to be discussed in Sect. 5).

3.1 OB/OD CHECKLIST

The EPA's *Subpart X Technical Resource Document* includes the *Subpart X Checklist* that is the primary aid in evaluating the completeness of OB/OD permits. A copy of the *Subpart X Checklist* is provided in Appendix A.1.

The *Checklist*, was developed to address all miscellaneous units. Sects. I – IV are applicable to OB/OD units. Sect. III, Specific Information Requirements is especially useful in preparing and evaluating OB/OD permit applications. The major components of Sect. III are:

A – Process Information
B – Environmental Performance Standards
C – Air Quality Assessments
D – Potential Pathways of Exposure and Potential Exposure Magnitude
E – Effectiveness of Treatment
F – Additional Information

An OB/OD Checklist has been developed to supplement the *Subpart X Checklist*. The OB/OD checklist provided in Appendix A.2 corresponds with Sects. 3 through 6 of the Subpart X Checklist.

3.2 WASTE DESCRIPTION

The permit application should describe all energetic waste candidates for OB/OD treatment and identify/justify any uncertainties in the information provided (e.g., same deteriorated UXO may be difficult to characterize). Ideally, the description should include the following information:

- Waste item identification
    + Munition nomenclature (based on standard DoD terminology)
    + Munition family (see example families in Table 3-1)
    + DoD National Stock Number (as applicable/available)
    + DoD Information Code (as applicable/available)

- Gross weight per item
- Net explosive weight per item
- Chemical composition by weight of the NEW per item (i.e., energetics, other hazardous constituents of concern [HCOCs], and all other constituents)
- Donor to be used for OD (not RCRA regulated since the donor is being used for its intended purpose, but should be provided to completely describe the treatment operation and accounted for in the impact assessment as discussed in Sects. 4.1, 4.3, and 4.4)
    + Donor type and NEW per item treated
    + Chemical composition of donor (i.e., energetics, other HCOCs and all other constituents)

- EPA hazardous waste codes (D003, et. al.)
- DOT hazardous classification code (Tables 2-1 to 2-3)
- Type treatment (OB or OD commensurate with Table 2-4)
- Safety data (e.g., industry/military special handling requirements, Material Safety Data Sheets, etc.)
- Waste treatment quantities
    + Per treatment event
    + Annual

Chemical composition information should be provided for inert components of the energetic waste stream including HCOCs, inert constituents and all other constituents in greater than trace quantities that have the potential for releases to the environment during treatment (e.g., in the past some propellant bags were lead-lined).

Many of the energetic waste to be treated by OB/OD units may be characterized by manufacturers and other sources. For example, the Munitions Items Disposition Action System (MIDAS) program, operated by the U.S. Army, includes a database of the composition of many military munitions. Although all of the military munition items are not currently included, a representative number of items have been characterized and additional items are routinely added. The MIDAS web site is at http://www.dac.army.mil/TD/Midas/Index.htm (registration is required for access). Characterization information for military munitions not included in the MIDAS data base are available from DoD and in Service-specific documents.

There are major uncertainties associated with waste description information for potential future OB/OD treatment operations, as follows:

- Potential for a wide range of energetic items to be treated.
- Variability of waste composition between items and potentially even for the same items (because many of the military munition specifications are performance based, not composition based).
- Uncertainties for item-specific treatment quantities.
- Incomplete data for historical OB/OD operations

Thus the permit application should include waste description information based on available historical data for existing units (at least three to five years to characterize the waste stream variability) and for future OB/OD operations for both existing and new units.

In order to address potential waste stream variables and uncertainties, the waste description information provided in the permit application should be sufficient to accomplish the following:

- Justify the appropriateness of OB/OD treatment.
- Establish risk-based treatment limits as permit conditions.
- Facilitate operational flexibility within risk-based treatment limits.

This approach is similar to defining the acceptable waste streams for a hazardous waste incinerator.

For OB/OD applications, the waste description information should be provided as a function of energetic classification and munition category. Sample energetic classifications are as follows:

- Propellants are low explosive agents such as explosive powder or fuel that provide the energy for propelling ordnance to the target. Propellants include both rocket and gun propellants.
- Primary or initiating explosives are high explosives generally used in small quantities to detonate larger quantities of high explosives. Initiating explosives will not burn, but if ignited, they will detonate. In general, propellants are ignited by applying a flame, while bursting explosives are ignited by a severe shock. The

initiating device used to set off a propellant is called a primer, and the device used to initiate the reaction of a bursting explosive is called a detonator.

- Auxiliary or booster explosives are used to increase the flame or shock of the initiating explosive to ensure that the burster charge performs properly. High explosives used as auxiliary explosives are less sensitive than those used in initiators, primers, and detonators, but are more sensitive than those used as filler charges or bursting explosives.

- Bursting explosives, burster charges, or fillers are high explosive charges that are used alone or as part of the explosive charge in mines, bombs, missiles, and projectiles.

- Pyrotechnics are low explosives used to send signals, to illuminate areas of interest, to simulate other weapons during training, and as ignition elements for certain weapons. Pyrotechnic compositions are considered low explosives because of their low rates of combustion. Examples of pyrotechnics are illuminating flares, signaling flares, smoke generators, tracers, incendiary delays, and photo-flash compounds.

- Non-military explosive reactive materials or materials contaminated with explosives.

Examples of munition classifications are as follows:

- **Hand Grenades** – Hand grenades are small explosive- or chemical-type munitions that are designed to be thrown at short range. Various classes of grenades may be encountered as UXO, including fragmentation, smoke, and illumination grenades. All grenades have three main parts: (1) a body, (2) a fuze with a pull ring and safety clip assembly, and (3) a filler. Grenades have metal, plastic, cardboard, or rubber bodies and may contain explosives, white phosphorus, or illumination flares, depending on their intended use. Fragmentation grenades are the most frequently used grenades.

- **Mortars** – Mortars range from approximately 1 to 11 ins. in diameter and can be filled with explosives, white phosphorus, or illumination flares. The mortar fuze is located in either the nose or the base.

- **Projectiles/Artillery Rounds** – Projectiles range from approximately 1 to 16 in. in diameter and from 2 in. to 4 ft. in length. Like mortars, projectile fuzes are located in either the nose or the base.

- **Submunitions** – Submunitions, usually bomblets and mines filled with either explosives or chemical agents, are used for a variety of purposes, including antipersonnel, antimateriel, antitank, dual-purpose, incendiary, and other. They are scattered over large areas by dispensers, missiles, rockets, or projectiles.

Submunitions are activated in a number of ways, including pressure, impact movement, or disturbance, while in flight or when near metallic objects.

- **Missiles** – Missiles consist of a warhead, a motor section, and a fuze, and they are guided to their target by any number of systems, including radar and video. Missiles rely exclusively on proximity fuzes.

- **Bombs** – Bombs range from 1 to 3,000 lbs. in weight and from 3 to 10 ft. in length. Bombs consist of a metal container (the bomb body), a fuze, and a stabilizing device. The bomb holds the explosive or chemical filler.

The above descriptions are provided for information purposes. However, a more detailed munition classification system should be included in the permit application (e.g., the MIDAS munition families shown in Table 3-1).

Waste characterization information should be provided for a representative range of energetics and munition items for each classification type as appropriate, based on historical and planned future OB/OD treatment operations. At a minimum, waste characterization data should be provided for the most recent five-year period for existing units and for future OB/OD operations for existing and new units. Major differences between historical and planned future waste streams should be justified.

Table 3-1. Sample munition families*

MIDAS Family	Description
FP	Pyrotechnics/Illumination/Nonfrag/Tracers
HA	HE Components/Devices (HC 1.1)
HB	HE Bombs
HCC	HE Cartridges: Cast Expl, Less than 90MM
HCS	HE Cartridges: Cast Expl, 90MM and greater
HCP	HE Cartridges: Pressed Expl, Less than 90MM
HCL	HE Cartridges: Pressed Expl, 90MM and greater
HDB	Bulk Explosive "D"
HDC	Explosive D: Cartridges
HDP	Explosive D: Projectiles
HE	Bulk High Explosives
HG	HE Grenades
HH	HE Depth Charges and Underwater Mines
HIC	Cluster Bomb Units (CBUs)
HII	Improved Conventional Munitions (ICMs)
HIM	Rockets with Submunitions (MLRS/ATACMS)
HMP	Guided Missiles: Practice
HMT	Guided Missiles: Tactical
HPC	HE Projectiles: Cast Explosives
HPP	HE Projectiles: Pressed Explosives
HR	HE Rockets
HT	HE Torpedoes
HXM	Demolition Materials
HZT	HE Land Mines
HXD	Demolition Donation Materials (donor charges)
HZP	HE Pressed Mines
LR1	Large Rocket Motor (HC 1.1)
LR3	Large Rocket Motor (HC 1.3)
N	No Family
PB	Bulk Propellants and Black Powder

* Additional family classifications may be warranted on a site-specific basis for munition items not addressed by the MIDAS family classifications.

3.3 WASTE ANALYSIS PLAN

An OB/OD permit application should include a Waste Analysis Plan (WAP). The WAP should address pretreatment wastes as well as post-treatment wastes. The characterization of energetic waste for OB/OD treatment can be a challenge, due to the wide variety and composition of energetics and munitions as well as safety factors associated with the conduct of explosive tests.

Information requirements for the WAP are summarized below:

- Waste analysis parameters
- Rationale for parameters
- Test methods
- Sampling methods (to ensure representativeness)
- Sampling frequency
- Management of wastes generated offsite

Additional details regarding these standard components of a WAP (as well as regulatory citations) are included in the *Subpart X Checklist*, Sect. II. B2, provided in Appendix A).

Waste analysis parameters for candidate OB/OD treatment items would ideally be explosive reactivity and the energetic/HCOC composition of the energetics. However, explosive hazard factors generally preclude testing/sampling/analysis of these parameters for OB/OD units.

Explosive reactivity test methods include:

- A stability test performed by heating the residue to 75°C for 48 hours. A waste is considered reactive due to instability if a sample of it detonates, deflagrates, or decomposes exothermically during the test. The stability test defines a forbidden explosive according to 49 CFR 173.51.

- A detonation test, performed by inserting a blasting cap into a sample and observing the detonation. Reaction of the sample to a strong initiating source and Class A explosives as defined in 49 CFR 173.53 are tested in this manner.

- A spark test, performed by inserting a time fuse or an electric squib into a sample and observing the waste for deflagration (an OB candidate) or detonation (an OD candidate). The test explosive is defined in 49 CFR 173.53 and 49 CFR 173.88.

Reactivity tests are dangerous to conduct and are not available commercially or at most DoD installations. In addition, it is generally dangerous, infeasible, or impractical to disassemble munition items to sample or test their energetic composition. Therefore, a facility may use generator knowledge to determine whether a waste is appropriate for OB/OD treatment. If generator knowledge is used, the generator should demonstrate that the waste is explosive, through means other than the use of test data. Documentation may consist of material safety data sheets (MSDSs), chemical formulations, manufacturer specifications, or DoD documents that attest to the explosive nature of the material. The waste description information provided in the permit application should also support this approach (see Sect. 3.2). Documentation of generator knowledge (e.g., qualifications, training, etc.) should be included in the permit application.

Some OB/OD units may be used for emergency treatment purposes and may involve nonstandard (or prohibited from routine OB/OD treatment) items (e.g., ethylene oxide tanks, containers of ether). Again, generator knowledge is the primary basis for waste analysis and characterization.

Recordkeeping of items treated, application as well as documentation of generator knowledge and item-specific waste description/composition data, quantities, information should be a standard permit condition for each OB/OD treatment event.

Post-treatment waste may include OB/OD ash/residues, scrap, and unexploded ordnance (UXO). The WAP should also address the waste analysis approach for these post-treatment wastes. Generator knowledge may be an appropriate approach for the evaluation of the explosive reactivity of OB/OD generated scrap and UXO (i.e., considering the dangers of reactivity tests). The concentration of energetics for a residue sample (e.g., burn pan ash) can be used to define an explosive reactivity criterion. Specifically, residues/soils with a 12 percent or greater explosive concentration may propagate into a high-order detonation (USEPA, March 2000). Extensive tests conducted by the U.S. Army using the spark/gap explosive reactivity tests for 36 OB/OD sites confirmed that soil/groundwater samples were not reactive on any of the sites (USEPA, April 2000). However, OB/OD post-treatment wastes may have other hazardous waste constituents or characteristics of concern that should be addressed by the WAP (e.g., metals). Table 3-2 identifies sample target constituents and methods for OB/OD post-treatment waste. TCLP metals and energetics (SW-846 Method 8330) are considered standards for most OB/OD units. Additional evaluations may be warranted on a site-specific basis for HCOCs (e.g., 2,4-DNT TCLP, dioxin/furans, cyanide reactivity etc.). It may be necessary for the facility to initially consider dioxins/furans if there is not available and sufficient generator or other knowledge which explicitly demonstrate that chlorinated wastes are not being treated by OB/OD. Ash/residue samples should be collected based on standard SW-846 sampling methods/strategies, but sparkless sampling equipment should be used. Although burn pan ash residues are easily obtained, the collection of OD residues is generally not practical long-term (long-term soil monitoring is an alternative).

Post-treatment waste analyses should be conducted at least annually if the waste energetics treated are consistent in composition. Otherwise, each individual waste stream should be analyzed separately at least once per year, or each ash/residue accumulative container (e.g., 55-gal drum) subject to disposal should be analyzed.

Table 3-2. Target constituents/methods for OB/OD post-treatment wastes

Parameter	EPA method no.[a]
TCLP metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver)	SW-846 1311/6010B/7000A Series[b]
Energetics[c] (to determine total energetic concentration relative to 12% explosive criterion)	SW-846 8330/8332
Dioxins/Furans (applicable if chlorinated wastes treated)	SW-846 8290
2,4-DNT TCLP (may be warranted if Method 8330 results indicate high concentrations of DNT of concern)	SW-846 1311 and 8330 or 8270
Additional HCOCs (on a site-specific basis)	SW-846

[a]USEPA *Test Methods for Evaluating Solid Wastes*, SW-846, Third Edition, Final Update III December 1996 (or latest update available).

[b] Preparation method 3010A is applicable for the TCLP extract. The 7000A Series analyses include mercury (7470A).

[c]See Sect. 4.2.1 for additional details regarding analytical methods for energetics and application of Method 8330.

3.4 WASTE MINIMIZATION PLAN

A waste minimization plan (WMP) should be provided in the permit application and should serve as the basis for the permit. Since OB/OD releases are not conducive to emission controls, the quantity and toxicity of input waste streams should be minimized to the extent possible, especially regarding metals that are part of the energetic chemical composition (e.g., lead in the primary explosive lead azide) based on mass balance considerations (i.e., what goes in is assumed to go out) and other HCOCs.

The OB/OD permit application should include a WMP that identifies measures to minimize the input waste stream to the OB/OD unit. The goal of the WMP should be to minimize annual OB/OD treatment quantities (i.e., in terms of both gross and net explosive weight) needed to achieve site-specific military mission or industrial needs that may vary (in terms of waste composition and quantities), as a function of time including the evaluation of potential offsite treatment options and alternative treatment technologies (see Sect.3.6). Processes such as disassembly and separation should be considered to reduce the OB/OD gross weight treatment quantities (since the ratio of energetic to inert composition can be large for many waste munition items).

The permit application should include an accounting of waste treated by OB and OD (separately) for the most recent three to five-year period for existing units with interim status and future estimates for both existing and new units. The information should include annual treatment quantities in terms of the gross weight and the NEW. This accounting information and the WMP will be used to establish waste reduction procedures and requirements for each permit.

3.5 TREATMENT EFFECTIVENESS DEMONSTRATION

The primary goal of OB/OD is to deactivate the energetic component of the waste treated. Therefore, the permit application should include a demonstration of treatment effectiveness. A measure of the effectiveness of treatment of the OB/OD process is the destruction and removal efficiency (DRE) for energetics. The DRE values for OB/OD can be calculated as follows:

$$DRE_{Total} = \sum_{i-l}^{n} (1.0 - EF_i)(100) \qquad \textit{Eq. 3.5-1}$$

where

DRE_{Total} = Destruction and removal efficiency (percent) for all energetics (i.e., the sum of the emission factor for each individual energetic based on OB/OD emission tests or other supporting data as available)

EF_i = Emission factor for energetic "i" (dimensionless)

i = Each energetic constituent for which an emission factor is applicable and available

n = Total number of energetic constituents with emission factors applicable and available.

Separate DREs should be calculated for OB treatment and OD treatment. OB-specific and OD-specific emission factors have been determined based on BangBox tests conducted by the U.S. Army and validated by EPA (USEPA, August 1998). The DRE for OD should also account for the use of donor explosive charge.

Another factor to be included in the treatment effectiveness demonstration is the explosive reactivity characteristic of the post-treatment wastes. These post-treatment OB/OD wastes include, but are not limited to, residues/ash, unburned bulk waste propellants, UXO, unexploded bulk explosives, and munition components/shrapnel fragments. The permit application should provide available historical site-specific information (e.g., sampling/test results or evaluations based on generator knowledge) for the most recent three-five-year period for existing units that demonstrates that post-treatment wastes are nonreactive (or an applicable offsite study). A Post-Treatment Waste Management Plan (PTWMP) should be included in the permit application to address the evaluation and treatment/disposition of OB/OD post-treatment wastes for future operations at both existing and new facilities (see Sect. 3.8).

The treatment effectiveness demonstration should establish a treatment performance standard to be included as a permit condition (see Sect. 5.3). Therefore, the applicant should also provide a plan to demonstrate and document compliance with treatment effectiveness standards before the permit is issued and while it is in effect.

3.6 OB/OD TREATMENT JUSTIFICATION

The permit application should include a justification of the need for the OB/OD unit that includes evaluation of the following factors:

- Treatment wastes are appropriate for OB/OD treatment (according to acceptability criteria in Sect. 2.2)
- Explosive safety hazards associated with transport and availability of appropriate offsite treatment
- Availability of alternative approaches and technologies for onsite treatment and associated feasibility, explosive safety hazards as well as potential human health and environmental impacts/benefits

Current and evolving alternative treatment technologies to OB/OD include the following processes:

- Destruction (e.g., deactivation furnaces, explosive waste incinerators, detonation/burn chambers)
- Disassembly (e.g., robotic disassembly, cryofracture, water jet/laser cutting)
- Recycling (e.g., chemical conversion, separation, fuel use)
- Removal processes (e.g., high-pressure water washout, dry machine-auger, solution)

Additional technical and availability information for these alternative treatment technologies is available from the U.S. Army Munitions Items Disposition Action System (MIDAS). The web site for MIDAS is at www.dac.army-mil/TD/Midas/Index.htm. Information for evolving alternative treatment technologies for energetics is also available at the Strategic Environmental Research & Development Program (SERDP) web site at www.serdp.org.

Alternative treatment technologies are generally more expensive than OB/OD and typically associated with large-scale/regional demilitarization operations. The Military Services have been reevaluating the impacts and requirements of installation-specific OB/OD based on the following factors (U.S. Army, February 1999):

- Can the installation meet mission requirements without a permitted OB/OD unit?
- Is there a reliable alternative to onsite treatment?
- Does operating the unit create an unacceptable environmental liability based on adverse effects to human and ecological receptors?

These questions are also applicable to commercial facilities and should be discussed in the permit application. Table 3-3 provides a summary of corrective measures evaluation criteria developed by EPA that may also be useful for the evaluation and selection of alternatives to OB/OD treatment.

Applicability of alternative destruction processes are also limited based on treatment capacity restrictions. For example, deactivation furnaces and explosive waste incinerators are designed to process only small arms ammunition, other small munitions, or bulk energetic material. Confined burn facilities and detonation chambers are being developed to meet onsite treatment requirements.

For example, the U.S. Navy at Indian Head has designed a Confined Burn Facility (CBF) that uses a batch-feed chamber. Overview information is available at http://www.ih.navy.mil/environm.htm. Upon ignition of the wastes in the chamber, the hot gases that are generated are quenched with water and stored in a containment reservoir for subsequent scrubbing and treatment at a slow continuous rate before discharge. The five burn chambers of the CBF are connected via ducts equipped with scrubbing and quenching sprays to a central exhaust gas storage vessel. Each burn chamber can hold up to 1,200 lbs. of explosive hazardous waste. All chambers are loaded at the beginning of the shift. Each chamber is ignited individually with 40 to 80 minutes between ignitions to allow processing of all gases. The design requires no additional pre-treatment, and it can burn up to 6,000 lbs. of energetics per shift. It includes redundant burn chambers of composite wall construction (inner wall is ablated during mass detonation to absorb shock waves, and it minimizes damage to the chamber should a mass detonation occur). It uses standard exhaust gas treatment technology, and it uses burn pans similar to existing OB site operations.

Another example of an alternative destructive technology is a Blast Chamber that is being evaluated by the U.S. Army. Overpressures and detonation gases are vented to an expansion chamber and finally to a baghouse system to filter out particulates associated with the detonation gases. Additional air pollution control systems (e.g., wet scrubber, dry scrubber or afterburner) can also be installed as warranted. The rated contained detonation capacity of the Blast Chambers being evaluated ranges from 3 to 130 lbs. net explosive weight. The lower capacities (3 to 13 lbs.) are for the portable blast chambers and the larger for permanent facilities. An important factor to consider in the use of detonation chambers is the life expectancy of the equipment. The prototype Blast Chamber, a permanent facility has been used for more than 10 years and has withstood 600,000 detonations without failure or serious maintenance problems. Additional information can be obtained at the U.S. Army-Huntsville Corps of Engineers web site at www.hnd.usace.army.mil.

Based on these considerations, the permit application should include a justification of the need for an onsite OB/OD unit and a rationale for using an onsite OB/OD unit as opposed to alternative treatment technologies.

Table 3-3. Summary of evaluation criteria for corrective measures (EPA)

FOUR GENERAL STANDARDS FOR CORRECTIVE MEASURES

Overall protection of human health and the environment	Attain media cleanup standards	Control the sources of releases	Comply with standards for management of wastes
How alternatives provide human health and environmental protection	Ability of alternative to achieve the media cleanup standards prescribed in the permit modification or enforcement order	How alternatives reduce or eliminate to the maximum extent possible further release	How alternatives assure that management of wastes during corrective measures is conducted in a protective manner

FIVE SELECTION DECISION FACTORS

Long-term reliability and effectiveness	Reduction of toxicity, mobility, or volume of wastes	Short-term effectiveness	Implementability	Cost
• Magnitude of residual risk • Adequacy and reliability of controls	• Treatment process used and materials required • Amount of hazardous materials destroyed or burned • Degree of expected reduction in toxicity mobility or volume. • Degree to which contamination is irreversible • Type and quantity of residuals remaining after treatment	• Protection of community during remedial actions • Protection of workers during remedial actions • Environmental impacts • Time when remedial action objectives are achieved	• Ability to construct and operate the technology • Reliability of the technology • Ease of understanding additional corrective measures if necessary • Ability to monitor effectiveness of remedy • Coordination with other agencies • Availability of offsite waste management facilities	• Capital costs • Operating and maintenance cost • Present worth costs

3.7 OB/OD UNIT LOCATION, DESIGN AND OPERATION

Subpart X units, especially OB/OD units, use nonstandard approaches for waste treatment. The design and operation of an OB/OD unit is not prescribed under 40 CFR 264, Subpart X. Instead, site-specific environmental standards are used to ensure protection of human health and the environment. Therefore, the permit application should provide sufficient information to describe the design and operation of the OB/OD unit to be used to determine environmental performance standards (as discussed in Sect. 4), as well as associated implementing permit conditions (as discussed in Sect. 5). In addition, the design and operation of OB/OD units should be based on the best management practices addressed in Sect. 2.4.

The following location and design information should be provided in the permit application to support the evaluation of proposed engineering controls for the OB/OD unit (see Sects II.A and III.A, *Subpart X Checklist,* Appendix A):

- Location information and demonstration of compliance with RCRA location standards (40 CFR 264.18).
- Topography map, including identification of unit boundary based on surveyor or GPS data, as well as OB and OD treatment areas within the unit.
- Design and construction of engineering controls (e.g., screens to control OB ejecta, run-on/run-off controls, containment structures, and liner systems)

A unit located in a 100-year flood plain must have procedures to prevent washout of hazardous waste or procedures to remove waste before flooding. Also, units in certain earthquake zones or in sensitive areas or with shallow aquifers may need special design controls and operational procedures as safeguards. Generally, for existing units it is preferable to continue future OB/OD operations at the same location (i.e., reduce the overall foot print of OB/OD impacts although corrective actions and design and operational information may be warranted). The alternative is to close the existing unit and potentially impact a new OB/OD unit location that has not been affected by historical OB/OD operations.

The definitive location of the OB/OD unit should be identified on the topographic map. Permanent markers such as survey monuments or a fenceline should be in place to readily identify the unit boundary in the field. It is preferable to restrict OB/OD operations to distinct subareas within the unit in order to limit the potential contamination footprint. The distance from the OB/OD treatment location to the property of others should comply with the interim status requirements of 40 CFR 265.382.

Engineering drawings should be provided to specify the design and construction of engineering controls. Burn pan drawings should include specifications for precipitation covers. The drawings for OB/OD engineering controls should identify the acceptable range of operational conditions and should be certified by a professional engineer to ensure adequacy for their intended use.

Operational procedures or plans should be provided in the permit application for the following:

- Treatment operations
- Inspection/maintenance
- Recordkeeping
- Security
- Preparedness and prevention
- General hazard prevention
- Prevention of accidental ignition or reaction of wastes
- Emergency procedures contingency plan
- Personnel training
- Source monitoring (Sect. 4.6)

Additional guidance regarding these information requirements are provided in Sects. II.C-E and III.A of the *Subpart X Checklist* (see Appendix A).

Procedures for OB/OD treatment operations should include the following:

- Staff responsibilities and qualifications
- Waste energetics storage, handling and transportation to the OB/OD unit
- Allowable waste for OB/OD treatment (see Sect. 3.2)
- Waste treatment limits (see Sect. 3.2)
- Use of donor charges for OD
- Operational conditions (e.g., meteorological conditions, brush fire hazard potential)
- Safety measures

The potential to ignite unplanned brush fires is a major concern for many OB/OD sites. Preventive measures and emergency response procedures should be addressed in the permit application.

The operational procedures provided in the permit application should be in sufficient detail to ensure protection of human health and the environment and to be incorporated directly as permit conditions. However, these procedures should allow an adequate margin of operational flexibility so as not to necessitate frequent permit revisions.

3.8 POST-TREATMENT WASTE MANAGEMENT PLAN

The OB/OD permit application should include a Post-Treatment Waste Management Plan for future OB/OD operations. Post-treatment OB/OD wastes may include residues/ash, unburned bulk waste propellants, UXO, unexploded bulk explosives, munition components and shrapnel/fragments. These wastes may occur at the point of treatment as well as at greater distances due to OB/OD ejecta and fragmentation of munition items. The Plan should include at a minimum the following elements:

- Post-treatment OB/OD site inspections
- Characterization and reactivity evaluation of post-treatment waste based on the WAP (see Sect.3.3)
- Identification of ejecta and fragmentation distances
- Dispersion patterns
- Possible effects on groundwater or surface water
- UXO/energetic safety sweep
- Assessment of effectiveness
- Recovery protocols
- Management of UXO and other reactive wastes
- Management of other hazardous wastes
- Management of energetic-contaminated wastes (residues)
- Management of solid waste
- Waste accumulation or storage requirements
- Recordkeeping to document compliance with the PTWMP

Following are some sample information resources applicable to the management of energetic-contaminated materials:

- Range Scrap (Firing Point) Study Project conducted by the U.S. Army Environmental Center. Information available at http://aec.army.mil/prod/usaec/eq/comp/munitions01c.htm

- Characterization of Scrap Materials for Mass Detonation Energetic Materials Study (CP-1194) being conducted by SERDP. Information available at http://www.serdp.org/research/Compliance.html

- Removal, Degradations and Recovery of Energetic Residue from Range Scrap Study (CP1196) being conducted by SERDP. Information available at http://www.serdp.org.research/compliance.html

The management requirements for UXO and other post-treatment wastes from OB/OD operations are also addressed in Sect. 3.9.

For comparative purposes a three to five-year summary of available historical post-treatment waste management practices for existing units should be included in the permit application. This information as well as site characterization data can be used by the permit writer to evaluate the effectiveness of the proposed PTWMP.

The PTWMP (including recordkeeping requirements) included in the permit application should be sufficient to be part of the permit, either directly or by reference. Modifications to the PTWMP after the permit is issued would require consultation with the regulatory agency. See Sect. 5 for additional guidance on appropriate permit conditions.

3.9 CLOSURE PLAN

The permit application should include a closure plan to document how closure will be accomplished commensurate with RCRA requirements and will be protective of human health and the environment. Information requirements for closure plans are specified in 40 CFR 265 Subpart G for interim status units and 40 CFR 264 Subpart G for permitted units. The *Subpart X Checklist* (see Appendix A) includes a summary of the information requirements for closure plans as applicable to OB/OD and other miscellaneous units.

Special considerations for the closure of OB/OD units include explosion safety hazards (e.g., UXO for media removal/remediation operations) and available remediation methodologies for energetic-contaminated media (see Sect. 6).

Another special consideration for closure of OB/OD units is the potential need for "delay of closure." Delay of closure (frequently called an administrative closure) is considered to be a temporary deferral of closure activities (i.e., without removal/remediation or the construction of a landfill cap). In some cases it may involve minimal removal/remediation (e.g., cleanup of hot spots). This approach is warranted when current and future military activities preclude an effective RCRA closure and public access is restricted.

The acceptability of the delay of closure concept to regulators will typically be limited to OB/OD units located within active military impact ranges. Under these circumstances, closure is complicated by the need to close the RCRA treatment unit while maintaining the active impact range. In many cases, the cleanup of UXO, debris, and soil will not be practicable because continuing range activities could adversely affect cleaned units. The exposure risks for delay of closure are different from those for final closure (e.g., the public would not generally have access during the delay of closure). The following requirements may be anticipated for implementation of delay of closure:

- Conduct a pre-closure site investigation (see Sect. 4.2) considering historical treatment operations/dispersion patterns and risk assessments (see Sects. 4.3 and 4.4) to demonstrate that OB/OD residues will not endanger human health or the environment.

- Implementation of long-term security measures to control unit access.

- Long-term detection monitoring to demonstrate that hazardous waste constituents are not migrating off the unit.

- Limited land use.

Delay of closure, if warranted, would require demonstration that the delay would not endanger human health and the environment. The permitting agency will consider the impact of delay of closure in the control of the overall risk of the unit based on relevant exposure conditions (e.g., limited public access). The need for environmental monitoring during the delay of closure period should be evaluated on a case-by-case basis.

Additional guidance for the closure of OB/OD units is available in *Closure/Post-Closure Guidance for RCRA OB/OD Units* (U.S. Army, March 2001).

3.10 ADDITIONAL SITE FACTORS

Information should be submitted to the permitting agency regarding the following site factors (as applicable):

- Emergency treatment operations

- Co-located military training, testing, and range clearance operations

These factors are also needed to evaluate potential OB/OD impacts and contributions from related munition treatment/expenditure sources.

3.10.1 Emergency Treatment

Some facilities may need to conduct emergency OB/OD treatment events because of imminent danger or other safety considerations. Examples of emergency treatment include the following:

- Military EOD use of the OD unit to detonate an improvised explosive device that could be transported from an offsite location.

- Treatment at the OB unit of propellant in storage that has been determined to be unstable.

- Discovery of UXO at a construction location onsite that can only be transported to the onsite OD unit for detonation.

Contact the permitting agency regarding the use of temporary emergency permits for these circumstances.

The permit should include provisions to accommodate and control emergency treatments, including, but not limited to, notifications requirements, monitoring, and recordkeeping.

3.10.2 Co-located Military Training, Testing, and Range Clearance Operations

At some military installations the OB/OD unit may be co-located with RCRA-exempt military activities that involve OB/OD or munitions expenditures. Such activities may include explosives ordnance disposal (EOD) training, range clearance OB/OD actions, and, at active ranges, munitions expenditures associated with military training and/or munitions testing. These military activities involve munitions-related releases similar to those for the RCRA-regulated OB/OD unit. A general description of these munitions-related activities should be included in the permit application as supplemental information to adequately characterize local/onsite land use.

3.11 SUBMISSION INSTRUCTIONS

This section provides instructions for the submittal of OB/OD permit applications to facilitate the needs of permit writers. Guidelines are provided for the following:

Sect. 3.11.1 Format/Completeness
Sect. 3.11.2 Modeling Input/Output Files
Sect. 3.11.3 Sampling Data

Additional requirements may be identified by the permit writer on a case-by-case basis.

3.11.1 Format/Completeness

The OB/OD permit application format should be based on the format, outline, and information requirements identified in the EPA "Checklist for Technical Review of RCRA Part B Permit Application for Subpart X Units" (see AppendixA.1). This Subpart X Checklist is included in the *RCRA 40 CFR Part 264, Subpart X Permit Writers Technical Resource Document* (USEPA, June 1997). Permit writers should also use the *Subpart X Checklist* to evaluate OB/OD permit applications for completeness and (along with this VIRGINIA DEQ guidance) technical adequacy. A supplemental OB/OD checklist for this guidance is included in Appendix A.2.

One original and three additional hard copies of the permit application should be submitted to the lead regulatory agency along with an electronic version of the text. The format of the electronic version should be compatible with the lead regulatory agencycomputer systems.

3.11.2 Modeling Input/Output Files

All modeling input/output files (used for dispersion evaluation, risk assessments, constituent migration, etc.) should be submitted to the lead regulatory agencywith the permit application. Electronic files should be provided, as well as a sample printed page (to illustrate modeling files format) and critical summary pages as warranted.

3.11.3 Sampling Data

Site characterization sampling data submitted with the permit application should include the following:

- Validated data listing
- Summary documentation of analytical data validation
- Summary tables (statistical tables and comparisons to applicable impact criteria)

The data can be submitted as electronic files as well as in hard copy format.

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4. OB/OD ENVIRONMENTAL PERFORMANCE STANDARDS

The regulation of permitted OB/OD units, as well as other RCRA miscellaneous units, is based on environmental performance standards pursuant to 40 CFR 264.600-603 (Subpart X). Therefore, permit applications should provide sufficient information for permit writers to define site-specific environmental performance standards.

The following topics are covered:

4.1 Air Pathway Assessments and Modeling
4.2 Baseline Site Characterization
4.3 Human Health Risk Assessments
4.4 Ecological Risk Assessments
4.5 Noise and Ground Vibration Assessments
4.6 Long-Term Source and Environmental Monitoring

Guidance for developing environmental performance standards regarding all of these issues is given in this section.

Fig. 4-1 illustrates the process of determining environmental performance standards for OB/OD units. This process involves the evaluation of information in the permit application that defines OB/OD design operations, environmental setting and procedures for risk management.

Assessments of air pathway, human health risk, ecological risk and noise/ground vibration should be conducted to determine if OB/OD operations endanger human health and the environment. Baseline site characterization data should be collected and evaluated for existing units. These assessments should be included in the permit application. If potential impacts are acceptable, the OB/OD unit design and operating conditions specified in the permit application can serve as proposed site-specific environmental performance standards that can be used by permit writers to craft permit conditions. (Revised OB/OD design, operations, and risk management specifications may be needed to mitigate any unacceptable impacts). Long-term source and environmental monitoring may be warranted to demonstrate that OB/OD operations are not endangering current and/or potential future human health or the environment.

Fig. 4-2 illustrates the process of determining closure performance standards. This process is similar to that for environmental performance standards except that a preclosure site characterization program is needed instead of a baseline program, and the impact assessments include the evaluation of potential and current contamination conditions (based on historical OB/OD operations) and impact on current and future receptors. Long-term monitoring would be needed only if a final risk-based clean closure cannot be accomplished or is delayed.

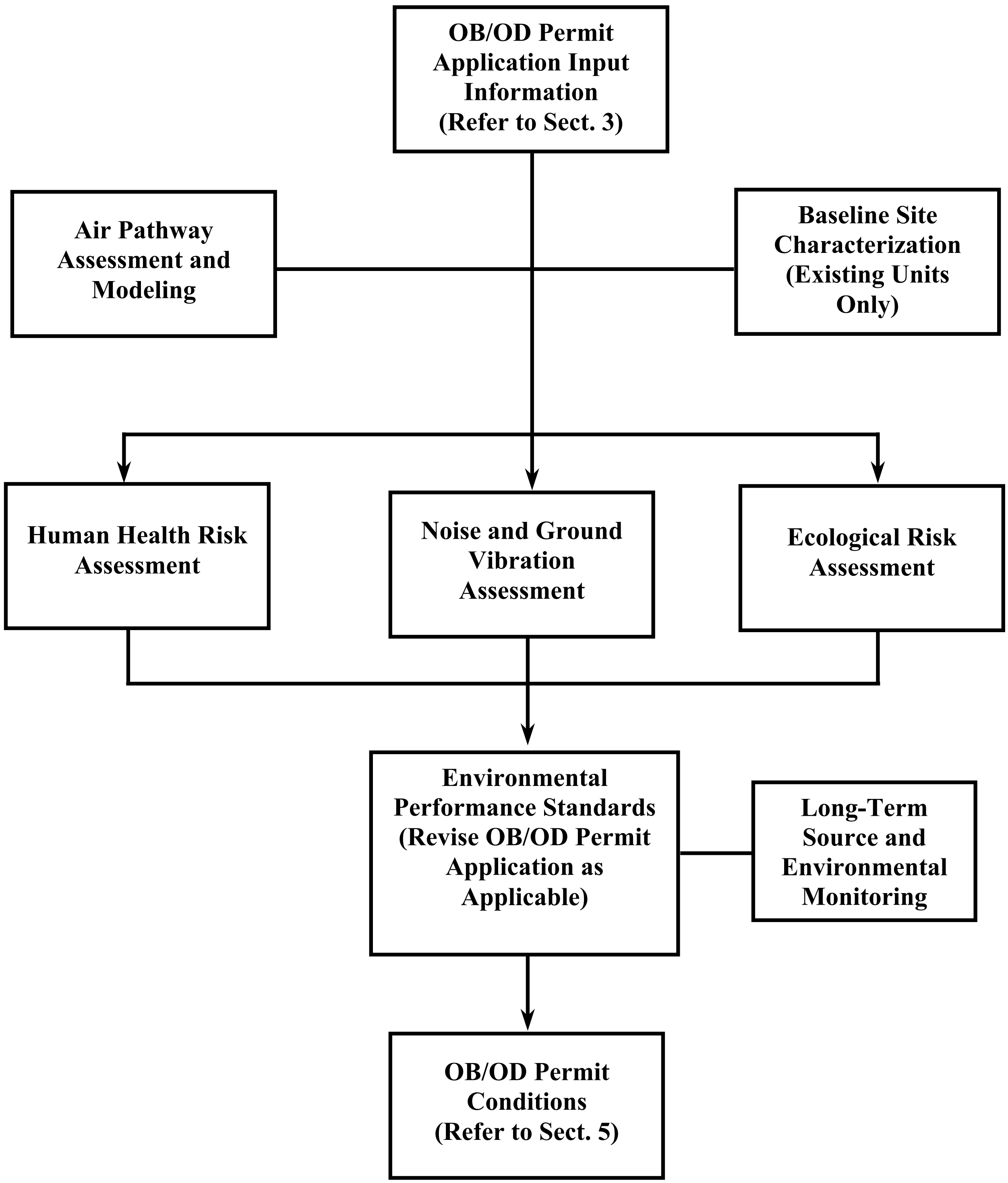


Fig. 4-1. OB/OD environmental performance standards determination process overview

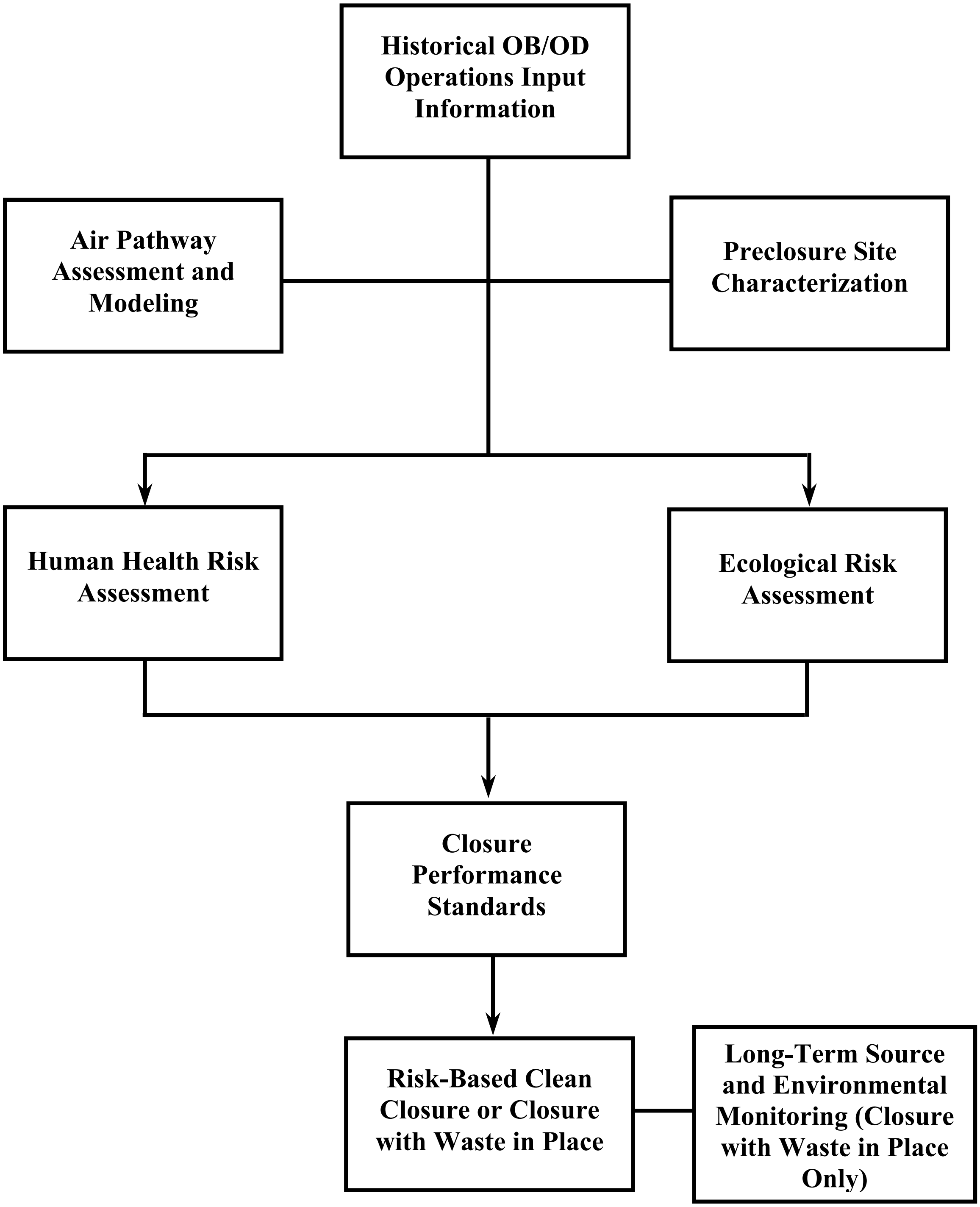


Fig. 4-2. OB/OD closure performance standards determination process overview

4.1 AIR PATHWAY ASSESSMENT PROTOCOL

An Air Pathway Assessment (APA) (including dispersion/deposition modeling) should be conducted for existing and new OB/OD units seeking a permit. In addition, dispersion/deposition modeling and field data should be used to identify and characterize areas impacted by past operation.

An APA Protocol should be submitted for review and concurrence by the lead regulatory agency. The subsequent APA documentation and results should be included in the RCRA permit application for the OB/OD unit(s). The APA Protocol should specify the planned technical approach for the following steps:

- Step 1 – Determine air emission factors
- Step 2 – Identify criteria
- Step 3 – Conduct dispersion modeling
- Step 4 – Evaluate air pathway impacts
- Step 5 – Conduct air monitoring (as warranted)

Steps 1-4 should be conducted first, based on the best available data, as a screening assessment. The need for additional data (with subsequent reevaluations) and/or air monitoring should then be evaluated based on data uncertainties and the potential to exceed risk-based criteria. Facilities should contact the lead regulatory agencyfor site-specific determinations regarding the need for air monitoring.

4.1.1 Step 1 – Determine OB/OD Air Emission Factors/Quantities

The APA protocol should provide a credible approach for the determination of air emission factors associated with OB/OD sources and related operations to include:

- Pretreatment emissions
- Treatment emissions
- Post-treatment emissions

Justification for the air emission factors proposed for each emission source should be provided.

Pretreatment Emissions

Potential pretreatment air emission sources may include fugitive dust from vehicular traffic on unpaved surfaces within the OB/OD unit (i.e., for the delivery of waste energetics) and heavy equipment used for earth-moving operations (e.g., excavation and filling of detonation pits). Typically, pretreatment fugitive dust emissions at OB/OD units in the eastern U.S. are not of concern. However, at the discretion of the lead regulatory agency, the applicant may be required to model pretreatment emissions and/or implement a routine dust suppression program. (Tailpipe emissions are considered insignificant for OB/OD unit activities.) Emission factors for pretreatment sources are available from the EPA Clearinghouse for Inventories and Emission Factors (e.g., *Compilation of Air Pollutant Emission Factors* [AP-42, Sects. 13.2.2-Unpaved

Road and 13.2.3-Heavy Construction Operations]) and related software are available at http://www.epa.gov/ttn/chief/ap42/index.html.

Treatment Emissions

OB/OD treatment emissions involve consideration of the following factors:

- Combustion byproducts (OB and OD)
- Casings and other munition components (OD)
- Crater soil ejecta (OD)
- Donor charge emissions since they are similar to detonation emissions from energetic wastes treated and contribute to the total impact of treatment operations (OD)

Generally, energetic compounds are composed mainly of carbon, hydrogen, nitrogen, and oxygen. The primary air emissions are products of combustion that typically include the following:

- Carbon dioxide
- Nitrogen and nitrogen oxides
- Water
- Sulfur dioxide
- Metals
- Ammonia

Secondary air emissions include various products of incomplete combustion (PICs) that can include energetics, carbon monoxide, methane, and other organics.

Direct measurements of air emissions (for the development of emissions factors) are generally not practical due to the unconfined, extremely violent nature and short-term duration of emissions from OB/OD treatment. Therefore, other available OB/OD emission factors data may be used as representative of site-specific treatment operations.

For example, the U.S. Army has conducted numerous OB/OD emission tests within a chamber (i.e., BangBox) for the Military Services. Results from many of these tests have been compiled and validated by the EPA in *Emission Factors for the Disposal of Energetic Materials by Open Burning and Open Detonation (OB/OD),* the best available OB/OD emission factor database (USEPA, August 1998). Emission tests included treatment of bulk propellants, bulk explosives, dunnage, and munition items. However, the BangBox test results have the following limitations, which should be addressed in, at a minimum, the air pathway assessment of the permit application:

- Emission factors for metals are incomplete (i.e., a consistent and comprehensive list of target analytes for metals was not used for all tests). This is a concern regarding trace metal constituents of energetics.

- Most of the emission factors for explosives are based on surface detonations, but many sites use subsurface detonations (to mitigate fragmentation and noise impacts). Based on theoretical oxygen availability considerations and limited BangBox results, there is a potential for greater emission factors for some chemicals for subsurface detonations.

- Dioxins and furans were not target analytes for most of the BangBox tests. However, burning energetics containing plastics and chlorine in the presence of diesel fuel and wood may produce dioxins and furans.

- Soil ejecta from OD treatment has not been accounted for.

In addition, BangBox-derived OB/OD emission factors may not be available for all the site-specific candidate energetics and munition items for OB/OD treatment. Additional OB/OD emissions test data are becoming available (e.g., tests at the Nevada Test Site [LLNL, May 2001]), but the permitting agency should be contacted prior to the use of alternatives to the BangBox emissions factors database for OB/OD units.

It can be assumed that metal, chlorine, and sulfur constituents of energetic materials treated by OB/OD will be released to the environment. But the issue of potential dioxin/furan formation and other munitions components, as well as OD soil ejecta, is a challenge to evaluate.

Fragmentation tests indicate that the detonation of munitions with metal casings and other inert metal components does not result in the vaporization of metals. However, these inert metal parts will be fragmented into relatively large pieces (shrapnel) not generally subject to environmental migration (U.S. Navy, March 2001).

The use of conservative assumptions and approaches to address OB/OD emission factors database limitations, availability of supplemental OB/OD test results and/or need for the conduct of additional OB/OD emission tests (sponsored by the permit applicant) should be evaluated on a case-by-case basis. Information regarding the potential use of the BangBox for site-specific studies and the availability of additional OB/OD emissions tests should be directed to the U.S. Army, Dugway Proving Ground, Utah, via e-mail to: rblack@dugway-emh3.army.mil. Field data, if available, can also be used to evaluate modeling results.

Emission factors for subsurface detonations should account for the increased emissions for oxygen-deficient energetics treated. Oxygen balance is a measure of the quantity of oxygen needed per unit of energetic to (in theory) completely convert the carbon, hydrogen and nitrogen components to stable oxides. Negative oxygen balance values indicate an oxygen deficiency (i.e., atmospheric oxygen is needed) and the potential for increased products of incomplete combustion (PICs) for subsurface detonation. Common energetics with oxygen deficiencies include (from most deficient to least deficient):

- TNT
- Ammonium picrate
- Tetryl

- Nitrocellulose
- Nitroguanidine
- RDX and HMX

TNT represents the worst-case example of an oxygen deficient energetic with the greatest potential for PICs. BangBox suppressed detonation tests (to evaluate subsurface detonation conditions) are available for tritonal (oxygen balanced) versus amatol (an oxygen deficient energetic composed of a mixture of TNT and ammonium picrate) (USEPA, August 1998). Comparison of these results can determine emission factor ratios (i.e., amatol ÷ tritonal) that can be used to adjust BangBox emission factors upward based on unsuppressed detonation tests for other energetics to estimate emissions for subsurface detonations.

Emission models for OB/OD treatment should be used if BangBox tests or field data are not available for candidate treatment items. A potential problem with such models, however, is that they may provide results based on the assumption of complete combustion and may not adequately address potential combustion byproducts. The POLU14 (U.S. Navy) and ADORA (commercially available) model descriptions indicate the capability to estimate emissions for subsurface detonations. However, if the APA Protocol includes use of OB/OD emission models for subsurface detonations or other OB/OD source scenarios, the permit applicant should include verification and validation information to demonstrate the adequate performance of the model to estimate PICs.

Post-Treatment Emissions

Post-detonation activities at an OD unit may involve the backfilling of pits and craters, which can generate fugitive dust emission, including contaminated soil and constituents. Such emissions resemble those of pretreatment: potential fugitive particulate emissions are the primary concern and tailpipe emissions are not significant. These activities may also involve vehicle-generated dust from travel on unpaved roads within the OB/OD unit.

At an OB unit, post-treatment operations would consist of removal and management of ash and residue from the burn pans. There is also the potential of wind erosion of ash/residual after treatment during the cooling-down period of the pans prior to ash/residue removal.

Past OB/OD operations may also have produced elevated levels of emission constituents in the surface soil at the unit. There is the potential that ejecta and fallout from current and future OB/OD operations could further increase these soil concentrations. Wind erosion of the surface soils (and the OB/OD emission constituents in the soil) therefore should be evaluated.

The emission factors for most of these post-treatment sources are available from the EPA Clearinghouse of Inventories and Emission Factors ([AP-42], Sect. 13.2.2-Unpaved Roads, Sect. 12.2.3-Heavy Construction Operations and Sect. 13.2.5-Industrial Wind Erosion) at http://www.epa.gov/ttn/chief/ap42/index.html.

Typically, post-treatment fugitive dust emissions at OB/OD units in the Eastern US are not considered significant. However, at the discretion of the lead regulatory agency the applicant may be required to model post-treatment emissions and/or to implement a routine suppression program.

4.1.2 Step 2 – Identify Criteria

Applicable site-specific air quality criteria should be identified for the following criteria pollutants:

- Carbon monoxide
- Particulate matter
- Sulfur dioxide
- Nitrogen dioxide
- Lead

For example, Virginia ambient air quality standards are available at http://www.deq.state.va.us/regulations/air30.html

Although there is an ambient air quality standard for ozone, the dispersion models available for OB/OD sources do not simulate photochemical reactions, and ozone formation impacts are not considered significant.

There can be very many requirements, as a function of air quality control regions, depending on the facility location.

A screening assessment may be conducted to evaluate the potential air quality impacts of hazardous air pollutants and other toxic pollutant emissions. HCOCs should be evaluated based on the comparison of modeling results to screening criteria (see Sect. 4.1.4). Air toxics screening criteria are available from the latest update to the EPA Region 9 Preliminary Remediation Goals (PRGs) at. http://www.epa.gov/region09/sfund/prg/index.htm If there are no exceedances of 0.1 of the PRGs then a human health risk assessment for the air pathway is not warranted.

4.1.3 Step 3 – Conduct Dispersion Modeling

The APA Protocol should define the dispersion modeling plan to be used to evaluate OB/OD source emissions. The protocol should include the following items:

- Select dispersion model
- Specify meteorological data set
- Identify potential receptors

The objective of the dispersion modeling is to estimate compliance with ambient air quality standards and to determine maximum concentrations, as well as exposure at other receptors of interest, for toxic air pollutants. At large facilities (such as military installations), human health risks should be evaluated to include onsite residential areas and onsite workplaces. It might also be appropriate to evaluate ecological risks beyond the OB/OD unit boundaries at large facilities/military installations.

Select Dispersion Model

Selection of the dispersion model should be justified based on the capability to adequately simulate OB/OD source releases. Although some OB sources may be considered as intermittent, quasi-continuous sources, OD units and other OB sources may be quasi-instantaneous sources. Therefore, specialized dispersion models are often needed for these noncontinuous sources.

The EPA maintains a Support Center for Regulatory Air Models (SCRAM), and information can be obtained at http://www.epa.gov/ttn/scram/. The only SCRAM dispersion model specific to OB/OD sources is the Open Burn Open Detonation Model (OBODM) developed by the U.S. Army.

OBODM can be used to calculate peak concentrations, time-weighted mean concentrations, dosage (time-integrated concentration), and particulate gravitational settling (but dry and wet deposition are not calculated) for emissions from multiple OB/OD sources. The model can consider instantaneous (detonation) or quasi-continuous (open burn) releases from point/volume and/or line sources. Other OBODM capabilities include combination of multiple source types and multiple emission items in a single run, rectangular (Cartesian) or polar coordinates with elevated ("flagpole") or surface-based receptors, standard or user-defined input data formats, user-specified engineering units, data input/solution save files, "brute force" computation mode with regulatory output tables (high, high second high, etc.), tabular print output, and screen and hard-copy graphics output. All OBODM source and receptor locations are defined relative to a rectangular or a polar coordinate system. All vertical (z) coordinates are heights above ground level except when the OBODM complex terrain screening mode is used, in which case the z coordinates are terrain heights above mean sea level. The model also includes an OB and OD emission factor database (i.e., based on BangBox results) and an option for user-specified inputs. Sequential hourly meteorological files (one to five years) can be used as input. For flat terrain scenarios the model has an option to use the final cloud height for all downwind distances or a distance-dependent cloud height algorithm. But the distance-dependent cloud height option for OBODM should not be used for complex terrain.

Although the OBODM dispersion model does not directly account for subsurface detonations, the energetic-specific heat content used by OBODM can be substituted with the energetic-specific residual heat content available from use of the POLU emissions model (U.S. Army, January 1996).

The OBODM model is the preferred dispersion model to be used for OB/OD sources. A summary comparison of OBODM and alternative models is provided in Table 4-1 (additional details are in Appendix C). Alternative dispersion models may be used, in which case the APA Protocol should include a justification for selecting the model and discussion of its applicability

Table 4-1. Summary of alternative dispersion models for OB/OD sources

Example Candidate Models	Major Advantages	Major Limitations
OBODM	OB/OD Source-Specific	Non-EPA Model
INPUFF	Puff Dispersions (EPA)	Stack Releases, Single Events
ISCST	EPA Model, Robust	Continuous Releases
ADORA	Refined OB/OD Cloud Behavior	Proprietary

to OB/OD sources. The discussion should include available model verification and validation documentation, if available, and a comparison of OBODM modeling results (for typical and worst-case scenarios) to the results based on the proposed model.

The APA Protocol should also identify and justify input data and model options to be used for the dispersion model selected.

Specify Meteorological Data Set

Meteorological data used as inputs to a dispersion model should be selected on the basis of spatial and temporal representativeness, as well as the ability of the individual parameters selected to characterize the transport and dispersion conditions in the area. Representativeness of data is dependent on:

- Distance from the meteorological monitoring station to the site
- Complexity of the terrain
- Exposure of the meteorological monitoring station
- Period of time during which data are collected

Spatial representativeness of long-term meteorological data can be adversely affected by large distances between the OB/OD unit(s) source and receptor(s) of interest and the complexity of the topographic characteristics. Therefore, these factors should be considered for the selection of representative offsite meteorological data to be used for dispersion modeling. Spatial representativeness for the candidate meteorological data set for dispersion modeling should be evaluated by comparison of wind direction patterns (based on a wind rose, generally for a five-year period at least) to the orientation of local terrain features. Preferably a professional meteorological or dispersion modeler should be consulted for this subjective assessment.

Meteorological input data are normally obtained either from the National Climatic Data Center at http://www.ncdc.noaa.gov/ol/ncdc.html, from SCRAM athttp://www.epa.gov/ttn/scram/ or from an onsite measurement program. The applicant should provide an analysis demonstrating data representativeness. In the case where the meteorological data are determined to be nonrepresentative, it may be necessary to collect data onsite. (The APA Protocol should describe the QA/QC program for onsite meteorological monitoring programs and conform to requirements in Sect. 4.6). At least one full year of representative meteorological data is needed for dispersion model analyses. If more than one year of data is available, the model should generally be run with all available years, up to five years. Five-year annual average concentrations can be used to evaluate long-term exposure to toxic air pollutants. Short-term exposures should be evaluated in terms of the hourly (or shorter, if possible) maximum concentration results from each of the five years modeled.

Identify Potential Receptors

Compliance with Ambient Air Quality Standards should be evaluated by determining the maximum offsite exposure. The maximum onsite and offsite exposure locations for toxic air pollutants should also be evaluated, as well as potential receptor locations (as identified later in this section). An adequate receptor grid is needed for modeling purposes, to identify the maximum onsite and offsite exposure points; proper receptor placement and evaluation are important issues in computer dispersion modeling. Receptor grids used in modeling analyses may be referenced using a polar or rectangular coordinate system. It is the applicant's responsibility to demonstrate that the final receptor network is sufficiently compact to identify the maximum estimated pollutant concentration for each applicable averaging period. Typically the maximum ground level concentrations for OB/OD sources occurs within 33 km (Tetra Tech, February 2002). Guidelines for the selection of a modeling grid is available in Sect. 3.7.3 of the *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (USEPA, August 1998).

In addition to using a network of evenly spaced receptors, the applicant may need to add discrete receptors at special locations including but may not be limited to the following:

- Property boundary
- Population centers
- Worst-case sensitive receptors (e.g., hospitals, nursing homes, schools, etc.)
- Nearest Class I or nonattainment area
- Human health and ecological receptors of interest based on Sect. 4.3 of *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (USEPA, July 1998) and Sect. 4.1 of *Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (USEPA, August 1999).
- Additional receptor locations for evaluation may be warranted on a case-by-case basis.

Determination of human health and ecological receptors of interest based on the EPA risk assessment protocols cited above (as well as the *Subpart X Checklist*) necessitate obtaining land use information to determine the following information including but not limited to :

- Current and potential future locations of residential, farming, and fishing areas
- Areal extent of watersheds and water bodies of interest
- Ecological habitats of interest

Typical human health exposure scenarios and associated potential receptor locations include by may not be limited to the following:

- Adult resident
- Child resident
- Subsistence farmer
- Subsistence farmer child
- Subsistence fisher
- Subsistence fisher child

- Onsite worker

4.1.4 Step 4 – Evaluate Air Pathway Modeling Results

Air pathway modeling results should be evaluated and the following evaluations included in the permit application.

- Source-specific and additive air pathway impacts
- Compliance with Ambient Air Quality Standards
- Noncriteria pollutant modeling information (including input/output data and identification of results used as input for risk assessment modeling)

Dispersion modeling results should be summarized separately for OB sources and OD sources as well as for all sources combined. This information should support the development of source-specific environmental performance standards and associated permit conditions.

Background air quality conditions should also be characterized in the permit application. Regional air quality monitoring may be used to characterize background levels for criteria pollutants. However, for noncriteria pollutants, the contribution from onsite or nearby sources with similar emissions should be considered on a case-by-case basis. For example, at military installations with OB/OD units, there is the potential for munition expenditures. Facilities should contact the permitting agency for site-specific determinations regarding background considerations.

A table should be provided that includes the following information for each criteria pollutant:

- Highest offsite annual arithmetic mean concentrations for PM-10, sulfur dioxide and nitrogen dioxide

- Highest offsite arithmetic mean averaged quantity lead concentrations

- Second-highest (although highest is acceptable for conservatism) offsite concentration for carbon monoxide, PM-10 and sulfur dioxide commensurate with applicable Ambient Air Quality Standards

- Location of pollutant-specific second-highest (or highest) offsite as identified above concentrations

- Concentrations at special receptors

- Ambient Air Quality Standards (primary and secondary) and associated time averaging periods

For noncriteria pollutants the following data are needed (separately for all OB sources combined, all OD sources combined, and all OB and OD sources combined) as input for the risk assessment process:

- Location and pollutant-specific, long-term annual concentrations associated with the maximum onsite and offsite chronic exposure locations (commensurate with the *Subpart X Checklist*).

- Location and pollutant-specific maximum short-term (acute) exposure (1-hr) concentrations associated with the maximum onsite and offsite exposure locations

- Pollutant-specific concentrations for all special receptors (commensurate with the *Subpart X Checklist*)

Dispersion modeling results should facilitate input for human health and ecological risk assessment modeling commensurate with EPA protocols (USEPA, July 1998; USEPA, August 1999). These EPA protocols should be directly consulted for details, and the required interface will vary depending on the software used.

Dry deposition estimates will be needed as input for the risk assessments. If the dispersion model selected does not account for gravitational settling or dry deposition, these values should be calculated based on calculational methods and standard default values. The OBODM model technical manual indicates that dispersion modeling results (air concentrations) can be multiplied by a deposition velocity to estimate deposition rates per unit area (U.S. Army, January 1996). A default dry deposition velocity of 3 cm/sec is recommended in Table B-1-1 in *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities* at http://www.epa.gov/earth1r6/6pd/rcra_c/protocol/protocol.htm.

One-hour concentrations for noncriteria pollutants should be compared to acute inhalation exposure criteria sources. The hierarchical listing of information sources for these acute inhalation (1-hr) exposures is as follows (USEPA, July 1998):

- Acute Inhalation Exposure Guidelines (AEGL)-1
- Emergency Response Planning Guidelines (ERPG)-1
- Acute Toxicity Exposure Levels (ATEL)-1
- Temporary Emergency Exposure Limits (TEEL)-1
- Subcommittee on Consequence Assessment and Protective Action (SCAPA) Toxicity-based approach

4.1.5 <u>Step 5 – Conduct Air Monitoring (As Warranted)</u>

Dispersion modeling is the primary method for the evaluation of air pathway impacts. However, air monitoring for OB/OD sources may be warranted on a case-by-case basis considering the results from Step 4-Evaluate Air Quality Impacts (see Sect. 2.6.4) and risk assessment results (see Sects. 2.8 and 2.9). Air monitoring for OB/OD sources may be a technical challenge because of the quasi-instantaneous and noncontinuous nature of the releases and variable wind direction conditions. Thus, air monitoring is not warranted for all OB/OD units. Facilities should contact the permitting agency for site-specific determinations on the need for air monitoring. An overview discussion of air and source monitoring for OB/OD units is presented in Sect. 4.6.

4.2 BASELINE SITE CHARACTERIZATION

Site characterization information, based on sampling and analysis programs and other site investigations is needed to support permitting, corrective actions, and closure. This information should be sufficient to determine the nature and extent of contamination attributed to past and current OB/OD operations as well as to related practices. Therefore, site characterization should be conducted as a baseline program to support the permitting of existing OB/OD units and implementation of corrective action, as warranted. A similar site characterization program is also needed at the time of closure. A closure plan addressing the sampling and data evaluation for all the media should be submitted to the lead regulatory agency for review and approval.

Environmental media of concern are (as applicable to a given site):

- Groundwater
- Surface water
- Surface soil
- Subsurface soil
- Sediments

Although major surface water bodies may not be on or near the OB/OD unit, the primary overland drainage pathways at the unit boundary are candidate locations for collecting surface water and sediment samples. The air pathway was addressed in Sect. 4.1.5.

Standard EPA guidance is available for site characterization at the EPA Corrective Action web page at http://www.epa.gov/epaoswer/hazwaste/ca/resource/guidance.htm. The following guidance may be particularly useful:

- *Interim Final RCRA Facility Investigation (RFI) Guidance* (USEPA, May 1989)

- *Handbook of Groundwater Policies for RCRA Corrective Action* (USEPA, September 2001)

- *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Addendum to Interim Final Guidance* (USEPA, July 1992; USEPA, April 1989).

Additional guidance resources are available at the EPA Corrective Action home page. Information requirements are specified in 9VAC20-60-1010. The permitting agency should also be contacted for guidance resources and site-specific requirements.

Ground vibrations and other potential detonations should be considered for the installations of groundwater monitoring wells. An evaluation of monitoring well integrity at OD units is presented in Appendix B.

Special site characterization concerns for OB/OD units include target analytes and analytical method, surface soil sampling, and UXO investigations. The need for a routine environment monitoring program should also be considered.

4.2.1 **Target Analytes/Analytical Methods**

The standard target analytes for baseline characterization of OB/OD units are:

- Energetics (SW-846 Method 8330 modified or Method 8321)
- Other semivolatiles (i.e., base, neutral and acid extractables – BNA; SW-846 Method 8270C)
- Total RCRA metals (SW-846 Method 6010B, Methods 7470A (aqueous) and 7471A (soil) for mercury)
- Other metals (as appropriate based on site-specific waste characterization information)
- Cyanide (SW-846 Method 9010B)
- Volatile organic compounds (VOCs; SW-846 Method 8260B)
- Nitrates/nitrites for water only (EPA 353.3)
- Other potential contaminants (as appropriate on a site-specific basis).

The composition of some pyrotechnics may necessitate an expanded metal analyte list (e.g., titanium, tungsten, zirconium, etc.).

The latest available analytical methods for the target analytes included in EPA *Test Methods for Evaluating Solid Waste, SW-846* (http://www.epa.gov/SW-846/main.htm) should be used.

The standard target analyte list for energetics is limited by the SW-846 analytical methods available. For instance, SW-846 Method 8330-modified (based on use of liquid chromatography/mass spectrometry [LC/MS]) is limited to the following target analytes:

- Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)
- 1,3,5-Trinitrobenzene (TNB)
- Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
- 1,3-Dinitrobenzene (DNB)
- Nitrobenzene (NB)
- 2,4,6-Trinitrotoluene (TNT)
- Methyl-2,4,6-trinitrophenylnitramine (Tetryl)
- 2,4-Dinitrotoluene (DNT)
- 2,6-Dinitrotoluene (DNT)
- 2-Amino-4,6-DNT
- 4-Aminoo-2,6-DNT
- 2-Nitrotoluene (NT)
- 4-4 Nitrotoluene (NT)
- 3-Nitrotoluene (NT)
- Nitroglycerin (NG)*
- PETN*
- EGDN*
- PGDN*
- Picric Acid*
- Picramic Acid*

*Only for Method 8330 modified. Method 8332 only addresses NG.

Method 8330 provides for the detection of parts per billion (ppb) of explosive compounds in soil, water, and sediments. Samples can be extracted with methanol or acetonitrile for TNT, but acetonitrile is preferred for RDX. The sample extracts are injected into the HPLC and eluted with a methanol-water mixture. The estimated quantitation limits in soil can range from 0.25 mg/kg to 2.0 mg/kg for each compound. The estimated quantitation limits in water can range from 0.02 µg/L to 0.84 µg/L for low-level samples and 4.0 µg/L to 14.0 µg/L for high-level samples (USEPA, June 2001).

The Method 8330 LC/ultra violet (UV) for energetics is good for relatively clean matrixes but limited to 14 energetic analytes. Method 8330 modified (LC/MS) can also be viewed as Method 8321-Solvent Extractable Nonvolatile Compounds by High Performance LC/Thermospray/MS or UV Detection. The advantage of Method 8330 modified is the expanded analyte list (20 energetics) with higher confidence in identifications (especially in complex matrices), but the precision is slightly lower and analytical costs are higher than for Method 8330.

Method 8330 is the standard EPA test method for explosive compounds. However, Method 8330 has a number of problems associated with it, including high solvent usage, multiple compound coelutions (one or more compounds coming out at the same time) in sample matrices with complex mixtures, and long run times. In order to address these problems, EPA Method 8095 has been proposed as an alternative analytical method. Method 8095 uses gas chromatography with electron capture detection. It can detect and quantify all of the same compounds as Method 8330. In addition, Method 8095 can also detect and quantify 3,5-dinitroaniline, nitroglycerine, and pentaerythritol tetranitrate (PETN).

The nitrocellulose can be analyzed based on a method used by the U.S. Army at Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire, based on EPA Method 353.2 for analyzing aqueous samples for nitrate/nitrite. A membrane filter/methanol treatment modification is used to minimize sources of nitrate/nitrite ion other than nitrocellulose, which can cause interferences. The nitrocellulose is converted to nitrate/nitrite ion, which is analyzed using EPA 353.2. Nitrocellulose is calculated based on the amount of nitrate/nitrite determined. Soil samples are extracted in acetone and the resultant extract analyzed in the same manner as an aqueous sample. Nitrocellulose has low toxicity and generally is not a standard target analyte for OB/OD sites, but it can be used as an indicator of previous OB activities.

A summary of available field screening methods for energetics is presented in Table 4-2. These screening methods may be useful for cost-effective identifying hot spot areas and prioritizing locations for collecting samples for laboratory analysis. However, they do not provide the quantitative data needed for evaluation of environmental compliance or for risk-based closure/corrective action.

The OB/OD site investigation data from the U.S. Army Environmental Hygiene Agency study suggest the following conclusions (U.S. Army, October 1985; U.S. Army, February 1986):

- The explosives most frequently detected in soil in significant concentrations at 100 OB sites were, in order of decreasing frequency of detection, TNT, 2,4-DNT, RDX, HMX, and 2,6-DNT.

- The explosives most commonly found in groundwater were TNT, RDX, and 2,4-DNT, followed by 2,6-DNT and HMX.

- Based primarily on apparent leaching potential, the explosives RDX, TNT, and 2,4-DNT should be of greater concern at OB/OD sites than 2,6-DNT, HMX, and tetryl.

The Cold Regions Research and Engineering Laboratory has compiled data on the frequency of nitroaromatics and nitramines detected in energetic-contaminated soils from many Army explosive manufacturing plants (FRTR, undated). TNT is the most common energetic contaminant, occurring in approximately 80 percent of the soil samples found to be contaminated with energetics. TNB, which is a photochemical decomposition product of TNT, was found in 40 to 50 percent of the soils. DNB, 2,4-DNT, and 2,6-DNT were found in less than 40 percent of the soils.

Method 8330 modified SW-846 is sufficient for most OB/OD situations. The potential for other energetics of concern (including transformation products) should be evaluated on a site-specific basis. However, there may be limited laboratory technology/capability (e.g., use of inductively coupled plasma technology) or no commercial laboratory capability for other energetics not covered by Method 8330, (and frequently laboratory standards are not available). For example, primary explosives (such as lead azide, mercury fulminate, lead styphrate, etc.) are

Table 4-2. Summary of EPA screening methods for energetics

Parameter	EPA Method[a]	Background Area	
TNT	Soil 8515 (colorimetric)	Soil	1 mg/kg
TNT	Soil/aqueous 4050 (immunoassay)	Aqueous Soil	0.005 mg/L 0.5 mg/kg
RDX	Soil/aqueous 4051 (mmunoassay)	Aqueous Soil	0.005 mg/L 0.5 mg/kg

[a]USEPA, *Test Methods for Evaluating Solid Waste*, SW-846

extremely dangerous to handle. Some DoD specialized laboratories may have additional capabilities. If there are site-specific energetics of concern that cannot be evaluated by laboratory analysis, the risk assessment should address these issues in the uncertainty analysis. In some cases energetic transformation products can be as undesirable as the parent energetic (e.g., TNT degradation at some sites). Additional information regarding the transformation and chemical fate properties of energetics is summarized in Sect. 6.

Perchlorates (EPA Method 314.0), sulfides (SW-846 Method 9030B), and white phosphorous (SW-846 Method 7580) could be potential target analytes if perchlorates, chlorine, sulfur and/or white phosphorous are constituents of the waste energetics treated by OB/OD. Perchlorates should be a target analyte at OB/OD units that treat solid fuel rocket motors or other energetics that contain ammonium perchlorate oxides.

There is the potential for the emission of dioxins and furans associated with the treatment of chlorinated propellants and munitions/wastes with certain constituents (e.g., plastics, etc) as well as use of dunnage and/or liquid fuels. Therefore, the need to include dioxins/furans as target analytes (SW-846 Method 8290) should be evaluated on a site-specific basis (e.g., if available emissions factors based on BangBox tests did not include dioxins/furans as target analytes).

As noted above, liquid fuels such as diesel have been used at some OB units. In addition some facilities (e.g., propellant manufactures) may use OB to treat energetic-contaminated solvents. Therefore, theses fuels/solvents should be target analytes for these situations.

Herbicides have been used at some sites to control vegetation in the vicinity of OB/OD areas as a fire prevention measure. Therefore, herbicides (SW-846 Method 8151A) should be considered a potential target analyte as appropriate based on their prior use.

Total organic content (TOC) and pH should also be included as target analytes. These parameters are routinely used to evaluate water quality at RCRA facilities. Soil TOC and pH are needed input for constituent migration modeling purposes.

4.2.2 <u>Soil Sampling Strategy</u>

Surface soil sampling locations should include coverage of the following areas based on the potential for contamination:

- Treatment source zone (e.g., pit/crater areas for OD, ground-based burn area for OB, as applicable, or within 1-3 m of burn pans)

- Ejecta zone (to be determined on a site-specific basis)

- Remainder of OB/OD unit

- Prevailing downwind location areas associated with maximum predicted gravitational settling/deposition potential (as practical)

- Natural background

The sample collection procedure, number of samples within each area, and statistical analysis approach should be based on standard EPA guidance (e.g., SW-846). Composite surface soil sampling commensurate with *EPA Soil Screening Guidance* (USEPA, July 1996, available at http://www.epa.gov/superfund/resources/soil/index.htm may be acceptable for baseline characterization for permitting purposes at OB/OD units where the location of the treatment source zone is stationary. However, followup discrete sampling may be needed if soil screening levels are exceeded or if there is a need to identify hot spots for corrective action or closure. The total number of discrete samples and sampling strategy (e.g., systematic or random) should be consistent with available permitting agency guidance and be sufficient for statistical analysis (i.e., significance compared to natural background).

Discrete surface soil samples for energetics (even those used to obtain a composite sample) should be collected using a small area (i.e., within a 4-ft diameter) composite sampling pattern as illustrated in Fig. 4-3. This is based on surface soil sampling tests for energetics conducted by the U.S. Army at several OB/OD units and military ranges (U.S. Army, December 1999). These tests indicate a heterogeneous distribution of energetics within surface soils and that use of the sample collection strategy as illustrated in Fig. 4-3 provided more reliable site characterization data.

4.2.3 UXO Investigation

At OB/OD sites that treat waste munitions or are located within active military ranges, there is the potential for the presence of UXO, munition components, and fragments. UXO and potential energetic-contaminated debris may present a safety hazard during OB/OD treatment operations, site investigations, corrective action and closure; therefore hazard avoidance procedures should be addressed in the operating procedures and sampling and analysis plan (SAP). In addition, there may be potential sources of environmental contamination. Therefore, the site characterization process should qualitatively evaluate the nature and extent of UXO and energetic-contaminated debris at OB/OD sites to determine the need for mitigating operating procedures, permit or closure conditions, and/or corrective action. This information would also be used to determine the need for more detailed UXO investigations and clearance.

Available guidance for UXO detection and clearance should be consulted and implemented as needed (USEPA, June 2001: USEPA, April 2000). Detailed UXO guidance and procedures have been developed by the U.S. Army Engineering and Support Center (Huntsville, AL) and are available at the Ordnance and Explosives Mandatory Center of Expertise and

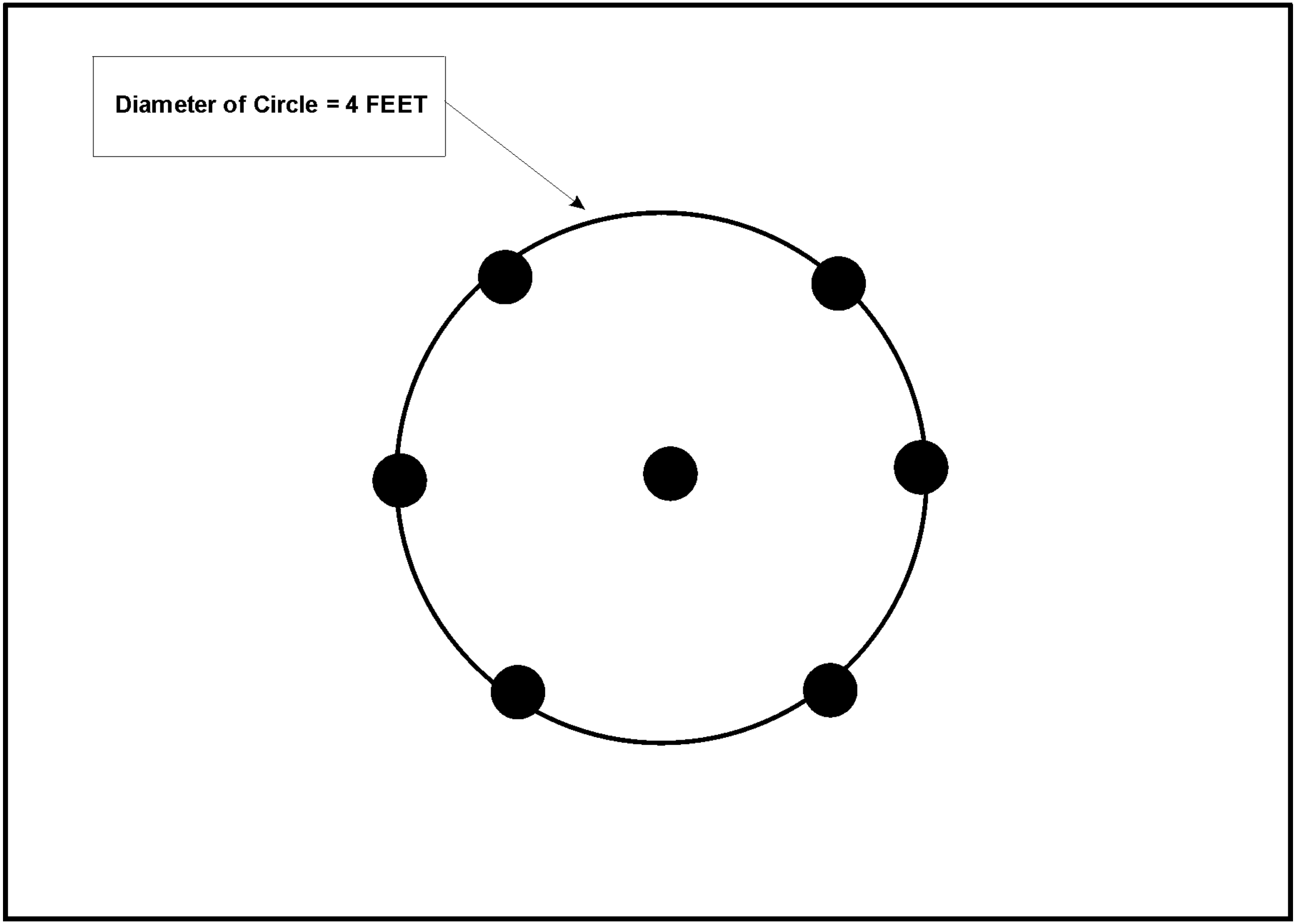


Figure 4-3. Composite sampling pattern at each surface soil sampling location

Design Center web site at www.hnd.usace.army.mil/oew/index.asp. This web site is frequently updated and should be consulted for the latest information. As an example of the type of information available, the Corps of Engineers on November 20, 2000, issued a new 50-page Engineer Pamphlet that describes procedures for finding or avoiding UXO in the characterization and remediation of other hazardous waste. The title is *Unexploded Ordnance (UXO) Support During Hazardous, Toxic, and Radioactive Waste (HTRW) and Construction Activities*, and it can be found at http://www.usace.army.mil/inet/usace-docs/eng-pamphlets/ep75-1-2/toc.htm. The pamphlet discusses situations likely to be encountered at existing and closing OB/OD units. It outlines required procedures for sampling soil, soil gas and groundwater; for monitoring well construction and other drilling; and for excavating.

4.3 HUMAN HEALTH RISK ASSESSMENTS

A human health risk assessment (HHRA) should be conducted to support permitting, closure, or potential corrective action. A summary of the HHRA process for OB/OD units is illustrated in Fig. 4-4. The process differs for existing units pursuing closure, existing units pursuing permits, and new units pursuing permits. However, in each case there is the need to evaluate potential contamination migration from the OB/OD unit source zone (i.e., potential soil, groundwater, and surface water contamination onsite at the unit) and potential direct/indirect exposures (onsite and offsite) attributed to air releases.

Sects. 4.3.1 and 4.3.2 identify guidance for the conduct of HHRAs for OB/OD units. However, a comprehensive HHRA protocol should be submitted for the permitting agency review and concurrence prior to implementation. The protocol should identify site-specific details that define how the guidance will be applied.

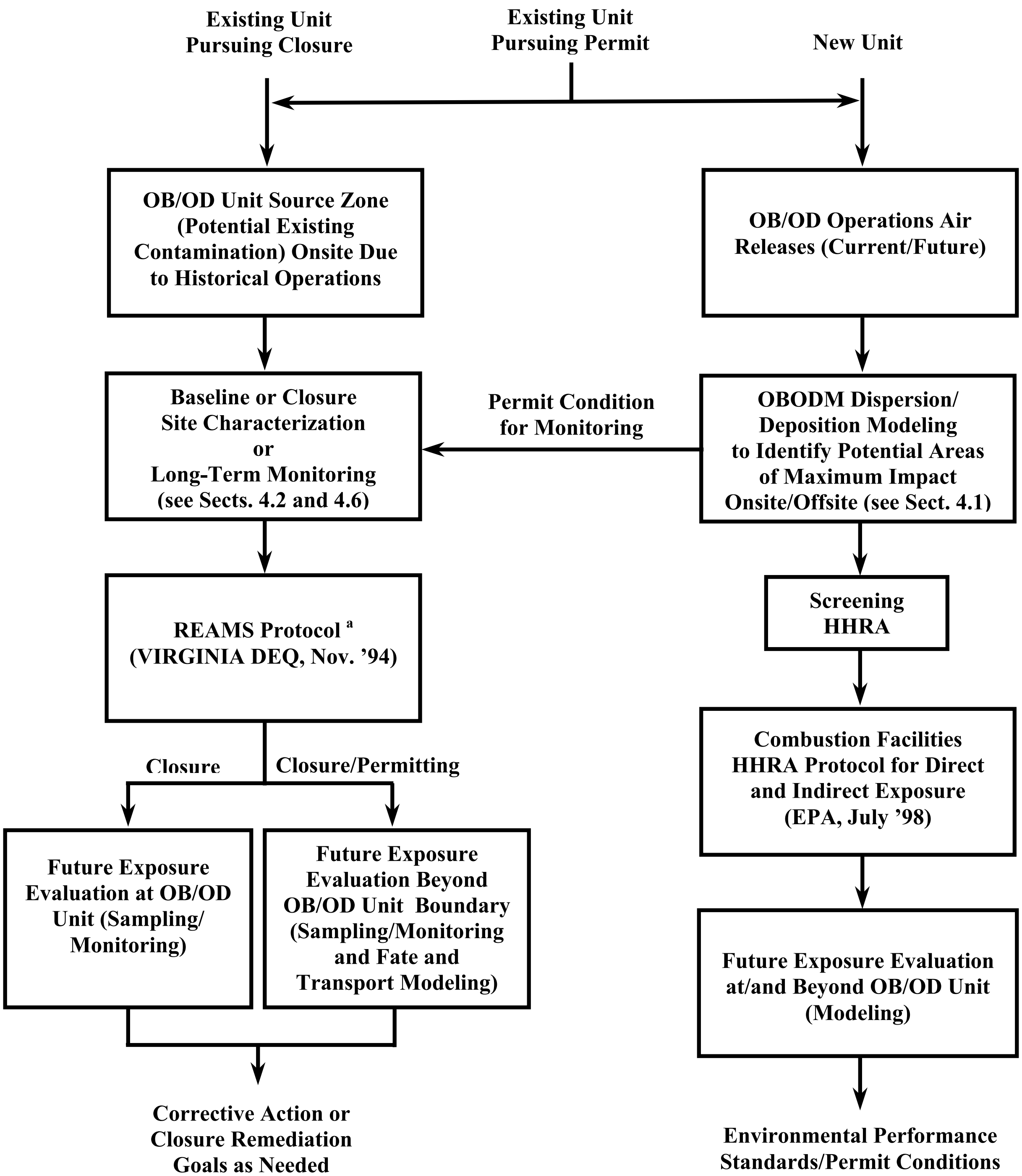
4.3.1 OB/OD Unit Source Zone – HHRA

The OB/OD unit source zone was previously defined for the OB/OD unit conceptual site model (see Sect. 2.3 and Fig. 2-11). This source zone is the potential existing contamination (i.e., soil, groundwater, and surface water) at the OB/OD unit (or nearby onsite) due to historical operations. Therefore, the OB/OD unit source zone HHRA is applicable to existing units pursuing closure as well as to existing units pursuing permits.

The baseline site characterization sampling and analysis results are used as input for this assessment for existing units pursuing permits (see Sect. 4.2). Similarly, data from the site characterization program to be conducted at closure are the inputs needed for existing units pursuing closure. Generally some long-term environmental monitoring may be warranted as a permit condition for existing and new units pursuing permits. For these cases, dispersion and deposition modeling results/patterns (see Sect. 4.1) can be used to identify potential areas of maximum impact for the design of the sampling/monitoring program and for evaluation of potential exposure at these locations.

Potential current and future receptors at these maximum impact locations should be evaluated for all media using the *Guidance Document and Submission Package for Site Remediation and Cleanup Using Health Based Standards, Risk Exposure, and Analysis Modeling System* (REAMS) (VIRGINIA DEQ, November 1994). This involves using sampling/monitoring data and REAMS guidance/software for the current exposure evaluation. Future exposure scenarios should be evaluated by using the REAMS fate and transport modeling capability to evaluate the potential for the migration of contaminants. The permitting agency should be contacted to determine the site-specific applicability of REAMS or alternative models.

These results will support the identification of the need for corrective action and remediation goals for operational OB/OD units. Similarly, remediation goals can also be determined for units pursuing closure. Closure should address the historical impacts onsite and offsite (using the HHRA protocol for indirect pathways).



a Contact permitting agency to determine applicability and site-specific requirements.

Fig. 4-4. HHRA process overview for OB/OD units

Based on the target levels used for REAMS, acceptable environmental performance standards for OB/OD units are as follows:

- Total Hazard Index (HI) of 1.0 or less for noncarcinogens;
- Total lifetime cancer risk of 1E-06 or less for individual carcinogens
- Total lifetime cancer risk of 1E-06 to 1E-04 or less for all carcinogens combined.

Equations for the definition/calculation of HI and total cancer risk values are presented in REAMS (Virginia DEQ, November 1994). The permitting agency should be contacted to determine the applicability of REAMS and for site-specific requirements.

4.3.2 OB/OD Operations Air Releases – HHRA

The HHRA should also include the evaluation of future OB/OD air releases (see Sect. 4.1). Therefore, this future long-term (i.e., chronic) exposure modeling evaluation is applicable to existing and new OB/OD units pursuing permits. Dispersion modeling results (typically based on the OBODM model as discussed in Sect. 4.1) should be used to identify potential areas of maximum impact onsite and offsite. The dispersion modeling results are also used as input for the calculation of media-specific exposure concentrations, quantifying potential receptors exposure and risk characterization. The HHRA guidance for these calculations should be based on the *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (USEPA, July 1998 draft and subsequent revisions/updates). The *Combustion Facilities HHRA Protocol* is available at the EPA Region 6 web page at http://www.epa.gov/earth1r6/6pd/rcra_c/protocol/protocol.htm. Software for the implementation of the *Combustion Facilities HHRA Protocol* is commercially available.

Portions of the *Combustion Facilities HHRA Protocol*, such as Sects. 1 and 2.2, are not applicable to OB/OD sources. In addition, Sect. 3, Air Dispersion and Deposition Modeling, includes generic guidance applicable to OBOD units, but information specific to the EPA's ISCST3 dispersion model used for the *Combustion Facilities HHRA Protocol*) is not generally applicable to the OBODM model. Therefore, the *OBODM User's Guide* should be consulted for details concerning the use of the OBODM model (U.S. Army, July 1997). In addition, site-specific adaptation will be needed to use OBODM modeling output files (as well as files for pretreatment and post-treatment emissions as warranted) as input for the *Combustion Facilities HHRA Protocol.*

A conservative risk-based, air concentration screen may be used to determine if a more refined air pathway assessment is warranted. The maximum ground-level, air concentration location based on dispersion modeling results should be directly compared to EPA Region 9 PRGs for ambient air (residential exposure) at http://www.epa.gov/region09/waste/sfund/prg/index.htm. The potential receptors evaluated by this screening assessment should be identified to clarify who the screening evaluation confers protection to and those that would be subject to an unequal level of protection. Risk targets for the air pathway screening assessment are listed below and include an order of magnitude of additional conservatism to account for potential modeling uncertainties (PRGs correspond to a HQ of 1.0 and total cancer risk of E-06 for individual chemicals):

- Equivalent HI of 0.1 or less for noncarcinogens (for screening purposes)

- Total lifetime cancer risk of 1E-07 or less

If the risk targets are not met for the screening assessment, then further evaluation of all pathways based on the *Combustion Facilities HHRA Protocol* should be conducted (e.g., selection of HCOCs, exposure calculations, risk characterization, uncertainty analyses). If the screening air pathways risk targets are not exceeded then a further evaluation of the direct air pathway is not warranted. However, indirect pathways should be evaluated even if the direct air pathway modeling results are not above the screening risk targets.

Commensurate with the *Combustion Facilities HHRA Protocol* the following standard exposure scenarios should be evaluated based on current and potential future land use:

- Adult residence
- Child residence
- Subsistence farmer
- Subsistence farmer child
- Subsistence fisher
- Subsistence fisher child
- Sensitive receptors (as identified in the air pathway assessment)

The assumptions and limitations section of the HHRA documentation should clarify the receptors that the permit would confer protection. In addition receptors for which or whom the permit (based on the HHRA) would provide an unequal level of protection.

Exposure pathways should include the following as applicable based on current and potential future land use (additional details are provided in the *Combustion Facilities HHRA Protocol*):

- Direct inhalation (chronic and acute)
- Incidental ingestion of soil
- Ingestion of drinking water (groundwater and surface water)
- Ingestion of homegrown produce, meats and dairy produce
- Dermal exposure (soil and groundwater)

The *Combustion Facilities HHRA Protocol* does not include equations for calculating exposures for groundwater ingestion or incidental dermal contact pathways. However, the groundwater pathway may be significant for OB/OD units because they are ground-based operations (i.e., as discussed in Sect. 2.3.7, OB/OD residues in the vicinity of the treatment area may leach from the soil to groundwater). Potential groundwater contamination from OB/OD units are of particular concern for sites with shallow aquifers, or a karst environment, and groundwater is used as drinking water. The groundwater pathway should be based on the approach discussed in Sect. 4.3.1.

Separate risk calculations of OB/OD treatment/post-treatment emission may be needed.

Based on the *Combustion Facilities HHRA Protocol*, evaluations of the dermal water exposure pathway is not typically warranted. However, if a surface water body is impacted by OB/OD releases and is frequently used for recreation purposes, such as a swimming or boating, dermal absorption of contaminated water becomes another possible route for human exposure. Dermal exposure from soil at some sites may also be of concern. EPA guidance for estimating dermal exposure is available from the *Risk Assessment Guidance for Superfund (RAGS), Vol. 1-Human Health Evaluations Manual, Part E-Dermal Exposure Guidance*. However, as indicated in the *Combustion Facilities HHRA Protocol,* available data indicates that the contribution of dermal exposure to soils to overall risk is typically small.

Supplemental HHRA guidance not included in the *Combustion Facilities HHRA Protocol* or permitting agency, specific guidance document should be based on RAGS. This includes multiple documents (as well as associated tools and other technical resources) and updates as identified at the EPA Superfund Risk Assessment web page at http://www.epa.gov/superfund/programs/risk/toolthh.htm.

The Combustion Facilities HHRA Protocol does not specify acceptable risk targets. However, based on the VIRGINIA DEQ target levels used for REAMS, acceptable environmental performance standards for OB/OD units are as follows:

- Total Hazard Index (HI) of 1.0 or less for noncarcinogens;
- Total lifetime cancer risk of 1E-06 or less for individual carcinogens;
- Total lifetime cancer risk of 1E-04 (for sites with multiple carcinogens) and 1E-06 or less for all carcinogens combined;

Equations for the definition/calculation of HI and total cancer risk values are presented in the *Combustion Facilities HHRA Protocol*.

If these criteria are exceeded, the implementation of risk management procedures (e.g., reduction in allowable treatment quantities) or a refined risk assessment may be warranted. For example, the summation methodology for the HI does not directly consider the portal of entry associated with each exposure pathway or the often unique toxic endpoints and toxicity mechanisms of the various HCOCs. Accounting for these factors may provide a rationale for segregating HI values for reevaluation based on the acceptance criteria.

In addition to long-term chronic effects, short-term or acute effects should be considered from direct inhalation of HCOCs. It is assumed that short-term emissions will not have a significant impact through indirect exposure pathways (as compared to impacts from long-term emissions).

To characterize the potential for adverse health effects from acute exposure to HCOC-specific emissions, the acute air concentration (C_{acute}) resulting from maximum emissions over a 1-hour period (commensurate with the acute exposure criteria) should be compared to the HCOC-specific acute inhalation exposure criteria (AIEC) to calculate the acute hazard quotient (AHQ_{inh}). Although OB/OD emissions may be quasi-instantaneous or last only a few minutes, public health acute exposure criteria are not available for less than 1-hr exposures. Guidance on the definition/calculation of AHQ_{inh} is provided in the *Combustion Facilities HHRA Protocol.*

The environmental performance criteria for OB/OD sources is an AHQ_{inh} value of 1.0 or less for each toxic air pollutant.

The hierarchical listing of information sources for the acute inhalation (1-hour) exposures is as follows (USEPA, July 1998):

- Acute Inhalation Exposure Guidelines (AEGL)-1
- Emergency Response Planning Guidelines (ERPG)-1
- Acute Toxicity Exposure Levels (ATEL)-1
- Temporary Emergency Exposure Limits (TEEL)-1
- Subcommittee on Consequence Assessment and Protective Action (SCAPA) Toxicity-based approach

4.4 ECOLOGICAL RISK ASSESSMENTS

An ecological risk assessment (ERA) should be conducted to support permitting, closure, or corrective action. Ecological risk assessment is conceptually similar to human health risk assessment but address potential effects on receptors other than humans or agricultural receptors. Whereas human health risk assessment tends to focus upon effects to individual human receptors, ecological risk assessment tends to focus on effects to populations and communities of terrestrial and aquatic plants, animals, and other ecological receptors. A summary of the ERA process for OB/OD units is shown in Fig. 4-5. A screening ERA can be conduted followed by a baseline ERA (if needed). It is similar to the HHRA process with the following exceptions:

- Methodology for conducting screening assessments
- Application of guidance developed by EPA Region 6 in *Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (USEPA, August 1999 draft and subsequent revisions/updates). This Protocol is available for download at http://www.epa.gov/epaoswer/hazwaste/combust/ecorisk.htm.

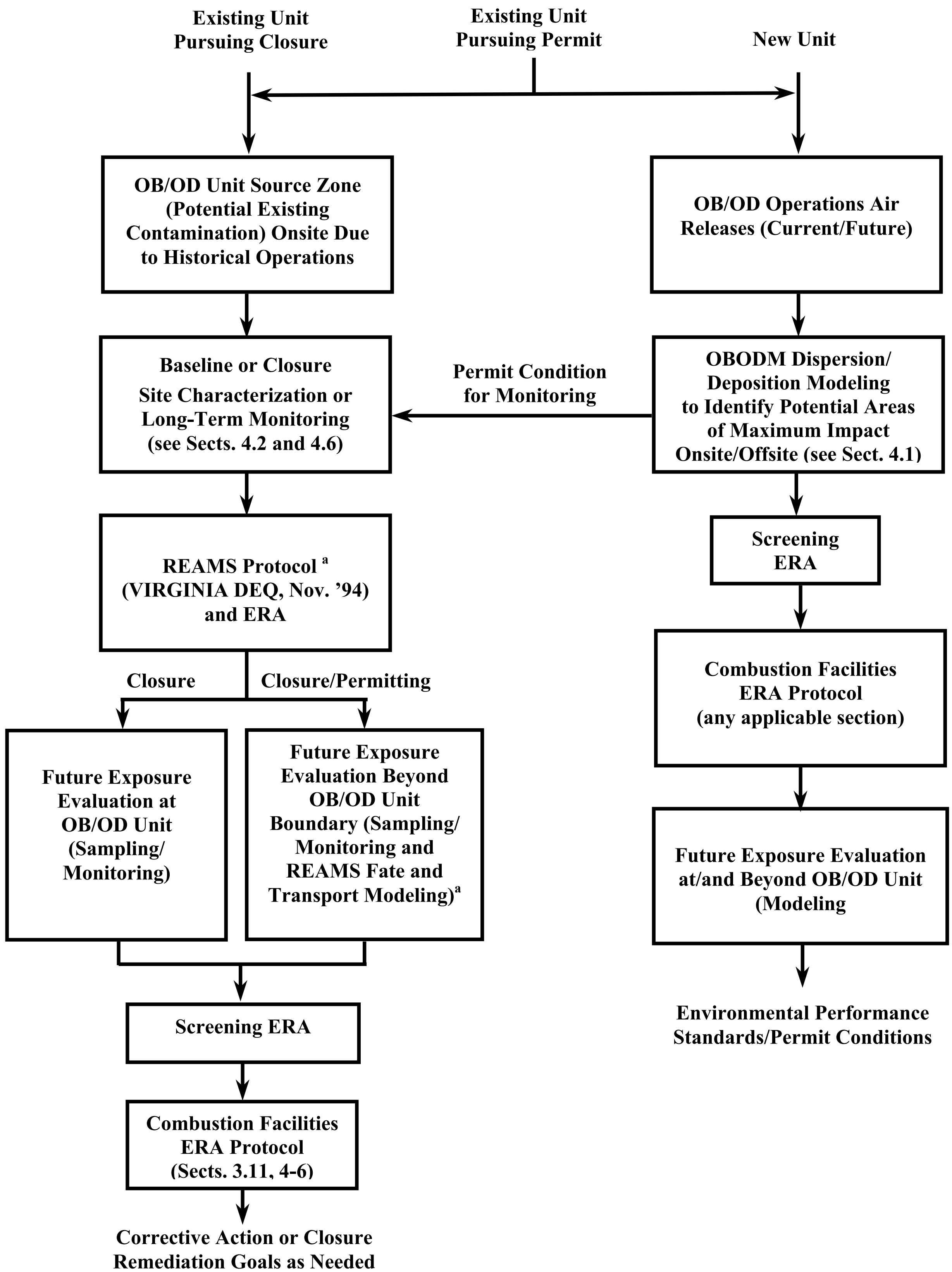
The ERA process differs for existing units pursuing closure, existing units pursuing permits and new units pursuing permits. However, in each case there is the need to evaluate potential migration of contaminants from the OB/OD unit source zone (i.e., potential soil, groundwater, and surface water contamination onsite) and potential direct/indirect exposures (onsite/offsite) attributed to air release. A common element for both types of evaluations is the need to identify potential areas of maximum impact and receptors (including target populations, species and media as well as sensitive and endangered species).

An ERA protocol (based on implementation of guidance in this section) should be submitted to the permitting agency for review and concurrence prior to implementation. The protocol should identify site-specific details that define how the guidance will be applied.

4.4.1 <u>OB/OD Unit Source Zone – ERA</u>

The OB/OD unit source zone, previously defined for the OB/OD unit conceptual site model (see Sect. 2.3 and Fig. 2-11), is the potential existing contamination (i.e., soil, groundwater and surface water) at the OB/OD unit (or near vicinity onsite) due to historical operations. Therefore, the OB/OD unit source zone ERA is applicable to existing units pursuing closure (i.e., evaluation of conditions at the OB/OD unit) as well as existing units pursuing permits (i.e., evaluation of fate and transport of potential contamination of the OB/OD unit).

The baseline site characterization sampling and analysis results are used as input for this assessment for existing units pursuing permits (see Sect. 4.2). Similarly, data from the site characterization program to be conducted at closure are the inputs needed for existing units pursuing closure. Generally some long-term environmental monitoring may be warranted as a



a Contact permitting agency to determine applicability and site-specific requirements

Fig. 4-5. ERA process overview for OB/OD units.

permit condition for existing and new units pursuing permits. For these cases, dispersion and deposition modeling results/patterns (see Sect. 4.1) can be used to identify potential areas of maximum impact for the design of sampling/monitoring programs and evaluation of potential exposure at these locations.

For screening purposes the facility may use ecological toxicity reference values (TRVs) identified in the *Combustion Facilities ERA Protocol* followed by Oak Ridge National Laboratory (ORNL) published benchmark values for different media. ORNL provides separate sets of benchmarks for plants, soil and litter invertebrates, sediment-dwelling biota, aquatic biota, and terrestrial wildlife. The ORNL benchmark publications may be downloaded from http://www.hsrd.ornl.gov/ecorisk/reports.html. The facility must identify appropriate target ecological communities, populations, species, and media in applying the standards. If no TRV or benchmark values are available from these sources, the facility may use other appropriate sources. EPA Region III, has established a BTAG that provides technical advice on the ERA process. Guidance on the availability and use of BTAGs is available (in USEPA, September 1991), and can be downloaded at http://www.epa.gov/superfund/programs/risk/ecoup/.

If the facility chooses to conduct a more detailed ERA, the *Combustion Facilities ERA Protocol* guidance is the recommended choice. This EPA Region 6 guidance can also be used to determine site-specific cleanup levels if needed.

4.4.2 OB/OD Operations Air Releases – ERA

The ERA should include the evaluation of future OB/OD air releases (see Sect. 4.1).

For screening purpose the facility may use ecological toxicity reference values (TRVs) identified in the *Combustion Facilities ERA Protocol* followed by Oak Ridge National Laboratory (ORNL) published benchmark values for different media. ORNL provides separate sets of benchmarks for plants, soil and litter invertebrates, sediment-dwelling biota, aquatic biota, and terrestrial wildlife. The ORNL benchmark publications may be downloaded from http://www.hsrd.ornl.gov/ecorisk/reports.html. The facility must identify appropriate target population, species, and media in applying the above. If no TRV or benchmark (values) are available from the above sources, the facility may use Region III BTAGs (see Sect. 4.4.1) or other appropriate sources. Media-specific concentrations should be calculated based on dispersion/deposition modeling results as input and the methodology specified in the *Combustion Facilities ERA Protocol* (Sect. 3.11). If the facility chooses to conduct further detailed ecological risk assessment, the *Combustion Facilities ERA Protocol* (Sects. 3.11, 4-6) is the recommended choice.

Major components of the ERA as addressed by the *Combustion Facilities ERA Protocol* (Sects. 4-6) are as follows:

- Estimation of COPC Concentrations in Media
  - + Calculation of COPC Concentrations in Soil
  - + Calculation of COPC Concentrations in Surface Water and Sediment
  - + Calculation of COPC Concentrations in Plants

- Replacing Default Parameter Values

- Problem Formulation
  - + Exposure Setting Characterization
  - + Food Web Development
  - + Selecting Assessment Endpoints
  - + Selecting Measurement Endpoints

- Analysis
  - + Exposure Assessment
  - + Assessing Exposure to Community Measurement Receptors
  - + Assessing Exposure to Class-Specific Guild Measurement Receptors
  - + Assessment of Toxicity

- Risk Characterization
  - + Risk Estimation
  - + Risk Description
  - + Uncertainty and Limitations of the Risk Assessment Process

Results of the ERA for OB/OD units pursuing permits should be used for the determination of site-specific environmental performance standards and permit conditions. Ecological HQs are calculated by dividing the measured concentration of a constituent in a medium (for example, surface soil) against the corresponding benchmark concentration, or by dividing the estimated dose of a constituent in the diet of a specific receptor species (for example, deer mouse), by the corresponding benchmark. An HQ less than 1.0 can usually be interpreted as indicating little potential for ecological risk. An HQ equal to or greater than 1.0 is usually interpreted as indicating that further investigation is needed or professional judgment should be used to determine whether ecological risk exists. The magnitude of an HQ that exceeds 1.0 is not customarily interpreted as indicating the relative severity of potential ecological risk.

4.5 NOISE AND VIBRATION ASSESSMENTS

Permit applications and conditions for OD units should address noise considerations commensurate with Sect. III.F.1 (refs. 40 CFR 264.601 and 270.23(e)) of the *Subpart X Checklist*. Noise-related environmental impacts from OB/OD unit operation are primarily associated with high-energy, low impulsion sounds from detonations (i.e., OD operations). The C-frequency weighting scale is used to evaluate impulsive noise, and sound pressure levels are expressed as dBC (decibels C-weighted) units. The higher frequency noise from OB operations (e.g., a whistling noise) or static firing of rocket motors are not usually sources of noise impacts of concern and are not addressed in this section. The higher frequency noises are expressed as dBA (decibels A-weighted). However, noise impact criteria and measurements may also be expressed as nonfrequency-weighted dBs. The Day-Night Average Sound Level (DNL) is a time-weighted measure used for assessing environmental noise.

The propagation of noise is complex and is affected by the following factors:

- Terrain (e.g., terrain between the source and the receptor may act as an intervening barrier)

- Ground surface (e.g., sound propagation is enhanced over hard surfaces and water)

- Trees, buildings and other structures (i.e., intervening barriers)

- Meteorological effects (in some conditions the atmosphere can focus noise or send it skyward so that little is heard at ground level). Meteorological factors that enhance the propagation of sound are nighttime temperature inversions, low overcast cloud layers that frequently occur in fall and winter, and wind shears.

An overview of noise factors (including detonations) is provided in *Environmental Noise Management: An Orientation Handbook for Army Facilities* (U.S. Army, May 2001), which can be downloaded at http://chppm-www.apgea.army.mil/enp/enp.htm.

4.5.1 <u>Noise/Vibration Effects and Criteria</u>

Noise and vibration effects associated with OD treatment can be classified as follows:

- Human impacts
- Structural impacts
- Ecological impacts

A general summary of airblast damage thresholds is provided in Table 4-3 (DNA, October 1981).

Table 4-3. Summary of airblast damage threshold levels (DNA, October 1981).

Effect	Corresponding Incident Peak Overpressure Level
Threshold of lethality	
+ Small animals in the open	20 – 40 kpa
+ 50-pound animal in the open	>55 kpa
+ Small animals (rabbits or smaller) in burrows	190 kpa[a]
+ Larger animals in burrows	320 kpa[a]
Threshold of lung damage to animals in burrows	
+ Small animals	45 kpa[a]
+ Large animals	85 kpa[a]
Threshold of eardrum rupture to animals in the open	20 – 35 kpa
Threshold of injury to birds in flight	35 – 70 kpa
Toppling of trees (small leaves or defoliated or light crowned)	35 – 70 kpa
Damage to small vegetation or tree branches	20 kpa
Damage to building walls/roofs	7 kpa
Skin penetrations from broken windows	3.5 kpa
Flight hazard to light aircraft	1.4 kpa
Window breakage (one window for each 1,000 of human population)	200 pa
Impulsive noise level limit for industrial workers by Occupational Safety and Health Administration (OSHA)	140 dB (0.2 kpa)
Tinnitus or ringing in ears	160 dB (2 kpa)

[a]The peak overpressure levels shown are the levels that occur without reflections. Airblast filling a burrow can produce pressures that are 2 or 3 times these values and are sufficient to result in the effect described.

pa = Pascals

4.5.2 Human Impacts

Effects of noise and vibration on humans include hearing damage and health effects, annoyance, speech interference, and sleep disturbance. Noise complaints from numerous OD operations indicate that there is some level of community annoyance. Speech interference is not of concern because the typical numbers and types of OD operations do not generate long duration blasts during the day. Sleep disturbance is not an issue because the OD operations are usually restricted to daylight working hours. Noise criteria identified in this study are therefore based on avoiding annoyance.

Concerns at very high noise levels include hearing damage and non-auditory health effects. Hearing damage is well documented (generally at greater than 140 dB, e.g., tinnitus can occur at 160 dB, see Table 4-3). Chronic noise exposure is suspected as a risk factor in hypertension, cardiovascular disease, and nervous disorders. However, no such effects have been proven to occur at noise levels below those known to affect hearing.

There are no federal environmental noise standards, but the EPA pioneered the use of A-weighted Day-Night Average Sound Level (DNL) and identified a level of 55 dB to "protect public health and welfare with an adequate margin of safety." ANSI S12.9 Part 4 [1996] recommends A-weighted DNL for assessment of general environmental noise. *American National Standards Quantities and Procedures for Description and Measurement of Environmental Sound-Part 5: Sound Level Descriptors for Determination of Compatible Land Use* (ANSI S12.9 Part 5, 1998) suggests 55 dB as the corresponding A-weighted DNL criterion in residential areas.

Although there is great variation from one state or locality to another, a preponderance of state and local governments regulate industrial and neighborhood noise (air conditioners, lawn mowers, pets, etc.) using the maximum A-weighted DNL. The typical criterion level ranges from 55 to 65 dBA during daylight hours.

Community sensitivity to noise annoyance is subjective and variable. Table 4-4 provides sample guidelines used by the U.S. Army for Installation Compatible Use Zone (ICUZ) planning (U.S. Army, May 2001). Alternative criteria can be applied to a site based on consultation with the permitting agency. For existing OD units, a noise compliance log going back five years and available offsite noise monitoring data should be provided to support alternative criteria.

4.5.3 Structural Impacts

Adverse structural effects of blast noise range from low-level effects such as nondamaging vibration which is perceived or causes objects to rattle, up to high-level effects such as physical damage to structures. Perceptible vibration and rattling are factors that contribute to annoyance. Vibration criteria identified in this study are directed toward avoiding annoyance and are therefore protective of physical damage.

Table 4-4. Sample guidelines for community noise annoyance (U.S. Army, May 2001)

Land Use Acceptability (Based on Noise Impacts)	Percent Population Highly Annoyed	Noise Limit Transportation and Small Arms ADNL in A-weighted dB	Noise Limit Impulsive CDNL in C-weighted dB
Compatible	<15	<65	<62
Normally Incompatible	15 – 39	65 – 75	62 – 70
Incompatible	>39	>75	>70

No published standard exists to assess structural damage from airborne or ground impulsive waves, but a great deal of research has been conducted on the probability of damage from impulsive pressure waves. These studies have demonstrated that the peak level relates directly to the probability of damage from structural components such as windows, plaster walls and drywall, as well as falling bric-a-brac and other household items.

In general, for impulsive noise, the threshold for minimal probability of the most superficial type of damage in residential structures begins when the peak sound level exceeds 134 dB. In terms of structural vibrations due to ground-borne or air-borne blast waves, the threshold of damage has been defined as a resultant peak vibrational level of 0.50 in/sec for older homes and 1.0 in/sec for modern homes.

4.5.4 Wildlife and Domestic Animals

Assessing the effects of noise and vibration on animals is complex, because species vary greatly in their responses. Each species has adapted, physically and behaviorally, to fill its ecological role, and its hearing usually reflects that role. Animals rely on their hearing to avoid predators, to obtain food, and to communicate with and attract other members of their species. Noise may mask or interfere with these functions. Secondary effects may include non-auditory ones similar to those exhibited by humans: stress, hypertension, and other nervous disorders. Tertiary effects may include interference with mating and resultant population declines.

There are many scientific studies of the effects of noise on wildlife, and wildlife flight due to noise has been reported. Some specific effects, such as panic and huddling of domestic fowl, have been documented. Other effects, such as bird egg hatch failure and reduced milk production from dairy cows, have been demonstrated not to occur. It is difficult to apply results from one species to others, so the studies have dealt with specific species of animals and cannot be generalized.

In the absence of definitive data, the Committee on Hearing, Bioacoustics, and Biomechanics of the National Research Council has proposed that protective noise criteria for animals be taken to be the same as for humans. In general, the appropriate levels would be those corresponding to adverse health effects. For threatened and endangered species, which require a higher degree of protection, levels would be those corresponding to annoyance.

4.5.5 Noise Modeling

Existing and new OD facilities seeking permits should conduct a noise modeling assessment to characterize potential noise impacts. Available models include the following:

- BNOISE (U.S. Army, May 2001): The BNOISE model can be used for DNL characterization of detonation operations. The BNOISE model is currently being revised and updated to correct previous problems and to add the following capabilities:

    + Include the effects of topography in the calculation

+ Include the effects of propagation over water, including the land-water interface
+ Improve the sound propagation algorithms

- SHOT (U.S. Army, May 2001): The SHOT computer model can be used to evaluate the potential impacts of single detonation events (Lewis, 1994). The SHOT model is used to predict the expected mean linear peak sound level and the distribution of the levels about this mean for the proposed detonation weights and selected receiver locations. The effect of topography features between the noise source and the receiver is included in the model. The inputs to this model are the explosive weight, distance between the source and the receiver, burial depth, and location and height of a barrier, if one exists, between the source and receiver. The accuracy of this model for large detonations was checked with the measurements taken at Sierra Army Depot. For the 29 measurements taken at Sierra, the mean level predicted by the SHOT model underpredicted the measured levels by an average of 1.4 decibels.

- Sound Intensity Prediction System (SIPS): SIPS is a tool developed by the U.S. Navy, employed to reduce complaints about noise from explosive operations at DoD facilities. It predicts the noise created by detonating explosive materials. SIPS deals with the long-range propagation of impulse noise in the atmosphere.

  Using data from weather balloons sent into the atmosphere near the detonation site, the SIPS computer system calculates the distribution of noise from the blast, the level of sound that may reach populated areas, and the location of high-intensity sound pockets formed by the current atmospheric conditions. SIPS uses a combination of sophisticated computer programming with the estimated TNT equivalent charge weight, terrain maps of the area, and current atmospheric data to generate a map showing the distribution of noise around the blast site, plus plots of sound speeds versus altitude and acoustic ray traces in directions of interest. All this information is then available to the decision-maker to help determine the noise risks involved in proceeding on any given day.

  SIPS also produces a long-term record of the atmospheric conditions during the blast situation and documents the reasons for not conducting a scheduled blast. Therefore, SIPS can be used as a noise complaint management tool. Information regarding SIPS is available at http://www.nswc.navy.mil/inserts/index.html.

- Noise Assessment and Prediction System (NAPS):

  A system has been designed to provide an assessment of noise levels that result from testing activities at Aberdeen Proving Ground, MD. The system receives meteorological data from surface stations and an upper air sounding system. The meteorological data are used as input into an acoustic ray trace model which projects sound level contours onto a two-dimensional display of the surrounding area. This information is also provided to the range control office where a decision can be made to proceed or delay the test activity depending upon acoustic propagation conditions. To evaluate the noise level predictions, a series of microphones is located off the reservation to monitor sound-pressure levels. Any events of significant level are transmitted back to the central display unit, allowing for comparison between prediction and data. The computer models are modular, allowing for a variety of models to be utilized and tested to achieve the best agreement with data. This technique of prediction and model validation will be used to improve the noise assessment system (U.S. Army, November 1994).

- BLAST (USAF, April 1997): A blast overpressure prediction model developed by the U.S. Air Force.

Noise modeling results should be used to identify worst-case offsite receptor exposures, sensitive receptors, and exposures at nearby population centers. Potential human, structural, and ecological impacts should be evaluated at potential/sensitive worst-case receptors and population centers. The noise modeling impact assessment results should be used to determine site-specific environmental performance standards and associated permit conditions. Potential OD operational restrictions may include a limited frequency and magnitude of detonations as well as meteorological, time-of-day, and seasonal restrictions. Buried detonations may be required. Modeling results can also be used to determine if a monitoring program is warranted for the site, the site boundary, or any offsite locations.

4.5.6 Noise Monitoring

Noise monitoring at or beyond the installation boundary may be warranted, depending on noise modeling results and the frequency and nature of community noise complaints regarding OD operations. Facilities should consult with the permitting agencyfor such a determination.

Since the pattern of noise propagation is complex, noise monitoring at the installation boundary may not be adequate to evaluate offsite noise impacts. For some sites it may be appropriate to consider noise monitoring locations based on the following:

- Worst-case exposure receptors (based on modeling results)
- Location based on historical noise complaints
- Nearby population centers

Because representative meteorological data are needed to interpret noise monitoring data, an onsite meteorological monitoring program may be needed to support the noise monitoring program.

Following are alternative noise monitoring systems appropriate for OD sites (U.S. Army, May 2001):

- Off the shelf
- Smart controller/one microphone
- Smart controller/two transducers

Off the shelf systems (i.e., capable of C-weighed equivalent and maximum/peak measurements) can be overwhelmed by false alarms caused by wind gusts and other non-OD transient events. Performance can be improved by the use of "smart" algorithms/software as well as additional co-located sensors (e.g., two microphones mounted vertically 1 to 2 meters apart). Smart algorithms also have the potential to reject some true detonation events as false alarms, but for a multiple noise monitoring station network the differences between the times when blast events are registered at monitors can be used as an independent validation of true and false events. Wind barriers should be used to reduce the potential for false alarms.

In general, an off-the-shelf noise monitoring system is adequate if (i) the microphones are sheltered from the wind, (ii) the times of detonation are known and documented, and (iii) the primary interest is noise levels above 115 dB peak. Otherwise, a two-transducer system is recommended (U.S. Army, May 2001).

4.6 LONG-TERM SOURCE AND ENVIRONMENTAL MONITORING

Source monitoring for OB/OD treatment is a technical challenge for nonstack, typically quasi-instantaneous, infrequent releases. Thus OB/OD source monitoring permit conditions may be limited.

The primary operational indicators of OB/OD treatment effectiveness are source temperature and emission rates; therefore, the baseline source temperature and time duration of the event can be used to characterize treatment effectiveness.

Source temperatures can be measured using remote infrared sensors, which can be applied to OB sources. Minimum acceptable baseline source temperature for OB treatment is a function of the candidate energetic wastes to be treated. These energetic source temperatures can be obtained from the technical literature or based on trial burns submitted by the applicant to assist the permit writer to specify appropriate permit conditions. A 10 sec duration from startup to attainment of the baseline treatment temperature can be used as a default permit condition value for OB sources. However, for OD sources, the use of remote technology to measure the fireball temperature may not be feasible, considering explosive dangers (i.e., exclusion distances for equipment survivability).

Emission concentration rate measurements from OB/OD sources usually are not practical, considering the limitations and uncertainties associated with available technology. Limited OB/OD cloud (but not source) measurements for some emissions constituents can be obtained by the application of remote sensing (i.e., "open path") technology. However, this evolving technology is prone to atmospheric interferences and provides an integrated dose mass for target constituents (i.e., within the OB/OD cloud at the measurement location).

Open path technologies that could be considered for OB/OD source include lidar, fourier transform infrared (FT-IR), and ultraband radiation systems. Following are some sources of information for open path technologies:

- FT-IR Open Path Monitoring Guidance Document (USEPA, April 1996) included in the EPA Technology Transfer (TTN) web, along with additional open path information, at http://www.epa.gov/ttn/amtic/longpath.html.

- "Fence Line Monitoring of Facilities" based on lidar technology at http://www.epa.gov/eq/atlas/evprogram/cleanair.htm

- "Detection and Identification of Multiple Hazardous Air Pollutants at Extended Distances" (SERDP, undated a) CP-1061 at http://www.serdp.org/research/compliance.html

An alternative approach for obtaining OB/OD emission rates is to use data from applicable BangBox tests (i.e., a scaled down treatment quantity within a chamber), including available BangBox tests for applicable energetic wastes. Additional BangBox tests should be conducted if available tests are not available to represent the expected site-specific range of candidate energetic wastes.

Environmental monitoring may involve the following media:

- Groundwater
- Soil
- Surface water/sediments
- Ambient air

A detection groundwater monitoring program is required for all OB/OD permits, but the need for routine, long-term monitoring of the other media is only warranted if baseline site characteristics or risk assessment results identify a particular site-specific environmental concern. For example, the baseline site characterization and risk assessment results for a small treatment quantity OB/OD unit may indicate minimal/acceptable impacts that do not warrant a long-term monitoring program. Guidance for the conduct of groundwater, soil, and surface water/sediments has been presented in Sect. 4.2. But ambient air monitoring for OB/OD sources is problematic. Successful installation of one upgradient monitor and one or more downgradient air monitors for each treatment event may not be achievable. This would require an extensive stationary air monitoring network or portable monitoring stations redeploying each time. Even data evaluation of a longer period (e.g., combination of all treatment events for one year) may not yield statistically significant data (because of variable wind conditions, the low frequency of treatment events and short release duration) and should be evaluated in conjunction with wind data and modeling predictions for the burn periods. Also, the maximum long-term level concentration location for OB/OD sources is typically within 3 km downwind. Standard EPA guidance for ambient air monitoring (for criteria pollutants as well as toxic air pollutants) is available from the TTNWeb-Ambient Monitoring Technology Information Center at http://www.epa.gov/ttn/amtic. Open-path technology, as previously discussed for source monitoring, is an alternative approach.

In summary, air monitoring for these quasi-instantaneous, nonstack, intermittent (infrequent), release sources is a technical challenge. Therefore the use of BangBox emission tests (in conjunction with dispersion modeling) is an alternative to ambient air monitoring for OB/OD sources. The facility should contact the permitting agencyto determine the need for air monitoring based on site-specific considerations.

Onsite meteorological monitoring is generally the most representative operational approach to determine if meteorological conditions are acceptable to conduct an OB/OD waste treatment event. A 10 m height for wind measurements is the standard exposure used for dispersion modeling. EPA guidance for meteorological monitoring is available in *Meteorological Monitoring Guidance for Regulatory Modeling Applications* (USEPA, February 2000), via the TTN-SCRAM Web page at http://www.epa.gov/scram001/guidance/met/mmgrma.pdf. The application of remote sensing technology is an alternative approach to the use of meteorological towers and can be used to characterize dispersion conditions from the surface to heights of more than 1 kilometer. A prototype system, based on commercially available equipment for OB/OD sources has been developed at Dugway Proving Ground (SERDP, undated b). This system includes wind-profiling radar equipment and a radio acoustic sounder and can be seen at http://www.serdp.org/research/Compliance.html.

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5. OB/OD PERMIT CONDITIONS

An OB/OD unit permit consists of three types of modules. The first two apply to all permits - the third specifies permit conditions for OB/OD units - the modules are:

- Standard conditions
- General facility conditions
- Treatment of energetic wastes
- Sitewide (HSWA) Corrective Action (not addressed in this document)

Module 1 contains the general conditions required by 40 CFR 270 for all Hazardous Waste Management Facility Permits such as:

- Standard administrative conditions
  - + Effect of permit, permit actions, duties and requirement, permit expiration, inspection and entry, transfer of permit, etc.

- Monitoring and records
  - + Samples taken by facility must be representative
  - + Records of monitoring must be maintained

- Record keeping and reporting requirements
  - + Reporting planned changes
  - + Documents to be submitted before operation begins
  - + Documents to be maintained
  - + 24-hour reporting requirements

- Definitions

- Confidential Information

Module 2 contains conditions covering the general facility requirements of 40 CFR 264, Subparts B through H and O. This module must be included in all RCRA permits. Land Disposal Restriction (LDR) (40 CFR 268) requirements may also be included in Module 2. The module should include the following:

- Required notices
- Location standards
- Procedures to prevent hazards
- Emergency procedures
- Personnel training

- Security
- Closure and post-closure
- Manifest system (only if offsite waste is accepted)
- Recordkeeping and reporting
- Liability requirements
- Corrective action

Sect. 5 provides a summary of recommended permit requirements that specifically address the OB/OD treatment of energetic wastes (i.e., Module 3), including the following permit conditions:

5.1 Permitted and prohibited waste
5.2 Design and construction requirements
5.3 Operating, inspection and maintenance requirements
5.4 Operating conditions
5.5 Monitoring requirements

The technical basis for these permit conditions is in Sects. 2 through 4.

5.1 PERMITTED AND PROHIBITED WASTES

The permit should specify the allowable types and quantities of waste energetics for OB/OD treatment as follows:

- Type of unit (OB or OD)
- Description of hazardous waste (e.g., bulk propellants for OB; see Sect. 3.2 for additional guidance)
- Hazardous classification codes (see Sect. 2.2 for criteria for burning and detonation of energetic)
- Hazardous waste number
- Allowable treatment quantities (i.e., lbs. NEW/event, lbs NEW/yr)

Allowable waste energetics and treatment quantities selected as permit conditions should facilitate operational flexibility and should be protective of human health and the environment. This should be accomplished by use of site-specific, risk-based environmental performance standards (see Sect. 4).

The emphasis should be placed on input waste composition limits for OB/OD units instead of emission concentrations (typically used for hazardous waste combustion facilities with stack releases) since monitoring the release concentrations may be impractical and associated with uncertainty.

Chemical-specific waste-feed restrictions (in addition to NEW limits) should be specified in order to ensure that OB/OD emissions will not endanger human health or the environment. Typically this will involve restricting waste composition (i.e., of the energetic, including trace chemicals but not the inert components of waste munitions) for the following HCOCs:

- RCRA metals
- Chlorine
- Sulfur

Additional HCOCs may be warranted for some OB/OD units based on site-specific environmental performance standards (see Sects. 4.1 – 4.3).

The waste stream for metals should be limited as follows:

$$HV_t = \sum_{i=l}^{n} \frac{W_{it}}{A_{it}} \leq 1.0 \qquad \text{Eq. 5-1}$$

where:

HV_t = hazard value for energetic waste stream (dimensionless)

W_{it} = the actual treatment amount for the i^{th} metal constituent (lbs)

A_{it} = the allowable treatment amount for the i^th^ constituent that is equivalent to a Hazard Quotient = 0.1 for noncarcinogen or a cancer risk of 1E-6 for carcinogens (lb)

t = the time-weighting period (1-hr for acute exposures, an 24-hr for chronic exposure)

For some situations it may be appropriate to have separate HV calculations for carcinogens and noncarcinogens.

The chlorine and sulfur content of the waste stream should be separately limited as follows:

$$HV_t = \frac{W_{it}}{A_{it}} \leq 1.0 \qquad \text{Eq. 5-2}$$

The allowable treatment amounts can be determined from risk assessment results (Sects. 4.1-4.3) as follows:

$$A_{it} = \left(\frac{W'_{it}}{R_{it}}\right)(T) \qquad \text{Eq. 5-3}$$

where:

A_{it} = as previously defined

W'_{it} = the treatment amount for the i^{th} constituent modeled in the risk assessment

R_{it} = the HQ for noncarcinogens and cancer risk value for carcinogens based on the human health risk assessment

T = target acceptable risk (i.e., Hazard Quotient = 0.1 for noncarcinogens or a cancer risk of 1E-6 for carcinogens)

For some sites allowable treatment values may also need to account for potential ecological impacts.

Operational OB/OD treatment records of items treated, waste composition and HV-related calculations should be required to document compliance with the waste stream limits discussed above.

If a permittee wishes to treat hazardous waste not specified in the permit, the permitting agencymust be notified in advance. The permitting agencywill either grant written authorization or modify the permit to cover the new waste stream.

All nonenergetic wastes are prohibited from routine OB/OD treatment. Some energetic wastes are prohibited as well, due to the potential for toxic releases or due to the availability of alternative treatment technologies – prohibited items include:

- Small arms ammunition (since this is not considered to have RCRA explosive reactivity characteristics based on EPA policy, and alternative treatment technologies are available)
- Chemical agent munitions
- Riot-control munitions
- White/red phosphorous
- Incendiaries (such as napalm)
- Colored smokes
- Depleted uranium (DU) munitions

The items listed may be excluded from routine OB/OD operations, but there may be site-specific need for emergency treatment to mitigate safety hazards.

The permittee should be required to implement a Waste Analysis Plan (WAP) that addresses both pretreatment wastes and post-treatment wastes. It is generally dangerous, infeasible or impractical to disassemble energetic items to determine whether a waste is appropriate for OB/OD treatment. Therefore, a facility may use generator knowledge to make the determination. In this case, the generator should demonstrate and document that the waste is potentially explosive, through means other than the use of test data or analytical data. Post-treatment waste with an energetic content of 12 percent or greater should be retreated, and the WAP should include such retreatment (see Sect. 3.3) for details).

The WAP submitted in the permit application can be incorporated by reference as a permit condition as appropriate. The permit writer may also specify additional WAP requirements on a case-by-case basis.

5.2 DESIGN AND CONSTRUCTION REQUIREMENTS

The permit should specify the design and construction characteristics of the OB or OD unit, preferably based on information in the application, as follows:

- Type of unit (OB or OD)
- Location of unit (including unit boundary and treatment areas within the unit boundary)
- Design dimensions and construction materials based on engineering drawings (type of soil for OD)
- Engineering controls
- Firing control systems

An OB unit should be designed and constructed to minimize the potential for environmental contamination (i.e., wastes should not be in direct contact with the ground) and migration of contaminants (i.e., to control the effects of precipitation and runon/runoff). At a minimum, an OB unit should include burn pans with precipitation covers. Additional features (e.g., cement pads to prevent direct contact of waste/residue spills with the ground, pan liners, ejecta control screens, soil liners, etc.), may be warranted on a site-specific basis (see Sect. 2.4).

An OD unit should be designed and constructed to minimize the potential for environmental contamination and migration of contaminants. At a minimum an OD unit should include a berm system or similar structures to control runon and runoff. Additional features (e.g., mounds, soil liners, special fill material), may be warranted on a site-specific basis (see Sect. 2.4).

5.3 OPERATING, INSPECTION AND MAINTENANCE REQUIREMENTS

Permit conditions for OB/OD units should address the Waste Minimization Plan (WMP) and Standard Operating Procedures (SOPs). Components of the permit application (e.g., SOPs, WMP, PTWMP, maintenance schedules) may be incorporated by reference if acceptable. The permit writer may also specify additional requirements on a case-by-case basis (see Sect. 2.4).

5.3.1 Waste Minimization Plan Requirements

The permittee must comply with 40 CFR Part 264.73(b)(9) and must certify, no less often than annually, that:

- The permittee has a program in place to reduce the volume and toxicity of hazardous waste generated, to the degree economically practicable.
- The proposed method of treatment, storage or disposal is the most practicable method available that minimizes the present and future threat to human health and the environment.
- The permittee shall maintain copies of certification in the facility operating record as required by 40 CFR 264.73(b)(9).

The waste minimization program requirement should include the implementation of the WMP (see Sect. 3.4) and treatment effectiveness demonstration (see Sect. 3.5). The DRE (as defined in Sect. 3.5) requirement for energetics should be 99.99 percent by weight.

5.3.2 SOP Requirements

Functional requirements for OB/OD operations should be documented in site-specific SOPs, which are typically attachments to the permit application pursuant to Sect. III-A of the *Subpart X Checklist* and 40 CFR 270.23(a)(2). They can be incorporated by reference as permit conditions. SOPs should address the following:

- Loading/unloading procedures
- Procedures for managing waste for treatment operations (e.g., quantity of waste placed in each burn pan)
- Special storage/accumulation requirements for waste before and after OB/OD treatment
- How the waste will be treated
- Duration of burns, duration of a treatment campaign, and number of treatment events per day, week and year.

- Explosion hazard safety precautions

- Post-treatment waste management (see Sect. 3.8)

- Prevention of unintended ignition or reaction of waste.

The SOPS should provide a framework for the consistent conduct of OB/OD operations that are protective of human health and the environment. However, the SOPs should be reasonably flexible because minor revisions may be needed (e.g., use of functional job classifications instead of the names of specific individuals).

5.3.3 Inspection and Maintenance Requirements

Permit conditions for OB/OD units should include inspection requirements (procedures and schedule) as follows:

- Inspection of physical integrity of unit/treatment device
- Inspection of secondary containment devices, berms, erosion control devices, etc.
- Inspection of safety and emergency equipment specific to the OB/OD unit
- Inspection for untreated energetic items, UXO, etc.
- Inspection to determine brush fire potential (e.g., vegetation cleared treatment area and condition of surrounding area)

Typically these inspections are conducted before each OB/OD treatment event and afterwards at a prescribed time for safe reentry of site personnel.

The following inspections should be conducted periodically:

- Inspection of the general area (e.g., fences, gates, locks, warning signs, monitoring devices)

- The unit should be inspected (regularly) for signs of erosion and other conditions that might result from washouts.

- The condition of the monitoring well casing, cap, and lock should be checked when the well is sampled.

- The integrity of surveyed benchmarks should be inspected regularly.

Permit conditions should include preventive and corrective procedures such as:

- Security. Signs should be replaced if they become illegible. The security fence and gate should be repaired or replaced as necessary to maintain unit security.

- Erosion. Washouts should be repaired whenever they occur. The vegetative cover should be restored as needed.

- Vegetative cover. Tree or bush growth should be controlled by mowing or prescribed burns. The vegetative cover should be reasonable height as a fire prevention measure.

- Runon and runoff controls. Drains and ditches should be cleaned and maintained to allow free drainage of stormwater. High-rate runoff areas (if any) should be protected with coarse stone to minimize erosion.

- Monitoring wells. Damaged monitoring wells should be repaired or replaced.

- Drainage collection/venting systems. Routine and emergency maintenance should be conducted for each system as warranted.

- Surveyed benchmarks. Missing benchmarks should be replaced and damaged benchmarks should be repaired.

Corrective maintenance action should be taken if a potential exists for exposure that could endanger human health or the environment. All maintenance actions should be documented in the OD unit maintenance log.

5.4 OPERATING CONDITIONS

The following operating conditions are applicable to all OB/OD units:

- Minimum safe distance from the property of others (40 CFR 265.382)
- Operation only during daylight hours (i.e., from 1 hour after sun rise to 1 hour before sunset)
- Required to operate within a wind speed range (between 3 and 15-20 mph)
- No operations during electrical storm within 3 miles
- No operations during inclement weather or if storms are forecasted
- No operations during a weather inversion or if an inversion is forecasted

Alternative (more or less stringent) and additional operational limits may be warranted based on site-specific conditions (see Sect. 4).

Another potential operating condition is source temperature which is typically a function of type of energetic and mode of treatment, OB or OD. But this parameter may be difficult to monitor, especially for OD units. Similarly, measurement of emission concentrations of HCOCs is frequently impractical and associated with great uncertainties. Therefore, it is often easier to enforce permit conditions based on input waste stream restriction (see Sect. 5.1).

5.5 MONITORING REQUIREMENTS

Monitoring requirements for OB/OD permits may include the following:

- Source monitoring
- Meteorological monitoring
- Air monitoring
- Other environmental monitoring

Source and ambient air monitoring for OB/OD treatment is a technical challenge for these nonstack, typically quasi-instantaneous and infrequent releases (see Sect. 4.6). Therefore, site-specific factors should be considered to determine if source monitoring or ambient air monitoring requirements should be included as permit conditions.

Operation of an onsite meteorological monitoring station should be required if real-time offsite wind data are unavailable are nonrepresentative of onsite conditions (see Sect. 4.6).

A baseline site characterization program (i.e., groundwater, soils, surface water) should be implemented (see Sect. 4.2) for all existing units if acceptance baseline data are not submitted with the permit application. Soil and surface water monitoring permit requirements should be considered on a site-specific basis depending on the relative risk and unit design/engineering controls.

A standard RCRA groundwater monitoring program should be a permit condition for all (existing and new) OB/OD units. Exemptions from the requirement should meet the criteria in 40 CFR 264.90(9).

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6. REMOVAL AND/OR REMEDIATION OF ENERGETIC – CONTAMINATED ENVIRONMENTAL MEDIA

Corrective action or closure of an OB/OD unit may involve the following:

- Management of UXO and munition fragments (see Sects3.8 and 4.2.3)
- Management of nonenergetic wastes (based onspecific requirements of the permitting agency)
- Management of energetic-contaminated environmental media.

The permit application should address the proposed management of OB/OD wastes. The management of energetic-contaminated soil and groundwater may involve removal and/or remediation actions.

Safety is the first consideration for handling energetic contaminated media that may be reactive. The permit application should define a methodology for evaluating reactivity, including cyanide and explosive reactivity. This may involve generic knowledge, reactivity tests, or field surveying analysis. Reactivity tests by DoD have indicated that an energetic concentration of 12 percent or more is a conservative criterion for determining explosion reactivity, and DoD sampling indicates that environmental media at OB/OD sites are not typically reactive.

Safety concerns necessitate remediation of energetic-contaminated soils, sediments, and sludges. Safety measures should include elimination of spark and static electricity hazards. Nonsparking equipment, such as beryllium tools instead of ferrous tools, conductive and grounded plastic, and no-screw tops developed for manufacturing explosives are standard equipment at explosive waste sites.

If contamination is above the 12 percent limit in some areas of a site, the contaminated material could be blended and screened to dilute the contamination and produce a homogenous mix below the 12 percent limit. This blending is not by itself a remedial action but a safety precaution; soils containing less than 12 percent secondary explosives by weight occasionally experience localized detonations but usually resist widespread propagation. Foreign objects and unexploded ordnance within the contaminated soil often impede the blending process and require specialized unexploded ordnance management procedures. Such blending is considered a treatment of a hazardous waste and, thus required a permit prior to treatment.

Once blending is completed, soil treatments such as incineration and bioremediation can proceed. Equipment used in treatment should have sealed bearings and shielded electrical junction boxes. Equipment also should be decontaminated frequently to prevent the buildup of explosive dust.

Common treatment technologies for energetics in soil, sediment and sludge include the following (FRTR, undated):

- In-situ biological treatment (e.g., enhanced biodegradiation, land treatment and phytoremediation)
- Ex-situ (assuming excavation) biological treatment (e.g., biopiles, composting, fungal biodegradations, landforming and shing-phase biotreatment)
- Ex-situ (assuming excavations) physical/chemical treatment (e.g., chemical extraction, soil washing and solar detoxification)
- Ex-situ (assuming excavations) thermal treatment (e.g., hot gas decontamination, incineration, thermal desorption and excavation with offsite disposal)

Common treatment technologies for energetics in ground water, surface water and leachate include the following (FRTR, undated):

- In-situ biological treatment (e.g., co-metabolic treatment, enhanced biodegradiations and phytoremediation)
- In-situ chemical treatment (e.g., passive treatment wells)
- Ex-situ (assuming pumping) biological treatment (e.g., bioreactors and constructed wetlands)
- Ex-situ (assuming pumping) physical/chemical treatment (e.g., UV oxidation)
- Containment (e.g., deep well injection)

Detailed information on alternative remediation technologies, including success stories, are available from information resources at EPA, DoD, et al. Following are some sources of information:

- Federal Remediation Technologies Roundtable at www.frtr.gov
- Strategic Environmental Research Development Program at www.serdp.org
- U.S. Army Environmental Center Cleanup Technology at www.aec.army.mil
- U.S. Army Environmental Security Technology Certification Program at www.estcp.org
- U.S. Army Corps of Engineers Environmental Research and Development Center at www.wes.army.mil

- EPA Technology Information Office at www.epa.gov/swertio1/ including:

    - + EPA Remediation and Characterizations Innovative Technologies at www.epareachit.org

    - + EPA Tech Direct at www.epa.gov/swertio1/techdrct/indextext

    - + Hazardous Waste Clean-up Information (CLU-IN) web site at www.clu-in.org

There have been many success stories regarding the application of treatment technologies to energetic contaminated environmental media. Bioremediation is typically an attractive treatment technology based on cost factors. Nevertheless, most of the current technologies fail to demonstrate complete destruction of explosives. Rather, explosives are transformed to related conjugation products that are recalcitrant to further characterization. Although these products are suspected of being relatively unavailable for transport in the short term (weeks or months) and not significantly toxic, their ultimate fate in the long term (years) is not known. This lack of understanding of the ultimate fate of explosives severely limits the credibility of certain remediation technologies (SERDP, undated c). Therefore, documentation should be submitted to the permitting agency for evaluating, selecting, and implementing treatment technologies for energetic-contaminated media (if removal is not planned).

Natural attenuation may be an attractive alternative at OB/OD units compared to more expensive remediation technologies at sites that meet well-defined selection criteria, fall within acceptable risk levels, and satisfy specific regulatory concerns. However, a significant unanswered question associated with natural attenuation is what transformation processes are relevant and should be monitored to assure that attenuation is effective (SERNP, undated d).

The concept of natural attenuation may initially appear to be an alternative approach to remediation to achieve closure of an OB/OD unit. The "natural attenuation processes" that are at work in such a remediation approach include a variety of physical, chemical, or biological processes that act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of hazardous waste constituents in soil or groundwater. These in-situ processes include biodegration, dispersion, dilution, absorption, volatilization, and chemical or biological stabilization or destruction of contaminants. Natural attenuation processes occur at all sites, but effectiveness varies depending on the types of hazardous waste constituents present and the physical, chemical, and biological characteristics of the soil and groundwater.

The EPA has issued a policy memorandum entitled "Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites" (USEPA, April 1999) that reaffirms the EPA's position that natural attenuation is an alternative to remediation in some cases, providing the following criteria are met:

- The site-specific remediation objective will be achieved within a reasonable time.

- A site-specific site characterization and risk assessment indicates that human health and the environment will not be endangered.

- Additional source controls will be implemented as necessary.

- A site-specific performance test has been conducted which demonstrates the effectiveness of natural attenuation.

- Performance is monitored as long as constituent levels in soil and groundwater remain above required cleanup levels on any portion of the unit.

The EPA does not consider monitored natural attenuation to be a "no action" remedy. Furthermore, its applicability to OB/OD units may be significantly limited, since metals (which are less amenable to short-term natural attenuation) are expected to be major constituents of concern at many sites.

Natural attenuation, or alternative treatment technologies for energetic-contaminated media, is dependent on many site-specific factors, especially fate and transport processes. Important chemical fate processes for energetics include the following (Fauth, undated):

1. Adsorption-desorption

   This is probably the most important process. For organic contaminants it is generally related to the aqueous solubility of the solute and the organic carbon content of the soil. Other variables such as clay content, mineralogy, and soil pH may strongly influence adsorption, especially if the solute has ionic properties. Adsorption processes are usually exothermic and desorption endothermic, so increasing temperature generally results in increased desorption or reduced adsorption.

2. Volatilization

   Volatilization is controlled by three main equilibrium conditions: concentrations of the compound in the soil, in soil air, and in the atmosphere. Seven major factors affect these equilibria: physical and chemical properties of the compound and the soil, adsorptive properties of the compound, concentration of the compound, soil-water content, air movement, temperature, and diffusion. Soil water is probably the most important factor. In dry soils, the compounds adsorb more to the soil particles, so overall volatilization is decreased.

3. Degradation

   The most important degradation processes are hydrolysis, photochemical degradation and microbial degradation.

Factors affecting hydrolysis include pH, temperature, functional group and properties of the reaction medium. Types of functional groups susceptible to hydrolysis include: alkyl halides, amines, epoxides, and nitriles. Generally resistant to hydrolysis are hydrocarbons, aromatic nitro compounds, and aromatic amines. Four of the compounds of interest are aromatic nitro compounds: namely two dinitrotoluenes (DNTs), trinitrotoluene (TNT), and trinitrobenzene (TNB). RDX is not hydrolyzed under acidic conditions, but 27% has been shown to be hydrolyzed under basic conditions.

Primary photochemical processes in organic molecules include fragmentation into free radicals or neutral molecules, rearrangement and isomerization, photoreduction by abstracting hydrogen atoms from other molecules, dimerization, photoionization, and electron transfer reactions.

Microbial degradation may bring about mineralization, detoxification, cometabolism activation, and change in toxicity. Man-made compounds are biodegradable only if the relevant microbes can use enzymes they already possess. The environmental factors are moisture, temperature, aeration and depth of application.

The transformation process and products for energetics can be complex and are not always fully understood. The half-life of typical OB/OD energetics varies significantly (Table 6-1).

Table 6-1. Chemical Fate Properties for Typical OB/OD Energetics

Energetics	Half-life (Years) Soil	Relative Mobility (Soil)	Transformation Products
DNB	Long[a]	Moderate[a]	
DNT	Long[a,c]	Moderate[a]	
HMX	39[b]	Least[a]	Non-toxic chemicals[a]
NC	Long[b]	Moderate[a]	
NQ		Most[a]	
RDX	36[b]	Least[a]	Non-toxic chemicals[a]
Tetryl	Long[a,c]	Moderate[a]	Picric acid[a]
TNB	Long[a,c]	Moderate[a]	
TNT	1[b]	Moderate[a]	DNT and other toxic chemicals[a]

[a]Fauth, undated
[b]DuBois and Baytos, undated
[c]Persistent in soil for more than 35 years

Potential information resources for the chemical fate properties of energetics include the following:

- "The Environmental Fate of Some Energetic Materials" (Fauth, undated).

- "Weathering of Explosives for Twenty Years" (DuBois and Baytos, undated).

- Health Advisories for specific energetics issued by the EPA Office of Drinking Water.

- "The Fate and Transport of Munitions Residues in Contaminated Soil" (USEPA, undated) available at http://es.epa.gov/ncerqa_abstracts/centers/hsrc/fate/fate_trans.html.

- "Distribution and Fate of Energetics on DoD Test and Training Ranges (SERDP, undatede) available at http://www.serdp.org/research/Compliance.html.

TNT, with a half-life of one year, is the best energetic candidate for monitored natural attenuation (Table6-1), but the transformation products may be as undesirable as TNT because of toxicity or mutagenicity and may also be more stable in the environment (U.S. Army, September 1999). Therefore, if monitored natural attenuation is a candidate treatment approach for an OB/OD site, a protocol for evaluation, selection, and implementation of monitored natural attenuation as a remedial alternative should be provided that addresses both primary energetic constituents and transformation products. The protocol should, at a minimum, address the following elements:

- Step 1. Evaluate adequacy of existing data for development of a preliminary conceptual model of the site

- Step 2. Evaluate existing data and conceptual model for evidence of natural attenuation

- Step 3. Develop numerical model(s)

- Step 4. Collect additional data specific to natural attenuation of explosives

- Step 5. Inform stakeholders and coordinate further evaluation

- Step 6. Refine the site conceptual and numerical models

- Step 7. Assess feasibility of monitored natural attenuation

- Step 8. Evaluate protectiveness of monitored natural attenuation for human health and the environment

- Step 9. Compare monitored natural attenuation to other alternatives using established evaluation criteria

- Step 10. Finalize long-term monitoring and contingency plans

A sample monitored natural attenuation protocol for energetic-contaminated sites has been developed by the U.S. Army (U.S. Army, September 1999). It has been published by SERDP and is available as Technical Report EL-99-10 from the U.S. Army Corps of Engineers, Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS, at http://www.wes.army.mil/el/elpubs/serdp.html.

Evaluation criteria developed by EPA for selection of corrective measures (Table 3-3) are also useful in the selection of remediation technologies.

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APPENDICES

APPENDIX A
CHECKLISTS

A.1 SUBPART X CHECKLIST
A.2 SUPPLEMENTAL OB/OD CHECKLIST

APPENDIX A.1

SUBPART X CHECKLIST

Checklist for Technical Review of RCRA Part B Permit Application for Subpart X Units I. PART A GENERAL INFORMATION REQUIREMENTS						
Item	Authority	Comments on Requirements	Location of Information in the Application	Addressed (Y/N)	Technically Adequate (Y/N)	See Attached Comment Number
SECTION I						
A. PART A GENERAL INFORMATION						
Description of activities conducted which require facility to obtain a permit under RCRA and brief description of nature of the business	40CFR270.13(a) and (m)					
Name, mailing address, and location of facility for which the application is submitted including a topographic map	40CFR270.13(b) and (l)					
Up to four Standard Industrial Classification (SIC) Codes which best reflect the products or services provided by the facility	40CFR270.13(c)					
Operator/owner's name, address, telephone number, and ownership status	40CFR270.13(d) and (e)	Ownership status must include status as federal, state, private, public, or other entity.				
Facility is new, existing, or located on Indian lands	40CFR270.13(f) and (g)	Also, description must include information on whether this is a first or revised application with date of last signed permit.				
Description of processes to be used for treating, storing, and disposing of hazardous waste	40CFR270.13(i)	Description must include the design capacity for these items.				
Specification of the hazardous wastes listed or designated under 40CFR261	40CFR270.13(j)	Specifications must include an estimate on the quantity of wastes to be treated, stored, or disposed.				
Listing of all permits or construction approvals received or applied for	40CFR270.13(k)	Permits include the following programs: Hazardous Waste Management under RCRA; UIC under Solid Waste Disposal Act (SWDA); Prevention of Significant Deterioration (PSD), Nonattainment Program, and National Emissions Standards for Hazardious Pollutants (NESHAPS) under the Clean Air Act (CAA); ocean dumping permits under the Marine Protection Research and Sanctuaries Act; dredge and fill permits under Section 404 of the Clean Water Act (CWA); or other relevant environmental permits including state permits.				

Checklist for Technical Review of RCRA Part B Permit Application for Subpart X Units II. PART B GENERAL INFORMATION REQUIREMENTS						
Item	**Authority**	**Comments on Requirements**	**Location of Information in the Application**	**Addressed (Y/N)**	**Technically Adequate (Y/N)**	**See Attached Comment Number**
SECTION II						
A. FACILITY DESCRIPTION						
A1. General Description	40CFR270.14(b)(1)					
Applicability of Part B to this facility	40CFR264.1					
Manages waste generated on-site and off-site						
Location						
Owner or operator's name						
Types of waste management activities conducted						
Type of treatment unit						
Engineering drawings						
Specification of all wastes that have been managed at the treatment unit						
Wind rose		The frequency of occurrence of various wind directions should be compared to sensitive (local and regional) receptor points downwind.				
General dimensions and structural description						
A2. Topographic Map	40CFR270.14(b)(19)	A distance of 1,000 feet around the unit at a scale of 1 inch to not more than 200 feet (multiple maps may be submitted at this scale) should be shown and should be similar to Part A topographic map.				
Scale and date		Other scales may be used if justified.				
The 100-year flood plain area						
Surface waters						
Surrounding land use						
Map orientation						
Legal boundaries						
Access control						
Injection and withdrawal wells (on-site and off-site)						
Buildings and other structures		See 40CFR270.14(b)(19)(x) for an example list.				
Drainage and flood control barriers						
Location of the treatment unit(s) and decontamination areas						
· Distance to property boundaries						
· Distance to buildings on- and off-site						

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Checklist for Technical Review of RCRA Part B Permit Application for Subpart X Units

II. PART B GENERAL INFORMATION REQUIREMENTS

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· Distance to public roadways						
· Distance to passenger railroads						
· Distance to closest receptor	40CFR270.23(e)	Receptors include human and environmental receptors within the facility boundary.				
Additional information on the topographic map	40CFR270.14(c)(3)					
· Uppermost aquifer and hydraulically connected aquifers beneath facility property	40CFR270.14(c)(2)					
· Ground water flow direction	40CFR270.14(c)(2)					
· Waste management areas	40CFR270.14(c)(3)					
· Property boundaries	40CFR270.14(c)(3)					
· Point of compliance location	40CFR270.14(c)(3)	Point of compliance is defined in 40CFR264.95; however, for open burning/open detonation (OB/OD) units, this will be determined on a case-by-case basis and may be at the unit boundary.				
· Location of ground water monitoring wells	40CFR270.14(c)(3)					
· Extent of any ground water contaminant plume	40CFR270.14(c)(4)(i)					
· Location of unsaturated zone monitoring	40CFR270.23(e)	If unit incorporates the soil as part of the zone of engineering control, the monitoring of this zone should be shown.				
A3. Description of Treatment Unit(s)	40CFR270.23(a)(2)	Includes detailed plans and engineering reports.				
· Location						
· Design						
· Operation						
· Maintenance						
· Monitoring						
· Inspection						
· Closure						
A4. Facility Location Information	40CFR270.14(b)(11) and 264.18					
A4a. Seismic Requirements	40CFR270.14(b)(11)(i), (ii) and 264.18(a)	Seismic requirements applicable only to new facilities.				
Political jurisdiction in which facility is proposed to be located	40CFR270.14(b)(11)(i)					
Indication of whether facility is listed in Appendix VI of 40CFR264 (new facilities)	40CFR270.14(b)(11)(i)					

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II. PART B GENERAL INFORMATION REQUIREMENTS

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New facility must be located at least 200 feet from a fault which has had displacement in Holocene time.	40CFR264.18(a) and 270.14(b)(11)(ii)	If facility location is listed in Appendix VI of 40CFR264, this information is required.				
A4b. Flood Plain Requirements	40CFR270.14(b)(11)(iii), (iv) and 264.18(b)					
Copy of Federal Insurance Association (FIA) or other flood map	40CFR270.14(b)(11)(iii)	The source to determine whether the facility is located in a 100-year flood plain should be indicated.				
Engineering analysis to indicate the various hydrodynamic and hydrostatic forces expected to result from the 100-year flood plain	40CFR270.14(b)(11)(iv) and 264.18(b)	Flood plain requirements applicable if facility is located in a 100-year flood plain.				
Demonstration that facility is designed, constructed, operated, and maintained to prevent washout, or detailed description of procedures to be followed to remove hazardous waste to safety before facility is flooded		Flood plain requirements applicable if facility is located in a 100-year flood plain.				
Demonstration that no adverse effects will result from failure to remove waste by providing:		Flood plain requirements applicable if facility is located in a 100-year flood plain.				
· Volume and physical and chemical characteristics of the waste in the facility		Flood plain requirements applicable if facility is located in a 100-year flood plain.				
· Concentration of hazardous constituents that would potentially affect surface waters as a result of washout		Flood plain requirements applicable if facility is located in a 100-year flood plain.				
· Impact of such concentration on current or potential uses of, and water quality standards established for, the affected surface waters		Flood plain requirements applicable if facility is located in a 100-year flood plain.				
· Impact of hazardous constituents on the sediments of affected surface waters, or the soils of the 100-year flood plain, that could result from washout		Flood plain requirements applicable if facility is located in a 100-year flood plain.				
Plans and schedule for future compliance	40CFR270.14(b)(11)(v)	Flood plain requirements applicable if facility is located in a 100-year flood plain and not in compliance with 40CFR264.816.				
A5. Traffic Patterns	40CFR270.14(b)(10)					
Estimate of number and types of vehicles around the facility						
Information about waste transfer or pick-up stations						
Quantity of waste moved per movement per vehicle						
Traffic control signs and persons						
Road surface composition and load-bearing capacity						

Checklist for Technical Review of RCRA Part B Permit Application for Subpart X Units II. PART B GENERAL INFORMATION REQUIREMENTS							
	Item	Authority	Comments on Requirements	Location of Information in the Application	Addressed (Y/N)	Technically Adequate (Y/N)	See Attached Comment Number
B.	**WASTE CHARACTERISTICS**						
B1.	**Physical and Chemical Characteristics of Wastes and Residues**	40CFR270.14(b)(2) and 264.13(a)	Data generated by testing the waste, published data on the hazardous waste, or data gathered from similar processes may be used.				
	Volume and composition of wastes	40CFR270.14(b)(2) and 264.13(a)					
	Wastes in containers	40CFR270.15					
	Wastes in tanks	40CFR270.16					
	Wastes in surface impoundments	40CFR270.17					
	Wastes in waste piles	40CFR270.18					
	Wastes in incinerators	40CFR270.19					
	Wastes in land treatment facilities	40CFR270.20					
	Wastes in landfills	40CFR270.21					
	Wastes in miscellaneous units	40CFR270.23					
	Wastes at facilities with process vents	40CFR270.24					
B2.	**Copy of the Waste Analysis Plan**	40CFR270.14(b)(3) and 264.13(b) and (c)					
	Parameters for which each hazardous waste will be analyzed	40CFR264.13(b)(1)					
	Rationale for parameters	40CFR264.13(b)(1)	The plan must discuss how analysis for these parameters will provide physical and chemical characteristics representative of the waste.				
	Methods used to test the parameters	40CFR264.13(b)(2)					
	Methods used to obtain representative samples of the waste being analyzed	40CFR264.13(b)(3) and 261 Appendix I	If a sampling method described in 40CFR261 Appendix I is not used, the facility must provide a detailed description of the proposed method and demonstrate its equivalency.				
	Frequency of revisions or repetition of analysis	40CFR264.13(b)(4)					
	Facilities managing wastes generated off-site	40CFR264.13(c)					
	· Copy of the waste analyses supplied by the waste generators	40CFR264.13(b)(5)					
	· Procedures used to inspect and analyze (if necessary) each shipment						
	· Procedures used to inspect each movement of hazardous waste received at the facility						

Checklist for Technical Review of RCRA Part B Permit Application for Subpart X Units II. PART B GENERAL INFORMATION REQUIREMENTS						
Item	**Authority**	**Comments on Requirements**	**Location of Information in the Application**	**Addressed (Y/N)**	**Technically Adequate (Y/N)**	**See Attached Comment Number**
· Methods of obtaining samples of the waste		If a sampling method described in 40CFR261 Appendix 1 is not used, the facility must provide a detailed description of the proposed method and demonstrate its equivalency.				
· For highly unstable wastes, a certification that the waste can be safely treated		Applicant must provide supporting data which demonstrate waste has potential to detonate or is bulk propellant.				
Additional waste analysis for demonstrating compliance with requirement of ignitable, reactive, or incompatible waste management (safe handling) methods	40CFR264.13(b)(6) and 264.17					
C. PROCEDURES TO PREVENT HAZARDS						
C1. Security Procedures and Equipment	40CFR270.14(b)(4) and 264.14					
Demonstration that unknown or unauthorized contact with waste is not harmful	40CFR264.14(a)(1)	This item required if requesting a waiver to the security procedures.				
Demonstration that disturbance of waste or equipment will not cause violation of 40CFR264	40CFR264.14(a)(2)	This item required if requesting a waiver to the security procedures.				
Description of a 24-hour surveillance system	40CFR264.14(b)(1)	Monitor/camera, guards, or personnel must continuously monitor or control access to active portions of the facility.				
Description of the artificial or natural barrier	40CFR264.14(b)(2)(i)	This item required if 24-hour surveillance system is not feasible.				
Method to control entry and number of personnel in the treatment area	40CFR264.14(b)(2)(ii)	This item equired if 24-hour surveillance system is not feasible.				
Sign posted at each entrance with legend "Danger - Unauthorized Personnel Keep Out"	40CFR264.14(c)					
C2. Inspection Schedule						
Copy of inspection schedule	40CFR270.14(b)(5) and 264.15	Inspection is required for monitoring equipment, safety emergency equipment, communication and alarm systems, decontamination equipment, security devices, and operating and structural equipment.				
Types of problems to be checked	40CFR264.15(b)(3)	Must provide checklist for each type of problem.				
Frequency of inspections of equipment and process	40CFR264.15(b)(4)					
Inspection record keeping	40CFR264.15(d)	An example log or summary must be provided.				
Schedule of remedial action	40CFR264.15(c)					
Daily inspection for leaks, spills, and fugitive emissions, and all emergency shutdown controls and system alarms	40CFR265.377(a)(3)	This must be provided as applicable for miscellaneous units (Subpart X units), thermal treatment units, and associated equipment.				
C3. Preparedness and Prevention	40CFR270.14(b)(6) and 264 (Subpart C)	The facility must submit justification of any waiver to the requirements of this section.				

Checklist for Technical Review of RCRA Part B Permit Application for Subpart X Units

II. PART B GENERAL INFORMATION REQUIREMENTS

	Item	Authority	Comments on Requirements	Location of Information in the Application	Addressed (Y/N)	Technically Adequate (Y/N)	See Attached Comment Number
	Description and location of internal communications and alarm system to instruct facility personnel	40CFR264.32(a)					
	Device (telephone, radio) to summon emergency assistance from outside the facility	40CFR264.32(b)					
	Access to communication or alarm control	40CFR264.34					
	Description of fire control, spill, and decontamination equipment	40CFR264.32(c)					
	Documentation of water volume and pressure required to operate equipment listed above	40CFR264.32(d)					
	Testing and maintenance schedule and procedures for the above mentioned equipment	40CFR264.33					
	Documentation of adequate aisle space	40CFR264.35	Aisle space is required for unobstructed movement of personnel, fire protection equipment, spill control equipment, and decontamination equipment in case of emergency.				
	Documentation of arrangements with:	40CFR264.37					
	· Police						
	· Fire Department						
	· Emergency Response Teams						
	· Local Hospitals						
C4.	**General Hazard Prevention**	40CFR270.14(b)(8)					
	Identification of possible loading and unloading hazards and documentation of steps taken to minimize or eliminate the possibility of these hazards	40CFR270.149(b)(8)(i)					
	Description of mechanisms to prevent runoff and flooding	40CFR270.14(b)(8)(ii)					
	Description of mechanisms to prevent contamination of water supplies	40CFR270.14(b)(8)(iii)					
	Identification of equipment failure and power outage hazards and description of procedures to mitigate effects of equipment failure and power outages	40CFR270.14(b)(8)(iv)					
	Personnel protection procedures	40CFR270.14(b)(8)(v)					
	Procedures to minimize releases to the atmosphere	40CFR270.14(b)(8)(vi)					
C5.	**Prevention of Accidental Ignition or Reaction of Wastes**	40CFR264.7(a) and 270.14(b)(9)					

Checklist for Technical Review of RCRA Part B Permit Application for Subpart X Units II. PART B GENERAL INFORMATION REQUIREMENTS							
	Item	Authority	Comments on Requirements	Location of Information in the Application	Addressed (Y/N)	Technically Adequate (Y/N)	See Attached Comment Number
	Description of procedures to prevent accidental ignition or reaction of wastes	40CFR264.17(a) and (b)	Waste must be protected from sources of ignition or reaction. Precautions must be taken to prevent reactions which generate toxic emissions, heat, or pressure, and cause explosions.				
	Documentation of adequacy of procedures	40CFR264.17(c)	Published literature, a trial test, waste analyses, or similar processes may be used.				
D.	**CONTINGENCY PLAN**						
D1.	**Copy of Contingency Plan**	40CFR270.14(b)(7)					
	Actions to take in case of emergency	40CFR264.52(a) and 264.56	The actions to be taken in response to any unplanned release of hazardous waste to air, soil, or surface water must be described.				
	Arrangements with local authorities	40CFR264.52(c)	Police and fire departments, hospitals, and emergency response teams must be notified.				
	Names, addresses, and phone numbers of emergency coordinators	40CFR264.52(d) and 264.55	There must at least be one primary emergency coordinator available at all times.				
	Location and description of emergency equipment at the facility	40CFR264.52(e)	It should include decontamination equipment and the capabilities of each item.				
	Evacuation plan for facility personnel	40CFR264.52(f)	Evacuation plans must include evacuation signals and primary and alternate evacuation routes.				
	Location and distribution of contingency plan	40CFR270.14(b)(7) and 264.53	A copy of the contingency plan must be maintained at the facility and submitted to local authorities.				
D2.	**Emergency Procedures**	40CFR264.56(a)					
	Immediate procedures for emergency coordinator to alert all facility personnel in case of emergency and notify state and local agencies if help is needed	40CFR264.56(a)					
	Plans for the emergency coordinator to identify the character, source, amount, and areal extent of any explosion, fire, or release	40CFR264.56(b)	Observation, records or manifest, or chemical analysis may be used by emergency coordinator.				
	Means for assessment of possible hazards to human health or the environment from an explosion, fire, or release	40CFR264.56(c)	Direct and indirect effects must be considered.				
	Procedures to be followed by emergency coordinator in case of a threat to human health or the environment outside the facility	40CFR264.56(d)	Local authorities and either EPA's on-scene coordinator or the National Response Center must be notified.				
	Procedures to be followed by emergency coordinator to prevent fires, explosion or release from occurring, recurring, or spreading to other hazardous wastes at the facility	40CFR264.56(e)					
	Storage, treatment, and disposal of released material	40CFR264.56(g)					

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Monitor for leaks, pressure buildup, gas generation or ruptures of released material	40CFR264.56(f)	This item applies if facility stops operations.				
Procedures for preventing handling of incompatible wastes until cleanup is complete	40CFR264.56(h)(1)					
Decontamination procedures	40CFR264.56(h)(2)	Decontamination is required for emergency equipment.				
Notification of EPA and state and local authorities before resuming operations	40CFR264.56(i)	EPA (or state) must be notified within 15 days of occurrence.				
Procedures for record keeping and reporting to EPA	40CFR264.56(j)					
E. PERSONNEL TRAINING						
Outline of both the introductory and continuing training programs	40CFR270.14(b)(12)	All facility personnel must be trained to perform their duties safely.				
A description of how training will be designed to meet actual job tasks	40CFR270.16(a),(b), and (c)	The training must be conducted by a qualified person; there must also be an annual review of the training.				
Training for emergency response	40CFR264.16(a)(3)	Personnel must be made familiar with emergency procedures, emergency equipment, and emergency systems.				
Maintenance of training records/copy of personnel training documents	40CFR264.16(d)(e) and 270.14(b)(12)	The owner or operator must maintain records of job titles, names of employees, job descriptions, and the types and amount of training given to each employee.				
· Training content, frequency, and techniques		Training must also be applicable to site conditions.				
· Training director is properly trained						
F. CLOSURE AND POST-CLOSURE PLAN						
F1. Closure Plan Documentation	40CFR270.14(b)(13)					
Description of partial or final closure procedures	40CFR264.112(b)(1) and (2)	Final closure must minimize the need for further maintenance and must control post-closure release to ground water, surface water, soil, and the atmosphere.				
Description of maximum unclosed portion during the active life of the facility	40CFR264.112(b)(2)					
Estimate of maximum waste inventory in storage and treatment during facility life	40CFR264.112(b)(3)					
Description of procedures for removal or decontamination of hazardous waste residues, equipment, structures, and soils	40CFR264.112(b)(4) and 264.114					
· Location of disposal facility (equipment, structures, and soils when removed)						
· Methods for sampling and testing surrounding soils						
· Criteria for determining decontamination levels						

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	Item	Authority	Comments on Requirements	Location of Information in the Application	Addressed (Y/N)	Technically Adequate (Y/N)	See Attached Comment Number
	Description of additional activities performed during closure:	40CFR264.112(b)(5)					
	· Ground water monitoring						
	· Leachate collection						
	· Run-on and run-off control						
	Description of closure schedule including:	40CFR264.112(b)(6) and 264.113					
	· Total time to close each unit		The hazardous waste must be treated, removed, or disposed of within 90 days after receiving the final volume of waste; all closure activities must be completed within 180 days after receiving the final volume of waste.				
	· Timetable of closure activities						
	Estimate of year of closure	40CFR264.112(b)(7)	Estimate of year of closure is required for those facilities that use trust funds to establish financial assurance and are expected to close before expiration of the permit.				
	Extension of closure time	40CFR264.113(a) and (b)	Justification is required if extension is expected to exceed 90 days for treatment, removal, and disposal of wastes and 180 days for completion of closure activities.				
F2.	**Copy of Post-Closure Plan**	40CFR264.117, 264.118, and 264.603	Post-closure plan is expected when the OB/OD unit incorporates the soil as part of the zone of engineering control, unless clean closure is to be attained.				
	Post-closure care mechanisms	40CFR264.603	This includes procedures to prevent any releases that have adversely affected human health or the environment due to migration of wastes in the ground water, surface water, wetlands, soils or air.				
	Description of maintenance, monitoring, inspection, and frequencies for:	40CFR264.118(b)(1) and (2)					
	· Waste-fabricated structures						
	· Facility monitoring equipment						
	Identification and location of person responsible for storage and for updating facility copy of post-closure plan during post-closure period	40CFR264.118(b)(3)					
	Procedure for updating all other copies of post-closure plan	40CFR264.118(b)(2)	A procedure is required to cover changes in operating plans, facility design, expected years to closure, or other events.				
F3.	**Copy of Most Recent Closure and Post-Closure (if applicable) Cost Estimates**	40CFR264.142, 264.144, and 270.14(b) (15) and (16)	Cost estimates must be detailed and assume the hiring of a third party to conduct closure and post-closure care.				
F4.	**Copy of Documents Used as Financial Assurance Mechanisms**	40CFR264.143, 264.145, and 264.146	For new facilities, the documentation may be substituted up to 60 days before initial receipt of hazardous waste.				
	Financial assurance document for closure						

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Adequacy of document						
Copy of document						
F5. Documentation of Notice of Deed	40CFR270.14(b)(14) and 264.119	This notice applies to a closed unit.				
F6. Copy of Insurance Policy	40CFR264.147					
Coverage for sudden accidental occurrences	40CFR264.147(a)	Liability coverage of $1 million per occurrence and $2 million for annual aggregate is required.				
Coverage for nonsudden accidental occurrences	40CFR264.147(b)	Liability coverage of $3 million per occurrence and $6 million for annual aggregate is required.				
G. PROTECTION OF GROUND WATER						
Unit is a regulated unit	40CFR270.14(c), 270.23(b), and 264.90(a)(2)	Protection of ground water must be addressed only for regulated units.				
Existing ground water monitoring data	40CFR270.14(c)(1) and 270.23					
Identification of upper-most aquifer and aquifers hydraulically interconnected beneath the facility property	40CFR270.14(c)(2) and 270.23					
Ground water flow, direction, rate, and source of information	40CFR270.14(c)(2) and 270.23					
Description of any plume of contamination that has entered the ground water from a regulated unit	40CFR270.14(c)(4) and 270.23					
· Indication of the extent of the plumes on the topographic map	40CFR270.14(c)(4)(i), 264.600, and 270.23					
· Concentration of pollutants in the plume	40CFR270.14(c)(4)(ii)	The description must identify constituents of 40CFR264 Appendix IX, waste open burned or detonated, and potential compounds formed in OB/OD.				
Proposed ground water monitoring program	40CFR270.14(c)(5), 264.97, 264.600, and 270.23					
· Description of well design and location	40CFR264.97, 264.600, and 270.23	The description should include discussion or inspection of well to withstand OB/OD or other activities.				
· Sample collection	40CFR264.97(d)(1), 264.600, and 270.23					
· Sample preservation and shipment	40CFR264.97(d)(2), 264.600, and 270.23					

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· Sampling and analysis procedures	40CFR264.97(d)(3), 264.600, and 270.23					
· Determination of the ground water surface elevation each time ground water is sampled	40CFR270.23(e)					
· Vadose zone monitoring	40CFR270.23(e) and 270.32(b)(2)					
· Field measurements	40CFR270.23(e)					
- Water level						
- pH						
· Well evacuation	40CFR270.23(e)					
· Sample preparation	40CFR270.23(e)					
· Analytical procedures	40CFR270.23(e)					
· QA/QC procedures	40CFR270.23(e)					
· Data evaluation and reporting	40CFR270.23(e)					
· Chain-of-custody control	40CFR264.97(d)(4), 264.600, and 270.23					
Detection monitoring program information:	40CFR270.14(c)(6), 264.98, 264.600, and 270.23	This applies when hazardous constituents have not been detected in the ground water at the time of permit application.				
· Indicator parameters	40CFR270.14(c)(6)(i), 264.98(a)(i), 264.600, and 270.23	This can include waste constituents.				
· Hazardous constituents	40CFR270.14(c)(6)(i), 264.600, and 270.23					
· A proposed ground water monitoring system	40CFR270.14(c)(6)(ii), 264.600, and 270.23					
· Background values for each proposed monitoring parameter or constituent	40CFR270.14(c)(6)(iii), 264.600, and 270.23					
· Description of proposed sampling, analysis, and statistical comparison procedures	40CFR270.14(c)(4)(iv), 264.600, and 270.23					
Record keeping of ground water analytical data	40CFR264.98(c) and (g)					
Compliance monitoring program	40CFR270.14(c)(7) and 264.94	This applies when hazardous constituents have been detected in the ground water at the point of compliance.				
· Description of wastes previously handled at the facility	40CFR270.14(c)(7)(i)					

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· Characterization of ground water	40CFR270.14(c)(7)(ii)	Any hazardous constituents should be included.				
· Use of Ground Water Information Tracking System (GRITS) or other system	40CFR270.32(b)(2) and 270.23(e)					
· List of hazardous constituents for which compliance monitoring will take place	40CFR270.14(c)(7)(iii)					
· Proposed concentration limits for each hazardous constituent	40CFR270.14(c)(7)(iv)					
· Detailed plans and an engineering report describing the proposed ground water monitoring system	40CFR270.14(c)(7)(v)					
· Description of proposed sampling, analysis, and statistical comparison procedures	40CFR270.14(c)(7)(vi)					
· Ground water flow rate and direction reported annually	40CFR264.99(e)					
· Reporting when concentration limits exceeded	40CFR264.99(h) and (i)					
Corrective action program or data showing that the existing levels are not harmful	40CFR270.14(c)(8)	When level of contaminants exceeds background level or the limits established under 40CFR264.94 Table 1, the facility may present data demonstrating that the levels are not harmful in place of a corrective action program.				
· Characterization of the contaminated ground water	40CFR270.14(c)(8)(i)					
· Concentration limit for each hazardous constituent	40CFR270.14(c)(8)(ii)					
Detailed plans and engineering report describing the corrective action to be implemented	40CFR270.14(c)(8)(iii)	A schedule for submitting this information may be presented.				
Description of use of the ground water monitoring program to demonstrate the adequacy of the corrective action	40CFR270.14(c)(8)(iv), 270.14(d), and 264.101	A schedule for submitting this information may be presented.				
H. PROTECTION OF SURFACE WATER						
Prevention of migration of wastes to surface water	40CFR264.601(b)	Location of surface waters must be depicted on a topographic map.				
I. OTHER APPLICABLE REGULATIONS						
Unit is classified as a "miscellaneous unit"	40CFR264.600	To address miscellaneous units, see Section III.				
Unit is classified as a process vent	40CFR264.1030	To address process vents, see Section IV.				
Unit is subject to equipment leaks	40CFR264.1050	To address equipment leaks, see Section V.				

Checklist for Technical Review of RCRA Part B Permit Application for Subpart X Units

III. SPECIFIC INFORMATION REQUIREMENTS FOR MISCELLANEOUS UNITS (SUBPART X)

Item	Authority	Comments on Requirements	Location of Information in the Application	Addressed (Y/N)	Technically Adequate (Y/N)	See Attached Comment Number
SECTION III						
A. PROCESS INFORMATION						
Applicability as a "miscellaneous unit"	40CFR264.600 and 270.23 56FR720002(2/21/91) and 52FR469252(12/10/87)	The Subpart X regulations cover "miscellaneous" units. Among these units are OB/OD units for propellants, explosives, and pytrotechniques (PEP), geologic repositories and thermal treatment units such as microwave destruction.				
A1. Open Burning (OB) in Containment Devices Where Unit Incorporates Soil as Part of the Unit	40CFR270.23 and 270.32					
Appropriateness of treatment methods	40CFR270.32(b)	The applicant must demonstrate that the treatment technology is protective of public health and various environmental media, in addition to being safe for the waste handler.				
Containment device description	40CFR270.23(a)	Dimensions, construction materials, and controls must be described.				
· Physical characteristics, construction materials, and dimensions of the unit	40CFR270.23(a)(1)					
· Engineering drawings of the fabricated device	40CFR270.23(a)(2)	Drawings must be provided to determine design specifications and dimensions.				
· Lining material within device	40CFR270.23(a)(1) and (2)	Construction materials and applicable physical properties must be described.				
· Lining material below device	40CFR270.23(a)(1) and (2)	Dimensions, type of material, applicable physical properties, and depth below the fabricated device must be described.				
Leak detection provisions	40CFR270.23(a)(1) and (2)	Items and equipment used, functions, types of materials, dimensions, and physical properties must be described.				
Precipitation cover	40CFR270.23(a)(1) and (2)	For nonoperational periods, dimensions, construction materials, physical properties, and method of covering device must be described.				
Control of releases of ashes and residues during OB (integrity of containment devices)	40CFR270.23(a)(1) and (2)	Control must be by preventing releases or collecting the ashes and residues.				
Methods to control deterioration of fabricated devices	40CFR270.23(a)(1) and (2)	When organic compounds are present in the waste, the device must be located above ground with secondary containment below the device.				
Prevention of accumulation of precipitation	40CFR270.23(a)(1) and (2)	Precipitation can cause releases of ashes or waste or prevent complete thermal treatment of wastes. The type of cover must be indicated.				
Handling of precipitation accumulated in fabricated devices	40CFR270.23(a)(1) and (2)	Treatment and disposal must be described.				
Controls to prevent wind dispersion of ash and other residue	40CFR270.23(a)(1) and (2)	Controls during and between burns must be described.				
Inspection, monitoring, and maintenance plan	40CFR270.23(a)(2)	A schedule should be included.				
Ash and residue management	40CFR270.23(a)(2)	Treatment and disposal must be described.				
Copy of standard operating procedures (SOPs)	40CFR270.23(a)(2)					46

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III. SPECIFIC INFORMATION REQUIREMENTS FOR MISCELLANEOUS UNITS (SUBPART X)

Item	Authority	Comments on Requirements	Location of Information in the Application	Addressed (Y/N)	Technically Adequate (Y/N)	See Attached Comment Number
A2. OB on the Ground Surface Where Unit Incorporates the Soil as Part of the Unit	40CFR270.23 and 270.32	Acceptance of this method must be evaluated on case-by-case basis.				18
Appropriateness of treatment technology	40CFR270.32(b)	The applicant must demonstrate that the treatment technology is protective of public health and various environmental media, in addition to being safe for the waste handler.				18
Description of OB unit	40CFR270.23(a)	A brief overview must be provided.				18
· Physical characteristics, construction materials, and dimensions of the unit	40CFR270.23(a)(1)					18
· Engineering drawings of the OB unit	40CFR270.23(a)(2)	To determine design specifications and dimensions, the drawings must indicate how the boundaries of the OB unit are marked.				18
· Pad description (if any)	40CFR270.23(a)(2)	Material, dimensions, compatibility with wastes, slope (if any), and permeability must be provided.				18
· Lining material (if any)	40CFR270.23(a)(2)	The grade just below the pad should be able to withstand OB.				18
Precipitation cover for nonoperational periods	40CFR270.23(a)(2)	Dimensions, construction materials, applicable physical properties, and method of covering the device must be described.				18
Measures to minimize subsurface contamination	40CFR270.23(a)(2)	Use of underground liner may be limited because accidental detonations may damage the liner.				18
Prevention of accumulation of precipitation	40CFR270.23(a)(2)	Precipitation can cause releases of ashes or waste or prevent complete thermal treatment of the wastes. The type of cover must be indicated.				18
Inspection, monitoring, and maintenance plan	40CFR270.23(a)(2)	A schedule should be included.				18
Copy of SOPs	40CFR270.23(a)(2)					18
A3. Open Detonation (OD)	40CFR270.23 and 270.32					
Appropriateness of treatment technology	40CFR270.32(b)	The applicant must demonstrate that the treatment technology is protective of public health and various environmental media, in addition to being safe for the waste handler.				
Description of OD Unit	40CFR270.23(a)					
· Physical characteristics, materials of construction, and dimensions of the unit	40CFR270.23(a)(1)					
· Engineering plan and drawings of the OD unit	40CFR270.23(a)(2)	To determine design specifications and dimensions, the drawings must indicate how the edges of the OD unit are marked.				
Inspection, monitoring, and maintenance plan	40CFR270.23(a)(2)	The schedule should be included.				
Ash and residue management	40CFR270.23(a)(2)	Although little or no ash is generated in OD units, provisions should be made to demonstrate that soils and surface water have not been contaminated (such as soil and surface water sampling from designated areas and depths at required frequencies).				

Checklist for Technical Review of RCRA Part B Permit Application for Subpart X Units						
III. SPECIFIC INFORMATION REQUIREMENTS FOR MISCELLANEOUS UNITS (SUBPART X)						
Item	**Authority**	**Comments on Requirements**	**Location of Information in the Application**	**Addressed (Y/N)**	**Technically Adequate (Y/N)**	**See Attached Comment Number**
Run-on and run-off management	40CFR270.23(a)(2)	Devices and equipment (berms, ditches, collection systems), dimensions, and other applicable physical properties are not of major concern for OD units because little or no ash is generated.				23
Copy of SOP	40CFR270.23(a)(2)					46
A4. Geologic Repositories - placement of containerized hazardous waste or bulk nonliquid hazardous waste in geologic repositories such as underground salt formations, mines, or caves	52FR46952(12/10/87)	Description of unit must be included.				19
A5. Deactivated Missile Silos	52FR46952(12/10/87)	This does not include underground injection wells or other units currently covered in 40CFR264.				19
A6. Certain Thermal Treatment Units other than incinerators such as:	56FR720002(2/21/91) and 57FR546952(12/10/87)					19
· Molten salt pyrolysis	52FR46952(12/10/87)	Description of unit must be included.				19
· Calcination	52FR46952(12/10/87)	Description of unit must be included.				19
· Wet-air oxidation	52FR46952(12/10/87)	Description of unit must be included.				19
· Microwave destruction	52FR46952(12/10/87)	Description of unit must be included.				19
· Carbon regeneration	56FR720001(2/21/91)	Description of unit must be included.				19
· Sludge dryers	56FR720102(2/21/91)	Sludge dryer refers to any enclosed thermal treatment device used to dehydrate sludge and that has a maximum thermal input of 1,500 British Thermal Units per pound (Btu/lb) sludge treated on a wet-weight basis. A description of unit should be included.				19
Future additions as needed.						
A7. Certain Chemical, Physical, and Biological Treatment Units.	52FR46952(12/10/87)	This does not cover treatment in tanks, surface impoundments, and land treatment units. Description of unit should be included.				19
B. ENVIRONMENTAL PERFORMANCE STANDARDS						
B1. Quantity and Physical and Chemical Characteristics of the Waste and Products of Combustion.	40CFR264.601(a)(1), (b)(1), and 270.23	Provide chemical properties pertinent to the compounds in wastes and potential compounds formed during OB/OD and their behavior in soil, ground water, or surface water.				20
EPA waste code	40CFR270.23(e)					
Amount burned at the unit	40CFR264.601(a)(1) and 270.23	This amount indicates the maximum amount of wastes that could migrate to the ground water.				

Checklist for Technical Review of RCRA Part B Permit Application for Subpart X Units

III. SPECIFIC INFORMATION REQUIREMENTS FOR MISCELLANEOUS UNITS (SUBPART X)

Item	Authority	Comments on Requirements	Location of Information in the Application	Addressed (Y/N)	Technically Adequate (Y/N)	See Attached Comment Number
Waste composition data	40CFR264.601(a)(1) and 270.23	These data should be briefly presented in this section again.				
Solubility in water	40CFR264.601(a)(1) and 270.23	Solubility should be provided for each compound.				47
Mobility in soil	40CFR264.601(a)(1) and 270.23	Mobility in soil should be provided for each compound.				47
Physical state and molecular properties	40CFR264.601(a)(1) and 270.23	Physical state and molecular properties should be provided for each compound.				47
Mobility in ground water	40CFR264.601(a)(1) and 270.23	Mobility in ground water should be provided for each compound.				47
Sorption properties of waste material relative to environmental media	40CFR264.601(a)(1) and 270.23					47
Biodegradability, bioconcentration, and biotransformation relative to environmental media	40CFR264.601(a)(1) and 270.23					47
Photodegradation rates of waste	40CFR264.601(a)(1) and 270.23					47
B2. Hydrogeological Characteristics of the Site	40CFR270.23(b), 264.601(a)(2), and (b)(3)					22
Depth to water beneath the unit	40CFR264.601(a)(2) and 270.23(b)	This information should be obtained from boring logs associated with the process of identifying the uppermost aquifer. The source of this information should be referenced.				22
Estimate of net recharge rate	40CFR264.601(a)(2) and 270.23(b)	Net recharge = (precipitation + runon) - (evapotranspiration + runoff)				22
Description of uppermost aquifer	40CFR264.601(a)(2) and 270.23(b)					22
Description of soil types and depth range of each soil	40CFR264.601(a)(2) and 270.23(b)	Between the ground surface and the water table.				22
Topography of the unit area	40CFR264.601(a)(2) and 270.23(b)	A brief description and maps showing natural surface drainage basins and storm water collection systems for the area affected by the operation should be provided.				
B3. Protection of Ground Water and Subsurface Environment	40CFR264.601(a) and 270.23(b)(c)	Applicant must conduct an assessment of the potential for a release to ground water or subsurface environment.				
Potential for migration through soil, liners, and containing structures	40CFR264.601(a)(1)					23
Ground water quality and all possible sources of contamination	40CFR264.601(a)(3)	To determine whether a particular contaminant is introduced by the OB/OD unit and evaluate the cumulative effect on ground water				24

Checklist for Technical Review of RCRA Part B Permit Application for Subpart X Units

III. SPECIFIC INFORMATION REQUIREMENTS FOR MISCELLANEOUS UNITS (SUBPART X)

Item	Authority	Comments on Requirements	Location of Information in the Application	Addressed (Y/N)	Technically Adequate (Y/N)	See Attached Comment Number
Ground water flow and rate	40CFR264.601(a)(4) and (b)(5)	To determine direction and rate of plume migration in case of ground water contamination				24
Proximity to and withdrawal rates of current and potential ground water users	40CFR264.601(a)(5)	The 1,000-foot radius of the unit is useful in determining need for and level of cleanup in case of ground water contamination.				
Potential for damaging unsaturated zone	40CFR264.601(b)(8)					25
Land use patterns in the area	40CFR264.601(a)(6) and (b)(9)					26
Potential for deposition or migration of waste constituents into subsurface physical structures, and into root zone of food chain crops and other vegetation	40CFR264.601(a)(7)					
Effects of explosion on geologic units and ground water flow under the unit	40CFR270.23(e), 264.601(a)(1), and (b)(2)					27
Potential impacts on human health	40CFR264.601(a)(8) and (b)(10)	When the uppermost aquifer is used as a drinking water supply, a risk evaluation should be developed. Potency factors by hazardous constituent should be used to determine risks.				
Potential for damage to flora, fauna, and physical structures due to exposure	40CFR264.601(a)(9) and (b)(11)					
B4. Protection of Surface Water, Wetlands, and Soil Surface	40CFR264.601(b), 270.23 (b), and (c)					
Effectiveness and reliability of containing, confining, and collecting systems and structures in preventing migration	40CFR264.601(b)(2)					
Precipitation patterns in the area	40CFR264.601(b)(4)					
Proximity of the units to surface waters	40CFR264.601(b)(6)					
Water and surface soil quality standards, quality data, and uses	40CFR264.601(b)(7)(8)	If operation does not affect surface waters, this item does not apply. Otherwise, actual uses of surface waters (including seasonal uses) should be discussed.				28
C. AIR QUALITY ASSESSMENTS						
C1. Volume and Physical and Chemical Characteristics of the Waste in the Unit	40CFR270.23(b) and 264.601(c)(1)	Emissions from evaporation or reaction processes should be evaluated for potential dispersal of gases, aerosols, and particulates. The emissions may be determined by direct measurement or by using emission factors. Emission factors for all suspected hazardous air pollutants and compounds formed in OB/OD should be determined.				
C2. Effectiveness and Reliability of Systems and Structures to Reduce or Prevent Emissions	40CFR264.601(c)(2) and 270.23(d)	Emissions during preburn phase should be zero.				
C3. Operating Conditions of the Unit (Case by Case)	40CFR264.601(c)(3)	The following operating conditions should be addressed: allowable quantities of waste per unit, operating time frames, ambient air monitoring requirements, acceptable meteorological conditions, meteorological requirements, and meteorological monitoring.				29

Checklist for Technical Review of RCRA Part B Permit Application for Subpart X Units

III. SPECIFIC INFORMATION REQUIREMENTS FOR MISCELLANEOUS UNITS (SUBPART X)

Item	Authority	Comments on Requirements	Location of Information in the Application	Addressed (Y/N)	Technically Adequate (Y/N)	See Attached Comment Number
C4. Atmospheric, Meteorological, and Topographic Characteristics of the Unit and Surrounding Areas	40CFR264.601(c)(4)	The mechanisms for using meteorological data to understand and manage air emissions should be specified.				
Frequency of inversions	40CFR264.601(c)(4)					
Lake and pond evaporation	40CFR264.601(c)(4)					
Annual and 24-hour rainfall data	40CFR264.601(c)(4)					
Seasonal temperatures	40CFR264.601(c)(4)					
Relative humidity	40CFR264.601(c)(4)	Relative humidity should be considered in terms of possible formation of harmful chemicals from the combustion products.				
Wind rose	40CFR264.601(c)(4)	Restriction should be applied when the direction is not appropriate for release emissions.				
C5. Existing Air Quality (Toxic Pollutants) and Other Sources of Contamination	40CFR264.601(c)(5)	Applicant must determine general ambient air quality conditions prior to releases. If not available, such data should be generated. Applicant must use EPA-approved air monitoring methods to provide data.				
C6. Potential Impacts to Human Health and the Environment	40CFR264.601(c)(6)	These impacts should be evaluated for the entire treatment process through modeling or emissions monitoring of hazardous constituents.				
C6a. Screening Assessment	40CFR264.601(c) and 264.602					
Types and quantities of wastes	40CFR264.601(c)(1)					
Number of fabricated devices, burn areas, or detonation pits involved in a burn or detonation event and the number of events per day	40CFR264.601(c)(3)					30
Total amounts of each pollutant emitted per event and the total combined amounts of pollutants emitted per year	40CFR264.601(c)(1)	The models and calculations used to determine the emission factors should be clearly identified. Emission factors for all suspected hazardous air pollutants should be determined. Units of measure should be presented in mass of pollutant emitted per mass of material burned.				31
Duration of release (from a few seconds to a few hours)	40CFR264.601(c)(3)					
Description of emissions (plume) to the atmosphere	40CFR264.601(c)(1)					
· Release height	40CFR264.601(c)(1)	For burns and detonations conducted on the ground surface, the release height will be 0 meters.				45
· Temperature	40CFR264.601(c)(1)	Typical values are around 6,700 degrees Fahrenheit (°F) for open burning. No detonation temperatures are given.				
Downwind concentrations of each known or suspected hazardous waste constituent emitted, including carcinogenic compounds	40CFR264.601(c)(1)	Air monitoring or an EPA-approved dispersion model can be used. The selection of the model will be a function of the geometry of the treatment unit, duration of the release, and local topography. Specific models used by the applicant must be evaluated and approved by EPA.				

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III. SPECIFIC INFORMATION REQUIREMENTS FOR MISCELLANEOUS UNITS (SUBPART X)						
Item	**Authority**	**Comments on Requirements**	**Location of Information in the Application**	**Addressed (Y/N)**	**Technically Adequate (Y/N)**	**See Attached Comment Number**
Compare concentrations with existing toxic air pollution standards	40CFR264.601(c)(1)	EPA Superfund guidance should be used for assessing the air pathway utilizing IRIS data.				
Risk analysis	40CFR264.601(c)(6)	EPA's Risk Assessment Guidance should be used for Superfund and RCRA Facility Investigation (RFI) documents.				32
· Urban or rural area	40CFR264.601(c)(6)					32
· Population density	40CFR264.601(c)(6)	The location of the facility in a densely or sparsely populated area should be described.				32
· Land use in nearby areas	40CFR264.601(c)(6)	Land use should be identified as residential, industrial, agricultural, or others.				32
· Sensitive receptors within a 69-kilometer (km) radius	40CFR264.601(c)(6)	This includes schools or hospitals.				32
· Estimate of number of exposed individuals	40CFR264.601(c)(6)	Estimate should include individuals living and working on the premises.				32
· Calculation of lifetime cancer risk	40CFR264.601(c)(6)	This is a function of downwind concentrations, unit risk value, and exposure duration. EPA's guidance documents (Superfund and RFI) should be used for the risk assessment. This result will determine whether a more detailed risk assessment is required.				32
C6b. Detailed Assessment	40CFR264.601(c)(6)					33
The following general parameters should be considered:	40CFR264.601(c)(6)					33
· EPA approved dispersion model should be used	40CFR264.601(c)(6)	Sufficient meteorological data (3 to 5 years) should be used to verify that worst-case meteorological conditions are addressed.				33
· Detailed network of receptor points	40CFR264.601(c)(6)	This is necessary to permit the estimation and identification of receptor points that are exposed to maximum concentrations.				33
· Detailed estimate of exposed population	40CFR264.601(c)(6)	Permit writers must consult with the regional EPA toxicologist for risk assessment issues.				33
· Noninhalation pathways (ingestion and dermal contact) must be addressed	40CFR264.601(c)(6)	Appropriate pathway exposure models for direct and indirect exposure should be used. The regional EPA toxicologist should be consulted.				33
· Estimate of individual excess lifetime cancer risk	40CFR264.601(c)(6)	This value is the sum of the excess cancer risk due to the inhalation of airborne carcinogens and the excess risk due to exposure from other paths (ingestion and dermal absorption).				33
C7. Potential Damage to Domestic Animals, Wildlife, Crops, Vegetation, and Physical Structures	40CFR264.601(c)(7)					34
D. POTENTIAL PATHWAYS OF EXPOSURE AND POTENTIAL EXPOSURE MAGNITUDE						
Potential for the public to be exposed to hazardous wastes	40CFR270.23(c)					35

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III. SPECIFIC INFORMATION REQUIREMENTS FOR MISCELLANEOUS UNITS (SUBPART X)

Item	Authority	Comments on Requirements	Location of Information in the Application	Addressed (Y/N)	Technically Adequate (Y/N)	See Attached Comment Number
Amount of time the waste will remain in the unit before it is detonated or burned	40CFR270.23(c)					36
Expected time to complete burning	40CFR270.23(c)					36
Protection or shelter for personnel during burning or detonation	40CFR270.23(c)	Description of personal protection equipment (PPE) should be included.				37
Meteorological conditions under which burning or detonation will be permitted or restricted	40CFR270.23(c)					37
Length of time after operation of the unit before reentry of personnel to the burning ground or detonation site is allowed	40CFR270.23(c)					37
D1. Potential Human and Environmental Receptors	40CFR270.23(c)	Based on current and future land use, including both short-term and long-term exposure receptors, receptors of indirect exposure, such as consumers of fish and agricultural products from the site area, must be considered.				
Locations of receptors relative to the site	40CFR270.23(c)					
Sensitive populations	40CFR270.23(c)	Include subpopulations such as children, elderly people, and endangered species, that are at increased risk.				
D2. Potential Exposure Pathways	40CFR270.23(c)	Use Risk Assessment Guidance for Superfund and RFI.				38
Release sources, characteristics, quantities, and duration	40CFR270.23(c)	Releases can occur from the waste itself, from contaminated soil and water, or from the compounds formed in OB/OD.				38
Release mechanisms	40CFR270.23(c)	Volatilization, fugitive dust, particulate emissions, surface runoff, leaching, and tracking are common mechanisms.				38
Receiving media	40CFR270.23(c)	Media include air, surface water, ground water, soil, sediment, and biota.				38
Fate and transport in receiving media	40CFR270.23(c)	Fate and transport include physical transport (convection), physical transformation (volatilization, precipitation), chemical transformation (photolysis, oxidation), biological transformation (biodegradation) and accumulation.				38
Exposure points	40CFR270.23(c)	Any point, both on-site and off-site, where any of the potential human and environmental receptors can contact the receiving media is considered an exposure point.				38
Probable exposure routes	40CFR270.23(c)					38
Wetting of the burning area	40CFR270.23(c)	If wetting area is required by operating procedures, descriptions of methods used in process and methods to minimize release of hazardous wastes or constituents should be included.				39
D3. Potential Magnitude and Nature of Exposure	40CFR270.23(c)					
Exposure concentrations	40CFR270.23(c)	Arithmetic average of concentration that is contacted over the exposure period at exposure points in air, surface water, ground water, soil, sediment, and biota is sufficient.				
Total risk	40CFR264.601 and 270.23(c)					40

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III. SPECIFIC INFORMATION REQUIREMENTS FOR MISCELLANEOUS UNITS (SUBPART X)

Item	Authority	Comments on Requirements	Location of Information in the Application	Addressed (Y/N)	Technically Adequate (Y/N)	See Attached Comment Number
E. EFFECTIVENESS OF THE TREATMENT						
Report demonstrating the effectiveness with supporting lab or field data	40CFR270.23(d)					
F. ADDITIONAL INFORMATION						
F1. Noise Considerations	40CFR264.601 and 270.23(e)	Protection of human health and the environment primarily related to OD units is the primary concern.				
Distance of the OB/OD unit, or area, from off-plant inhabited buildings	40CFR265.382					
Wind direction	40CFR264.601 and 270.23(e)	Noise will be carried in the direction of the wind.				
Airblast	40CFR264.601 and 270.23(e)	See 30CFR816.67(b)(69).				
· Airblast maximum levels	40CFR264.601 and 270.23(e)	The use of explosives and control of adverse effects are covered by 30CFR816.67(b)(1). It presents a table of the maximum acceptable levels of decibels (dB). Also see 30CFR816.67(b)(69).				
· Monitoring of airblast effects at several receptors	40CFR264.601 and 270.23(e)	See 30CFR816.67(b)(69).				
· Type, sensitivity, and capability of blast-monitoring equipment	40CFR264.601 and 270.23(e)					
· Procedure	40CFR264.601 and 270.23(e)					
· Map showing monitoring receptors	40CFR264.601 and 270.23(e)					
· Range of sizes of explosive charges in the monitoring data	40CFR264.601 and 270.23(e)					
· Atmospheric conditions during the monitoring	40CFR264.601 and 270.23(e)					
Ground vibration	40CFR264.601, 270.23(e), and 30CFR816.67(d)(69)	Three methods of compliance are presented in 30CFR816.67(d)(69) with maximum acceptable levels of ground vibration: (1) maximum peak-particle-velocity limits; (2) scaled-distance equation; and (3) blasting level chart.				
· Specific maximum ground vibration	40CFR264.601 and 270.23(e)					
· Method of determination of ground vibration	40CFR264.601 and 270.23(e)					
Manner of placing the waste in the unit	40CFR264.601 and 270.23(e)					
· Use of supplemental fuels, type, amount, and manner of placing them in the waste	40CFR264.601 and 270.23(e)					

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III. SPECIFIC INFORMATION REQUIREMENTS FOR MISCELLANEOUS UNITS (SUBPART X)						
Item	**Authority**	**Comments on Requirements**	**Location of Information in the Application**	**Addressed (Y/N)**	**Technically Adequate (Y/N)**	**See Attached Comment Number**
Minimum protective distances	40CFR265.382 and 270.23(e)	Minimum distances to the property of others are: Quantity of Explosive Distance 1. 0 to 100 lb - 670 ft 2. 101 to 1,000 lb - 1,250 ft 3. 1,001 to 10,000 lb -1,730 ft 4. 10,000 to 30,000 lb - 2,260 ft or other distances as demonstrated to protect human health and the environment.				

Note: Miscellaneous general guidance documents such as:

- Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual - Part A
- RCRA Guidance Manual for Permitting Commercial Explosive Industry Open Burning/Open Detonator Units, 1989

may also be used for guidance purposes only.

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IV. SPECIFIC INFORMATION REQUIREMENTS FOR PROCESS VENTS (SUBPART AA)

Item	Authority	Comments on Requirements	Location of Information in the Application	Addressed (Y/N)	Technically Adequate (Y/N)	See Attached Comment Number
SECTION IV						
A. GENERAL DEFINITION OF PROCESS VENTS						
Description of process vent	40CFR264.1030 and 264.1031	A process vent is any open-ended pipe or stack that is vented to the atmosphere either directly, through a vacuum-producing system, or through a tank.				
B. OPERATIONS ASSOCIATED WITH PROCESS VENTS						
Applicability - operations that manage hazardous waste with organic concentrations of at least 10 parts per million by weight (ppmw)	40CFR264.1030(b) and 264.1031	Concentrations should be determined by a time-weighted average annually or when waste or process changes.				
B1. Distillation Error! Bookmark not defined. - a batch or continuous operation which separates one or more feed stream(s) into two or more exit streams, each exit stream having component concentrations different from those in the feed stream(s)	40CFR264.1030(b) and 264.1031	A description of process should be included.				
B2. Fractionation - a distillation operation or method used to separate a mixture of several volatile components of different boiling points in successive stages	40CFR264.1030(b) and 264.1031	A description of process should be included.				
B3. Thin-film Evaporation - a distillation operation that employs a heating surface consisting of a large diameter tube that may be either straight or tapered, horizontal or vertical	40CFR264.1030(b) and 264.1031	A description of process should be included.				
B4. Solvent Extraction - an operation or method of separation in which a solid or solution contacts a liquid solvent (the two being mutually insoluble) to preferentially dissolve and transfer one or more components into the solvent	40CFR264.1030(b) and 264.1031	A description of process should be included.				
B5. Air Stripping - a desorption operation employed to transfer one or more volatile components from a liquid mixture into a gas (air) either with or without the application of heat to the liquid	40CFR264.1030(b) and 264.1031	A description of process should be included.				
B6. Steam Stripping - a distillation operation in which vaporization of the volatile constituents of a liquid mixture takes place by the introduction of stream directly into the charge	40CFR264.1030(b) and 264.1031	A description of process should be included.				
C. METHODS FOR REDUCING EMISSIONS FROM PROCESS VENTS						

Checklist for Technical Review of RCRA Part B Permit Application For Subpart X Units

IV. SPECIFIC INFORMATION REQUIREMENTS FOR PROCESS VENTS (SUBPART AA)

Item	Authority	Comments on Requirements	Location of Information in the Application	Addressed (Y/N)	Technically Adequate (Y/N)	See Attached Comment Number
C1. Reduce Total Organic Emission Below 1.4 Kilogram Per Hour (3 pound per hour) and 2.8 Million Grams Per Year (3.1 tons per year), or	40CFR264.1032(a)(1), (c), and 270.24(b)	Engineering calculations or performance test may be used.				
C2. Reduce Total organic Emissions of 95% by Weight with the Use of a Control Device, or	40CFR264.1032(a)(2), (b), and 270.24(b)					
C3. Reduce Emissions for Various Control Devices with Closed-vent Systems Under the Following Operational Conditions:	40CFR264.1032(a) and (b), 264.1033 (b-j), and 270.24(b)	Closed-vent systems are optional devices but must comply with regulations if they are used.				
· Control device involving vapor recovery (condenser or absorber) shall recover at least 95 percent by weight of the organic vapors	264.1032(a)(1) and (b)	A less than 95 percent recovery is permissible if the control devices meet emission limits set in 40CFR264.1032(a)(1).				
· Closed combustion device (a vapor incinerator, boiler, or process heater) shall recover at least 95 percent by weight of organic emissions	40CFR264.1033(c)	The device must achieve 20 ppmw or ½ second residence time at 760 degrees Celsius (°C).				
· A flare shall operate under the following four conditions: (1) no visible emissions, (2) a flame present at all times, (3) an acceptable net heating value, and (4) appropriate exit velocity	40CFR264.1033(d)					
· Carbon adsorption system shall recover at least 95 percent by weight of the organic vapors	40CFR264.1032(a)(2), (b), and 270.24(b)					
D. MONITORING AND INSPECTION OF CONTROL DEVICES						
Inspection readings are conducted at least daily. Vent stream flow information is provided at least hourly.	40CFR264.1033(f)(l) and (3)					
D1. Continuous Monitoring for the Following Control Devices:	40CFR264.1033(f)(2)					
· Thermal vapor incinerator (one temperature sensor)	40CFR264.1033(f)(2)(i)	Sensor must have accuracy of ± 1 percent °C or ± 0.5 °C, whichever is greater.				
· Catalytic vapor incinerator (two temperature sensors)	40CFR264.1033(f)(2)(ii)	Sensors must have accuracy of ± 1 percent °C or ± 0.5 °C, whichever is greater.				
· Flare (heat sensing device)	40CFR264.1033(f)(2)(iii)					
· Boiler or process heater with heater input capacity equal or greater than 44 megawatts (recorder which indicates good combustion practices)	40CFR264.1033(f)(2)(v)					

Checklist for Technical Review of RCRA Part B Permit Application For Subpart X Units IV. SPECIFIC INFORMATION REQUIREMENTS FOR PROCESS VENTS (SUBPART AA)						
Item	**Authority**	**Comments on Requirements**	**Location of Information in the Application**	**Addressed (Y/N)**	**Technically Adequate (Y/N)**	**See Attached Comment Number**
· Condenser (device to measure organic vapors or temperature sensor)	40CFR264.1033(f)(2)(vi)	Sensor has accuracy of ± 1 percent °C or ± 0.5 °C, whichever is greater.				
· Carbon adsorption system (device to measure organic vapors or a recorder that verifies predetermined regeneration cycle)	40CFR264.1033(f)(2)(vii)					
D2. Alternate Monitoring of Control Device	40CFR264.1033(i) and 270.23(c)	Information should be provided describing measurement of applicable monitoring parameters.				
D3. Inspection of the Following Control Devices	40CFR264.1033(g) and (h)					
· Regenerable carbon adsorption system	40CFR264.1033(g)	Carbon replacement schedule must be acceptable.				
· Nonregenerable carbon adsorption system	40CFR264.1033(h)	Carbon must be replaced when breakthrough is observed or on an acceptable schedule.				
D4. Use of Reference Method 21 for Compliance Testing	40CFR264.60 and 1034					
E. BASIC OPERATIONAL PROPERTIES OF CLOSED-VENT SYSTEMS						
No detectable emissions	40CFR264.1033(k)(1)	Emissions must be less than 500 parts per million (ppm) above background.				
Monitoring to verify no detectable emissions	40CFR264.1033(k)(2)	The monitoring shall be done: (1) the date the system is subject to the regulation, (2) annually, and (3) other times requested by the regional administrator of the EPA.				
F. RECORD KEEPING REQUIREMENTS FOR CONTROL DEVICES AND CLOSED-VENT SYSTEMS						
Owner complies with record keeping requirements	40CFR264.1035 and 270.24(d)	Closed-vent systems are optional devices but must comply with regulations if they are used.				
Semiannual report is submitted according to subpart AA requirements	40CFR264.1036	Closed-vent systems are optional devices but must comply with regulations if they are used.				
Implementation schedule is provided	40CFR264.1033(a)(2) and 270.24(a)	A schedule must be provided when facilities cannot install a closed-vent system and control device to comply with 40CFR264 on the date the facility is subject to the requirements.				
Performance test plan is provided	40CFR264.1035(b)(3) and 270.24(c)	A performance test plan must be provided where an owner/operator applies for permission to use a control device other than a thermal vapor incinerator, catalytic vapor incinerator, flare, boiler, process heather, condenser, or carbon adsorption system, and chooses to use test data to determine the organic removal efficiency achieved by the control device.				

Checklist for Technical Review of RCRA Part B Permit Application for Subpart X Units

V. SPECIFIC INFORMATION REQUIREMENTS FOR EQUIPMENT LEAKS (SUBPART BB)

Item	Authority	Comments on Requirements	Location of Information in the Application	Addressed (Y/N)	Technically Adequate (Y/N)	See Attached Comment Number
SECTION V						
A. EQUIPMENT LEAKS						
Definition of equipment leaks	40CFR264.1050	Equipment leaks are associated with operations that manage hazardous waste with organic concentrations of at least 10 ppmw. Equipment in a vacuum is excluded from Subpart BB requirements. Each piece of equipment shall be marked.				
B. STANDARDS FOR PUMPS IN LIGHT LIQUID SERVICE						
Monthly monitoring for leaks	40CFR264.1052(a)(1) and 270.25(d)					
Visual inspection for pump seal leakage on a weekly basis	40CFR264.1052(a)(2) and 270.25(d)					
Leak detection	40CFR264.1052(b), 264.1063, and 270.25(d)	Leak detected if: (1) A leak detection instrument reads 10,000 ppm or greater or (2) there are indications of liquids dripping from the pump seal.				
Leak repair as soon as practicable	40CFR264.1052(c), 1059, and 270.25(d)	Repairs are to be made within 15 calendar days after detection. Repair extensions are allowed under conditions specified in 40CFR264.1059.				
Specific exceptions to these standards	40CFR264.1052(d), (e), (f), and 270.25(d)	Exceptions to these standards are dual mechanical seal systems or no detectable emissions.				
C. STANDARDS FOR COMPRESSORS						
Barrier fluid pressure greater than the compressor stuffing box pressure	40CFR264.1053(b)(1) and 270.25(d)					
Barrier fluid system connected by a closed-vent system to a control device as described in Subpart AA	40CFR264.1053(b)(2) and 270.25(d)					
No detectable atmospheric emissions of hazardous contaminants from the barrier system	40CFR264.1053(b)(3) and 270.25(d)					
Sensors checked daily or an audible alarm checked monthly	40CFR264.1053(d),(e) and 270.25(d)					
Leak detection	40CFR264.1053(f) and 270.25(d)	A leak is detected if sensor indicates a failure of: (1) the seal system or (2) the barrier fluid system.				
Leak repair as soon as practicable	40CFR264.1053(g)(1), 264.1059, and 270.25(d)	Repairs are to be made within 15 calendar days after detection. Repair extensions are allowed under conditions specified in 40CFR264.1059.				
Specific exceptions to these standards	40CFR264.1053(h),(i), and 270.25(d)	Exceptions to these standards are certain closed vent systems or no detectable emissions.				

Checklist for Technical Review of RCRA Part B Permit Application for Subpart X Units

V. SPECIFIC INFORMATION REQUIREMENTS FOR EQUIPMENT LEAKS (SUBPART BB)

Item	Authority	Comments on Requirements	Location of Information in the Application	Addressed (Y/N)	Technically Adequate (Y/N)	See Attached Comment Number
D. STANDARDS FOR PRESSURE RELIEF DEVICES IN GAS/VAPOR SERVICE						
Except during pressure releases, no pressure relief device shall release detectable emissions.	40CFR264.1054(a) and 270.25(d)	Emissions shall be less than 500 ppm above background levels.				
Within 5 calendar days after a pressure release, no detectable emissions shall emanate from pressure release device.	40CFR264.1054(b) and 270.25(d)	Emissions shall be less than 500 ppm above background levels.				
Specific exceptions to these standards	40CFR264.1054(c) and 270.25(d)	Exceptions to these standards are certain closed vent systems.				
E. STANDARDS FOR SAMPLING CONNECTING SYSTEMS						
Sampling connecting system equipped with a closed-purge system or closed-vent system	40CFR264.1033, 264.1055(a),(b), 264.1060, and 270.25(d)	Each closed-purge system or closed-vent system shall either: (1) release no detectable air emissions into the hazardous waste management process line, (2) release no detectable air emissions to the recycled hazardous waste stream, or (3) meet operational conditions of control devices as found in 40CFR264.1033 and 40CFR264.1060.				
Specific exception to these standards	40CFR264.10(c) and 270.25(d)	Exceptions to these standards are in situ sampling systems.				
F. STANDARDS FOR OPEN-ENDED VALVES OR LINES						
Open-ended valve or line	40CFR264.1056(a),(c) and 270.25(d)	Each open-ended valve or line shall be equipped with a cap, blind flange, plug, or a second valve that seals the open end at all times except during operations. A double block and bleed system will follow the same operating procedures except when operations require venting the line between block valves.				
Second valve	40CFR264.1056(b) and 270.25(d)	A second valve shall be operated such that the primary valve must be closed before the second valve is opened.				
G. STANDARDS FOR VALVES IN GAS/VAPOR SERVICE OR IN LIGHT LIQUID SERVICE						
Monitoring schedule based on detection of leaks and predetermined schedule	40CFR264.1057(a-e), and 270.25(d)	A reading of 10,000 ppm denotes a detected leak.				
Specific exceptions to the monitoring schedule	40CFR264.1057(f-h), 264.1061, 264.1062, and 270.25(d)	Exceptions to the schedule include unsafe-to-monitor valves, no detectable emissions, and difficult-to-monitor valves.				
H. STANDARDS FOR PUMPS AND VALVES IN HEAVY LIQUID SERVICE, PRESSURE RELIEF DEVICE IN LIGHT LIQUID OR HEAVY LIQUID SERVICE, AND FLANGES AND OTHER CONNECTORS						
Monitoring	40CFR264.1058(a), 264.1063(b), and 270.25(d)	Monitoring is required within 5 days after a leak is found by sight, sound, smell, or other detection method.				

Checklist for Technical Review of RCRA Part B Permit Application for Subpart X Units

V. SPECIFIC INFORMATION REQUIREMENTS FOR EQUIPMENT LEAKS (SUBPART BB)

Item	Authority	Comments on Requirements	Location of Information in the Application	Addressed (Y/N)	Technically Adequate (Y/N)	See Attached Comment Number
Leak detection	40CFR264.1058(b) and 270.25(d)	A leak is detected if a leak detection instrument reads 10,000 ppm or greater.				
Leak repair as soon as practicable	40CFR264.1058(c), 264.1059, and 270.25(d)	Repairs are to be made within 15 calendar days after detection. The first attempt at repair shall be made no later than 5 calendar days after each leak is detected. Repair extensions are allowed under conditions specified in 40CFR264.1059.				
I. TESTING						
Use of reference method 21 for compliance testing	40CFR264.60 and 264.1034					
J. RECORD KEEPING AND REPORTING REQUIREMENTS						
Owner complies with record keeping requirements	40CFR264.1064					
Semiannual report	40CFR264.1065	The semiannual report must be submitted according to requirements.				
Implementation schedule	40CFR270.25(b)	An implementation schedule must be provided if the facility cannot install a closed-vent system and control device to comply with the provisions of 40CFR264 Subpart BB on the effective date that the facility becomes subject to the provisions of 40CFR264 and 265.				
Performance test plan	40CFR270.25(c)	A test plan must be provided if the owner/operator applies for permission to use a control device for other than a thermal vapor incinerator, flare, boiler, process heater, condenser, or carbon adsorption system and chooses to use test data to determine the organic removal efficiency achieved by the control device.				

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APPENDIX A.2

SUPPLEMENTAL OB/OD CHECKLIST

OB/OD Guidelines Section	Requirements	Location of Information in the Application	Addressed (Y/N)	Technically Adequate (Y/N)	See Attached Comment Numbers
3 **3.2**	**OB/OD Permit Application** **Waste Description** • Waste item identification + Munition nomenclature (based on standard DoD terminology) + Munition family (see example families in Table 3-1) + DoD National Stock Number (as applicable/available) + DoD Information Code (as applicable/available) • Gross weight per item • Net explosive weight per item • Chemical composition by weight of the NEW per item (including energetic and other hazardous constituents of concern [HCOCs] as well as any inert constituents of the NEW) • Donor to be used for OD (not RCRA regulated since the donor is being used for its intended purpose, but should be provided to completely describe the treatment operation) + Donor type and NEW per item treated + Chemical composition of donor (including energetic and other HCOCs as well as any inert constituents of the NEW) • EPA hazardous waste codes (D003, et. al.) • DOT hazardous classification code (Tables 2-1 to 2-3) • Type treatment (OB or OD commensurate with Table 2-4) • Safety data (e.g., industry/military special handling requirements, Material Safety Data Sheets, etc.) • Waste treatment quantities + Per treatment event + Annual				
3.3	**Waste Analysis Plan** • Waste analysis parameters • Rationale for parameters • Test methods • Sampling methods (to ensure representativeness) • Sampling frequency • Management of wastes generated offsite				

OB/OD Guidelines Section	Requirements	Location of Information in the Application	Addressed (Y/N)	Technically Adequate (Y/N)	See Attached Comment Numbers
3.4	**Waste Minimization Plan** • Measures to minimize input waste stream • Goal to minimize annual OB/OD treatment quantities commensunt with installation mission + Gross weight + NEW weight • Potential offsite treatment options • Alternative treatment technologies application				
3.5	**Treatment Effectiveness Demonstration** • Destruction and removal efficiency (DRE) + OB + OD • Post Treatment Waste Management Plan • 3 to 5-yr historical treatment effectiveness data (existing units)				
3.6	**OB/OD Treatment Justification** • Treatment wastes are appropriate for OB/OD treatment • Explosive safety hazards associated with transport and availability of appropriate offsite treatment • Availability of alternative technologies for onsite treatment and associated feasibility and explosive safety hazards • Can the installation meet mission requirements without a permitted OB/OD unit? • Is there a reliable alternative to onsite treatment? • Does operating the unit create an unacceptable environmental liability?				
3.7	**OB/OD Unit Location, Design and Operation** • Location information and demonstration of compliance with RCRA location standards (40 CFR 264.18). • Topography map, including identification of unit boundary, based on surveyor or GPS data, as well as OB and OD treatment areas within the unit. • Design and construction of engineering controls (e.g., screens to control OB ejecta, run-on/run-off controls, containment structures, and liner systems) • Operational procedures or plans should be provided in the permit application for the following: + Treatment operations + Inspection/maintenance + Recordkeeping				

OB/OD Guidelines Section	Requirements	Location of Information in the Application	Addressed (Y/N)	Technically Adequate (Y/N)	See Attached Comment Numbers
	+ Security + Preparedness and prevention + General hazard prevention + Prevention of accidental ignition or reaction of wastes + Emergency procedures contingency plan + Personnel training + Source monitoring • Procedures for OB/OD treatment operations should include the following: + Staff responsibilities and qualifications + Waste energetics storage, handling and transportation to the OB/OD unit + Allowable waste for OB/OD treatment + Waste treatment limits (as discussed in Sect. 3.2) + Use of donor charges for OD + Operational conditions (e.g., meteorological conditions, brush fire hazard potential) + Safety measures				
3.8	**Post-Treatment Waste Management Plan** • Post-treatment OB/OD site inspections • Characterization and reactivity evaluation of post-treatment waste based on the WAP (see Sect. 2.1) • Identification of ejecta and fragmentation distances • Dispersion patterns • Possible effects on groundwater or surface water • UXO/energetic safety sweep • Assessment of effectiveness • Recovery protocols • Management of UXO and other reactive wastes • Management of other hazardous wastes • Management of energetic-contaminated wastes (residues) • Management of solid waste • Waste accumulation or storage requirements • Recordkeeping to document compliance with the Post-Treatment Waste Management Plan				

OB/OD Guidelines Section	Requirements	Location of Information in the Application	Addressed (Y/N)	Technically Adequate (Y/N)	See Attached Comment Numbers
3.9	**Closure Plan** • Delay of closure support information (as appropriate) + Conduct of a pre-closure site investigation (see Sect. 4.2) considering historical treatment operations/dispersion patterns and risk assessments (see Sects. 4.3 and 4.4) to demonstrate that OB/OD residues will not endanger human health or the environment. + Implementation of long-term security measures to control unit access. + Long-term detection monitoring to demonstrate that hazardous waste constituents are not migrating off the unit. + Limited land use.				
3.10	**Additional Site Factors** • Emergency treatment operations + 3 to 5-yr history of emergency treatment operations (existing units) + Potential for military EOD use of the OD unit to detonate an improvised explosive device that could be transported from an offsite location. + Potential for treatment at the OB unit of propellant in storage that has been determined to be unstable. + Potential for discovery of UXO at a construction location onsite that can only be transported to the onsite OD unit for detonation. • Co-located military training, testing, and range clearance operations				
3.11	**Submission Instructions** • Format/Completeness + Compliance with *Subpart X Checklist* + One original and three additional hard copies of the permit application should be submitted to the permitting agency + Electronic version of the text should be submitted + The format of the electronic version should be compatible with computer systems of the permitting agency • Modeling Input/Output Files + Electronic Files + Hard copy examples • Sampling Data + Validated data listing + Summary documentation of analytical data validation + Summary tables (statistical tables and comparisons to applicable impact criteria)				

OB/OD Guidelines Section	Requirements	Location of Information in the Application	Addressed (Y/N)	Technically Adequate (Y/N)	See Attached Comment Numbers
4. **4.1** **4.1.1**	**OB/OD Environmental Performance Standards** **Air Pathway Assessment Protocol** **Step 1 – Determine OB/OD Air Emission Factors/Quantities** • Pretreatment emissions • Treatment emissions • Post-treatment emissions				
4.1.2	**Step 2 – Identify Criteria** • Ambient air quality standards • Air toxics				
4.1.3	**Step 3 – Conduct Dispersion Modeling** • Select and justify model • Specify meteorological data set • Identify potential receptors + Adult residence + Child residence + Subsistence farmer + Subsistence farmer child + Subsistence fisher + Subsistence fisher child + Onsite worker				
4.1.4	**Step 4 – Evaluate Air Pathway Modeling Results** • Source-specific and additive air pathway impacts • Compliance with Ambient Air Quality Standards • Input information for noncriteria pollutants to support the risk assessment process				
4.1.5	**Step 5 – Conduct Air Monitoring (As Warranted)** • Facilities should contact the permitting agency for site-specific determinations on the need for air monitoring				
4.2	**Baseline Site Characterization** • Groundwater • Surface water • Surface soil • Subsurface soil • Sediments				

OB/OD Guidelines Section	Requirements	Location of Information in the Application	Addressed (Y/N)	Technically Adequate (Y/N)	See Attached Comment Numbers
4.2.1	**Target Analytes/Analytical Methods** • Energetics (SW-846 Method 8330 modified or Method 8321) • Other semivolatiles (i.e., base, neutral and acid extractables – BNA; SW-846 Method 8270C) • Total RCRA metals (SW-846 Method 6010B, Methods 7470A (aqueous) and 7471A (soil) for mercury) • Other metals (as appropriate based on waste characterization information for the site) • Cyanide (SW-846 Method 9010B) • Volatile organic compounds (VOCs; SW-846 Method 8260B) • Nitrates/nitrites for water only (EPA 353.3) • Other potential contaminants (as appropriate on a site-specific basis).				
4.2.2	**Soil Sampling Strategy (soil sampling locations)** • Treatment source zone (e.g., pit/crater areas for OD, ground-based burn area for OB, as applicable, or within 1-3 m of burn pans) • Ejecta zone (to be determined on a site-specific basis) • Remainder of OB/OD unit • Prevailing downwind location areas associated with maximum predicted gravitational settling/deposition potential (as practical) • Natural background				
4.2.3	**UXO Investigation** • Nature and extent of UXO and energetic-contaminated debris • Need for mitigating operating procedures, permit or closure conditions, and/or corrective action • Need for more detailed UXO investigations and clearance.				
4.3 **4.3.1**	**Human Health Risk Assessments** **OB/OD Unit Source Zone – HHRA** • Protocol based on *Guidance Document and Submission Package for Site Remediation and Cleanup Using Health Based Standards, Risk Exposure, and Analysis Modeling System* (REAMS) (VADEQ, November 1994) • Contact permitting agency to determine its applicable of REAMS and alternative or site-specific guidanceAcceptable results + Total Hazard Index (HI) of 1.0 or less for noncarcinogens; + Total lifetime cancer risk of 1E-06 or less for individual carcinogens				

OB/OD Guidelines Section	Requirements	Location of Information in the Application	Addressed (Y/N)	Technically Adequate (Y/N)	See Attached Comment Numbers
	+ Total lifetime cancer risk of 1E-06 1E-04 or less for all carcinogens combined				
4.3.2	**OB/OD Operations Air Releases – HHRA** • Protocol based on *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (EPA, July 1998 draft and subsequent revisions/updates • Following standard exposure scenarios should be evaluated based on current and potential future land use + Adult residence + Child residence + Subsistence farmer + Subsistence farmer child + Subsistence fisher + Subsistence fisher child + Sensitive receptors (as identified in the air pathway assessment) • Exposure pathways should include the following as applicable based on current and potential future land use + Direct inhalation (chronic and acute) + Incidental ingestion of soil + Ingestion of drinking water (groundwater and surface water) + Ingestion of homegrown produce, meats and dairy produce • Results acceptable + Total Hazard Index (HI) of 1.0 or less for noncarcinogens; + Total lifetime cancer risk of 1E-06 or less for individual carcinogens; + Total lifetime cancer risk of $1E\text{-}0^{-6}$ and $1E\text{-}0^{-4}$ or less for all carcinogens combined • Short-term or acute effects should be considered from direct inhalation of HCOCs.				

OB/OD Guidelines Section	Requirements	Location of Information in the Application	Addressed (Y/N)	Technically Adequate (Y/N)	See Attached Comment Numbers
4.4	**Ecological Risk Assessments** • Methodology for conducting screening assessments • Application of guidance developed by EPA Region 6 in *Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (EPA, August 1999 draft and subsequent revisions/updates). This Protocol is available for download at http://www.epa.gov/epaoswer/hazwaste/combust/ecorisk.htm.				
4.4.1	**OB/OD Unit Source Zone – ERA** • For screening purposes the facility may use ecological toxicity reference values (TRVs) identified in the *Combustion Facilities ERA Protocol* followed by Oak Ridge National Laboratory (ORNL) published benchmark values for different media • The facility must identify appropriate target population, species, and media in applying the standards. • If no TRV or benchmark values are available from these sources, the facility may use other appropriate sources • EPA Region III, has established a BTAG that provides technical advice on the ERA process • Guidance on the availability and use of BTAGs is provided in EPA September 1991 • If the facility chooses to conduct a more detailed ERA, the *Combustion Facilities ERA Protocol* guidance is the recommended choice. This EPA Region 6 guidance can also be used to determine site-specific cleanup levels if needed.				
4.4.2	**OB/OD Operations Air Releases – ERA** • For screening purpose the facility may use ecological toxicity reference values (TRVs) identified in the *Combustion Facilities ERA Protocol* followed by Oak Ridge National Laboratory (ORNL) published benchmark values for different media • The facility must identify appropriate target population, species, and media in applying the above • If no TRV or benchmark values are available from the above sources, the facility may use Region III BTAGs (see Sect. 4.4.1) or other appropriate sources • Media-specific concentrations should be calculated based on dispersion/deposition modeling results as input and the methodology specified in the *Combustion Facilities ERA Protocol* (Sect. 3.11) • If the facility chooses to conduct further detailed ecological risk assessment, the *Combustion Facilities ERA Protocol* (Sects. 3.11, 4-6) is the recommended choice. • Major components of the ERA as addressed by the *Combustion Facilities ERA Protocol* (Sects. 4-6) are as follows + Estimation of COPC Concentrations in Media				

OB/OD Guidelines Section	Requirements	Location of Information in the Application	Addressed (Y/N)	Technically Adequate (Y/N)	See Attached Comment Numbers
	– Calculation of COPC Concentrations in Soil – Calculation of COPC Concentrations in Surface Water and Sediment – Calculation of COPC Concentrations in Plants + Replacing Default Parameter Values + Problem Formulation – Exposure Setting Characterization – Food Web Development – Selecting Assessment Endpoints – Selecting Measurement Endpoints + Analysis – Exposure Assessment – Assessing Exposure to Community Measurement Receptors – Assessing Exposure to Class-Specific Guild Measurement Receptors – Assessment of Toxicity + Risk Characterization – Risk Estimation – Risk Description – Uncertainty and Limitations of the Risk Assessment Process				
4.5 **4.5.1**	**Noise and Vibration Assessments** **Noise/Vibration Effects and Criteria** • 3 to 5-yr historical noise complaint records (existing units) • Human impacts • Structural impacts • Ecological impacts • Noise monitoring (as appropriate) + Worst-case exposure receptors (based on modeling results) + Location based on historical noise complaints + Nearby population centers				
4.6	**Long-Term Source and Environmental Monitoring** • Groundwater • Surface soil • Surface water/sediments • Ambient air (as warranted)				

OB/OD Guidelines Section	Requirements	Location of Information in the Application	Addressed (Y/N)	Technically Adequate (Y/N)	See Attached Comment Numbers
5	**OB/OD Permit Conditions (permit application support information provided)** • Module 1 (general conditions required by 40 CFR 270 for all Hazardous Waste Management Facility Permits; see *Subpart X Checklist*) + Standard administrative conditions – Effect of permit, permit actions, duties and requirement, permit expiration, inspection and entry, transfer of permit, etc. + Monitoring and records – Samples taken by facility have to be representative – Maintain records of monitoring + Record keeping and reporting requirements – Reporting planned changes – Documents to be submitted prior to operation – Documents to be maintained – 24-hour reporting requirements + Definitions + Confidential Information • Module 2 (conditions covering the general facility requirements of 40 CFR Part 264, Subparts B through H and O. This module must be included in all RCRA Permits. Land Disposal Restriction (LDR) (40 CFR 268) requirements may also be included in this module; see to *Subpart X Checklist*. + Required notices + Location standards + Procedures to prevent hazards + Emergency procedures + Personnel training + Security + Closure and post-closure + Manifest system (only if offsite waste is accepted) + Recordkeeping and reporting + Liability requirements + Corrective action				

OB/OD Guidelines Section	Requirements	Location of Information in the Application	Addressed (Y/N)	Technically Adequate (Y/N)	See Attached Comment Numbers
	Module 3 includes the following permit conditions: • Permitted and prohibited waste (Sect. 5.1) • Design and construction requirements (Sect. 5.2) • Operating, inspection and maintenance requirements (Sect. 5.3) • Operating conditions (Sect. 5.4) • Monitoring requirements (Sect. 5.5)				
5.1	**Permitted and Prohibited Wastes** • Type of unit (OB or OD) • Description of hazardous waste (e.g., bulk propellants for OB; see to Sect. 3.2) • Hazardous classification codes (see Sect. 2.2 for criteria for burning and detonation of energetic) • Hazardous waste number (D003, etc.) • Allowable treatment quantities (lbs. NEW/event, lbs NEW/yr) • Prohibited items include: + Small arms ammunition in the absence of RCRA explosive reactivity, characteristics based on EPA policy and alternative treatment technologies are available) + Chemical agent munitions + Riot-control munitions + White/red phosphorous + Incendiaries (e.g., napalm) + Colored smokes + Depleted uranium (DU) munitions				
5.2	**Design and Construction Requirements** • Type of unit (OB or OD) • Location of unit (including unit boundary and treatment areas within the unit boundary) • Design dimensions and construction materials based on engineering drawings (type of soil for OD) • Engineering controls (e.g., berms, etc.) • Firing control systems • Minimum design requirements for an OB unit include the use of burn pans with precipitation covers. • Additional features (e.g., pan liners, ejecta control screens, soil liners, see Sect. 2.4) may be warranted on a site-specific basis to mitigate the impacts of runon/runoff and the potential for environmental migration.				

OB/OD Guidelines Section	Requirements	Location of Information in the Application	Addressed (Y/N)	Technically Adequate (Y/N)	See Attached Comment Numbers
	• The minimum design requirements for an OD unit is for a berm system to control runon/runoff (e.g., berms, etc.). • Additional features (e.g., use of mounds, soil liners, special fill material; see Sect. 2.4) may be warranted on a site-specific basis.				
5.3 **5.3.1**	**Operating, Inspection and Maintenance Requirements** **Waste Minimization Plan Requirements** • Comply with 40 CFR Part 264.73(b)(9) and certify, no less often than annually, that: + A program is in place to reduce the volume and toxicity of hazardous waste generated to the degree determined by the permittee to be economically practicable to meet installation mission requirements. + The proposed method of treatment, storage or disposal is the most practicable method that minimizes the present and future threat to human health and the environment. + Maintain copies of certification in the facility operating record. • The waste minimization program requirement includes implementation of the WMP (see Sect. 3.4) and treatment effectiveness demonstration (see Sect. 3.5). • The DRE (defined in Sect. 3.5) requirement for energetics should be 99.99 percent by weight.				
5.3.2	**SOP Requirements** • Loading/unloading procedures • Procedures for managing waste for treatment operations (e.g., quantity of waste placed in each burn pan) • Special storage/accumulation requirements for waste prior to and after OB/OD treatment • How the waste will be ejected • Duration of burns, duration of treatment campaign, number of treatment events per day, week and year. • Explosion hazard safety precautions • Post-treatment waste management (see Sect. 3.9) • Prevention of unintended ignition or reaction of waste.				

OB/OD Guidelines Section	Requirements	Location of Information in the Application	Addressed (Y/N)	Technically Adequate (Y/N)	See Attached Comment Numbers
5.3.3	**Inspection and Maintenance Requirements** • Inspections are conducted before each OB/OD treatment event and afterwards (at a prescribed time duration for safety reentry of site personnel). + Inspection of physical integrity of unit/treatment device + Inspection of secondary containment devices, berms, erosion control devices, etc. + Inspection of safety and emergency equipment specific to the OB/OD unit + Inspection for untreated energetic items, UXO, etc. + Inspection to determine brush fire potential (e.g., vegetation cleared treatment area and condition of surrounding area) • The following inspections should be conducted periodically. + Inspection of general area (i.e., fences, gates, locks, warning signs, monitoring devices) + The unit should be inspected regularly for signs of erosion and other conditions that might result from washouts. + The condition of the monitoring well casing, cap, and lock should be checked at the time the well is sampled. + The integrity of surveyed benchmarks should be inspected regularly. • Preventive and corrective procedures to be implemented, including: • <u>Security</u>. Signs should be replaced if they become illegible. The security fence and gate should be repaired or replaced as necessary to maintain unit security. • <u>Erosion</u>. Washouts should be repaired as they are detected. The vegetative cover should be restored as needed. • <u>Vegetative cover</u>. Tree or bush growth should be controlled by mowing or prescribed burns. The vegetative cover should be kept mowed to a reasonable height as a fire prevention measures. • <u>Runon and runoff controls</u>. Drains and ditches should be cleaned and maintained to allow free drainage of stormwater. High-rate runoff areas (if any) should be protected with coarse stone to minimize erosion. • <u>Monitoring wells</u>. Damaged monitoring wells should be repaired or replaced as necessary. • <u>Drainage collection/venting systems (as warranted)</u>. Routine and emergency maintenance should be conducted for each system. • <u>Surveyed benchmarks</u>. Missing benchmarks should be repaired or replaced. • Corrective maintenance action should be taken if a potential exists for exposure that could endanger human health and environment • All maintenance actions should be documented in the OD unit maintenance log.				

OB/OD Guidelines Section	Requirements	Location of Information in the Application	Addressed (Y/N)	Technically Adequate (Y/N)	See Attached Comment Numbers
5.4	**Operating Conditions** • The following operating conditions apply to all OB/OD units. + Minimum safe distance from the property of others (40 CFR 265.382) + Operation only during daylight hours (from 1 hour after sun rise to 1 hour before sunset) + Required to operate within a wind speed range (between 3 and 15-20 mph) + No operations during electrical storm within 3 miles + No operations during inclement weather or if storms are forecasted + No operations during a weather inversion or if an inversion is forecasted • Alternative (more or less stringent) and additional operational limits may be warranted based on site-specific conditions				
5.5	**Monitoring Requirements (as warranted)** • Source monitoring • Meteorological monitoring • Air monitoring • Other environmental monitoring • Operation of an onsite meteorological monitoring station should be required if real-time offsite wind data are unavailable or nonrepresentative of onsite conditions. • A baseline site characterization program (i.e., groundwater, soils, surface water) should be implemented (see Sect. 4.2) for all existing units if acceptance baseline data were not submitted with the permit application. • Soil and surface water monitoring permit requirements should be considered on a site-specific basis depending on the relative risk and unit design/engineering controls. • A standard RCRA groundwater monitoring program should be a standard permit condition for all (existing and new) OB/OD units. Exemptions should meet the criteria of 40 CFR 264.90(9).				
6	**Removal and/or Remediation of Energetic – Contaminated Environmental Media (as applicable)** • Management of UXO and munition fragments (see Sects.3.8 and 4.2.3) • Management of nonenergetic wastes (based onapplicable waste management requirements) • Management of energetic-contaminated environmental media.				

APPENDIX B

MONITORING WELL INTEGRITY EVALUATION AT OD UNITS

Guidelines
for
Monitoring Well Siting
Airhas Activities

Prepared for

HALLIBURTON NUS

by

Douglas A. Anderson

July 24, 1992

vibra-tech engineers, inc.

001395

Guidelines for Monitoring Well Siting Airhas Activities

Prepared for

HALLIBURTON NUS

by

Douglas A. Anderson
Vibra-Tech Engineers
Re: GPAD-CS-92-0919
July 24, 1992

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vibra-tech engineers, inc.

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Guidelines for Monitoring Well Siting
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Prepared for

HALLIBURTON NUS

by

Douglas A. Anderson
Vibra-Tech Engineers

Re: GPAD-CS-92-0919
July 24, 1992

1. Executive Summary

This document, prepared by Vibra-Tech Engineers, Inc., provides guidelines for the siting of monitoring wells near explosive ordnance detonation areas, and the rationale for those guidelines.

The conclusions are at the end of this document; however, in summary:

- For depths of charge less than 10 feet, and for detonation in unconsolidated material, the distance should be greater than 15 feet in all cases to avoid disruption due to cratering.
- If the charge is greater than 100 pounds, use the distances calculated in the following table:

Weight (pounds)	Distance (ft)
500	25
1000	31
5000	53
10,000	67

- For other situations, consult the tables at the end.

vibra-tech engineers, inc.

In developing these recommendations we have used certain standard reference works f developing the guidelines which follow. Among these are Dowding,[1] Clark,[2] and Powder Company.[3] We also used the results of a critical study by Duvall and Atchi which, in part, determines the geometry and strain generated by explosive cratering.

2. Description of Blasting Procedures and Mechanisms

2.1 Mechanics of Explosive Rock Fragmentation

Detonation converts a solid explosive to a very hot gas in a very short period of time. Whe an explosive is detonated in a borehole, the rapid expansion of this gas exerts a pressur pulse on the borehole wall which propagates away from the borehole. If the borehole is i rock, the stress induced by the pressure pulse exceeds the elastic limit of the rock in th neighborhood of the borehole, and fracture occurs. The processes which produce this fractur are complex, and there is some controversy about the relative importance of various contribu tions to this process. However, a description of likely processes is given by Anderson et al.[5] Based upon model and field studies, the following conclusions were reached:

- In homogeneous, unflawed material, radial cracks (typically 6-12) dominate fragmentation.
- In flawed models and field rock, fragmentation flaws, joints, and bedding planes dominat the fragmentation process.
- In flawed models, new fractures are initiated at the pre-existing flaws by the P and S waves. The resolved shear stress of the P waves initiates new fractures.
- New fractures in the field tests form at about twice the time for the P wave to traverse th burden distance.
- Old fractures are the loci of new fractures or are re-initiated themselves early in the event they continue to be active for several tens of milliseconds after detonation of the explo
- Fragmentation continues in blocks of rock following detachment from the main rock m
- The fracture pattern on the free face is well-developed prior to the expected time of arriva of radial cracks from the borehole.
- Gas venting occurs through already open cracks relatively late in the event, indicating tha most of the fractures observed on the free-face are not gas-pressurized.

If the detonation is in an already weak material, such as soil or intensely fractured rock, th scattering and attenuation of the pressure pulse dominates, and little additional fracturin occurs. In either case, the pressure pulse, its work done, propagates away from the borehole This propagation is discussed in the next section.

The gases, after giving the initial punch to the rock, expand more slowly, filling the new an existing cracks in the rock or soil, pushing and moving the rock mass. The punch gives ris to ground vibration, and the push to [illegible]

2.2 Elastic Wave Generation by Explosives

The pulse produced by the explosive decays as it propagates from the borehole, due to the work done by fragmentation, heat generated by anelastic processes, and geometric spreading. Eventually the stress is below the elastic limit of the rock, and passes through the rock as an elastic wave. It is beyond the scope of this report, and not necessary, to discuss in detail the types of body and surface waves which may be propagated from an explosive detonation. It is sufficient to note that waves are reflected and refracted as they pass through the rock, and the pulse, which initially had a duration approximately equal to the detonation time of the explosive, is lengthened into a wave train which may be several seconds long for a single borehole at a distance of a few hundred meters.

The method for determination of probable vibration levels is based upon a concept called *Scaled Distance*. Two factors comprise a Scaled Distance: the distance from the explosive charge, D,[1] and the weight of the charge, W. Conventionally, in the US, D is in feet and W is in pounds. Scaled Distance SD is then a normalization of the distance from an explosive detonation by the charge weight to some power:

$$SD = \frac{D}{W^N}$$

where N depends upon whether the measurements are taken at the surface or underground.

In many cases, the concern for the effects of explosives on surrounding structures is limited to above-ground structures such as buildings. The appropriate measure is then the particle velocity of waves measured at the surface. The scaled distance for surface measurements uses a value for N of 1/2, and is called square-root scaled distance. For surface measurements, the relationship between SD and peak particle velocity $\dot{x}$ (attenuation) has been shown to be of the following form:

$$\dot{x} = A\,(SD)^K$$

where A and K are experimentally determined constants. These constants are site-specific; however, for a broad range of explosive types and geological settings, it has been found practical to use the following values (from the Du Pont Blasters' Handbook[6]):

$$\dot{x} = 160\,SD^{-1.6} \qquad (1)$$

For measurements below the surface (as in this study), the appropriate Scaled Distance for such measurements uses a value of N of 1/3:

1. Note that the nomenclature used in this report is consistent with general practice; however, because several subjects are covered, the nomenclature may be consistent only within each section for some terms.

$$SD = \frac{D}{W^{1/3}} \tag{2}$$

and is called cube-root scaled distance. For the effect of vibration on a pipe emplaced in a borehole, the *strain* on the pipe needs to be determined. As will be shown, the strain can be related to the particle velocity through the cube-root scaled distance.

All waves are the propagation of strain through or on the surface of a material. Strain, measured in change in length per unit length (and therefore non-dimensional) determines the amount of deformation of a material. It is symbolized by a small Greek epsilon, ϵ. Assuming isotropic elasticity, strain is related to stress σ (which is force per unit area) through a modulus E.

$$\epsilon = \frac{\sigma}{E} \tag{3}$$

Waves propagating outside the crater zone no longer fracture the material to any substantial extent. However, the strain associated with the waves may, in fact, be greater than the yield strain (the strain at which the material will no longer return to its previous state unaltered) of some other material which is buried.

2.3 Restrained Response of Buried Structures

There are two ways in which we can determine the strain on a buried structure such as a pipe:

- Relating peak particle velocity to strain
- Experimentally determining strain itself

Figure 1 following (reproduced from Dowding[1]) shows the relationship between peak particle velocity and scaled travel distance for tunneling experiments, which uses the cube-root scaled distance approximation appropriate for buried charge, buried target relationship here, Equation 2.

This can then be related to the strain by the equation[1]

$$\epsilon = \frac{\dot{u}}{2c_s} \tag{4}$$

where $\dot{u}$ is peak particle velocity, and c_s is the shear wave velocity in the material through which the wave propagates.

We then need to relate this strain to the strain on the pipe, or in terms of the stress on the pipe. Dowding[1] indicates that for materials like thin-walled steel pipe in rock or soil, the pipe is flexible enough that the strain in the pipe is the same as that of the surrounding material.

This may be tested by actually determining the flexibility ratio:

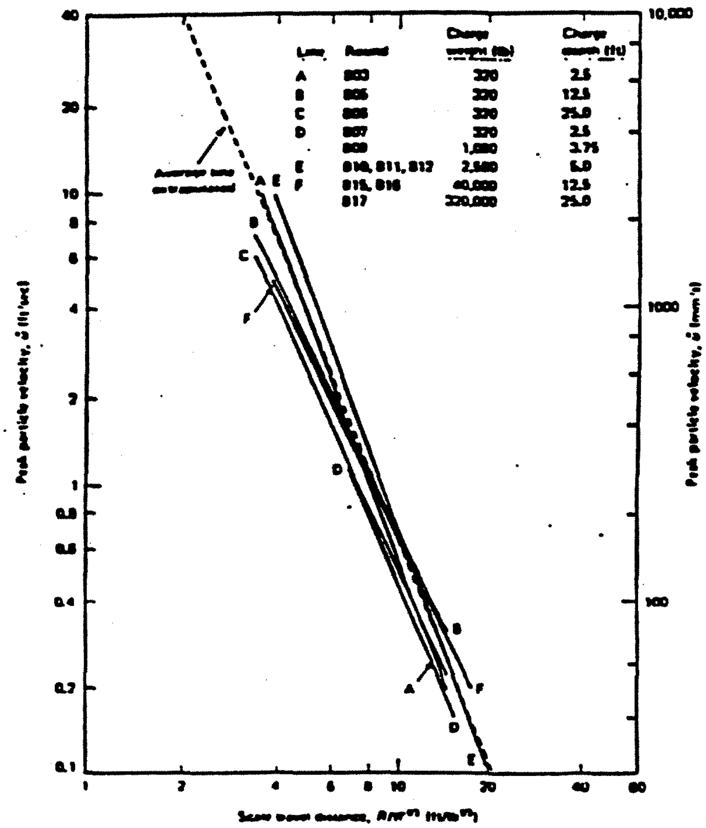

Figure 1. Attenuation of peak particle velocity — Figure 12-8 from Dowding[1]

$$J = \frac{E/(1+\nu)}{[6E_l I_l/(1-\nu_l^2)](1/R^3)}$$

where the appropriate quantities are the moduli E and Poisson's ratios ν of the pipe and the surrounding material, the thickness and radius of the pipe, and the moment of inertia I of the pipe. If this ratio is greater than 10, then the pipe behaves like the surrounding material. Although we do not have all of the material parameters necessary for the calculations, the examples given by Dowding indicate that for the situation here, the likely value of J will be of the order 20 to 40.

2.3.1 *Determining Strain from Peak Particle Velocity*

Therefore, the stress on the rock or soil may be used to determine the stress on the pipe, and the appropriate equation combines Equations 3 and 4:

$$\sigma = \frac{E\dot{u}}{2c_s} \quad (5)$$

We now need to find the appropriate distance given a known strength of the pipe (in compression) σ, the weight of charge W, and the shear wave velocity c_s and elastic modulus E of the material in which the pipe is embedded.

We solve for $\dot{u}$:

$$\dot{u} = \frac{2\sigma c_s}{E} \quad (6)$$

and can find the appropriate distance from the chart (Figure 1) for each charge weight. Dowding[1] has shown an "Average line extrapolated" on this figure, which corresponds to an equation (similar to attenuation Equation 1 for surface measurements):

$$\dot{u} = 240\,SD^{-2.6} \quad (7)$$

Combining Equations 6 and 7, and solving for D:

$$\frac{2\sigma c_p}{E} = 240\,SD^{-2.6}$$

$$\frac{\sigma c_p}{120E} = SD^{-2.6}$$

$$\log\left(\frac{\sigma c_p}{120E}\right) = -2.6\log(SD)$$

$$-0.38\log\left(\frac{\sigma c_p}{120E}\right) = \log\left(\frac{D}{W^{1/3}}\right)$$

$$= \log D - \frac{1}{3}\log W$$

$$\log D = \frac{1}{3}\log W - 0.38\log\left(\frac{\sigma c_p}{120E}\right)$$

$$D = W^{1/3}\left(\frac{\sigma c_p}{120E}\right)^{-0.38} \qquad (8)$$

2.3.2 *Determining Strain Directly*

The study by Duvall and Atchison[4] determined that peak strain is related to the charge weight and distance in a manner similar to the particle velocity chart shown in Figure 1 — i.e., proportional to distance, and inversely proportional to the cube root of the charge weight. The strain levels depended upon the type of material through which the waves propagate more than to the type of explosive. Figures 2 through 5 are for different rock types obtained from that study. Note that the abscissa axis is $L/\sqrt[3]{}$ — this is equivalent to our previous cube-root scaled distance $D/W^{1/3}$.

We can determine the allowable strain, and then find the appropriate distance for a given charge weight from these figures. We cannot use the same process as we did for determining Equation 8 because, as can be seen from the figures, the relation between ϵ and $L/\sqrt[3]{}$ is non-linear. Therefore we must solve Equation 3 using the strength of the pipe σ and the modulus E of the surrounding material. We find the appropriate scaled distance from one of the figures. We then solve for distance from Equation 2:

$$D = SD \times W^{1/3} \qquad (9)$$

2.4 Cratering Process

When an explosive is detonated near the surface, without a vertical free face, a process known as cratering occurs. The fragmentation mechanisms and effect of gas pressures are the same as in the previous sections; however, the geometry of the cratering configuration leads

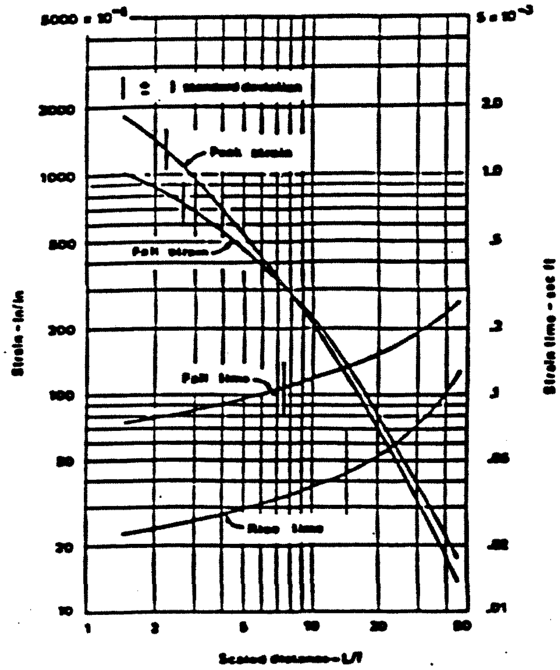

Figure 2. Strain Data, granite — from Duvall and Atchison[4]

to special properties of material movement. Figure 6 shows the appropriate variables, and the situation for optimum crater development, and (on the left) for the charge below optimum depth, but above critical depth.

Cratering theory was developed by C.W. Livingston.[7] Assuming that a charge has a length to diameter ratio of ≤ 6:1, he determined, both theoretically and experimentally, that there is a burden distance d_o between the charge and free surface, called the optimum distance, which yields the largest crater. There is also a burden distance N, called the critical distance, below which there no crater or expulsion of material to the surface results. There is a relationship between the critical burden distance N and the weight of explosive W:

$$N = E \times W^{1/3}$$

where E is a nondimensional proportionality constant called the *Strain Energy Factor*.[2] E is

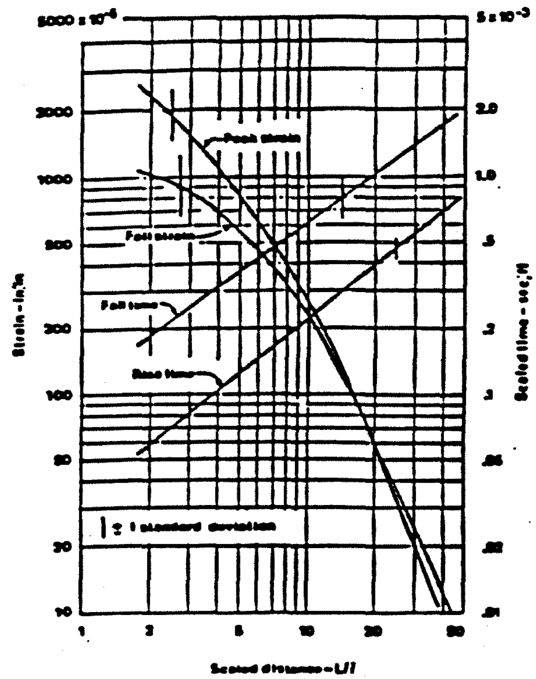

Figure 3. Strain Data, marlstone — from Duvall and Atchison[4]

constant for a given explosive-rock combination, but generally in the range from 1.8 to 4.6. E increases with the brittleness of the rock, and the optimum crater volume occurs at lower values of the depth ratio Δ, where

$$\Delta = \frac{\textit{Depth of Burial}}{N}$$

The Strain Energy Factor E is experimentally determined for each explosive/rock configuration. It is likely that for shallow detonations (discussed in the assumptions below) and the types of materials considered, that these detonations will be above the critical depth, although perhaps below the optimum depth. For the smallest charge W (50 lbs), and smallest E (1.8), the critical depth would be 6.63 feet. It is also not likely that an unconsolidated material

2. Note the similarity to Scaled Distance.

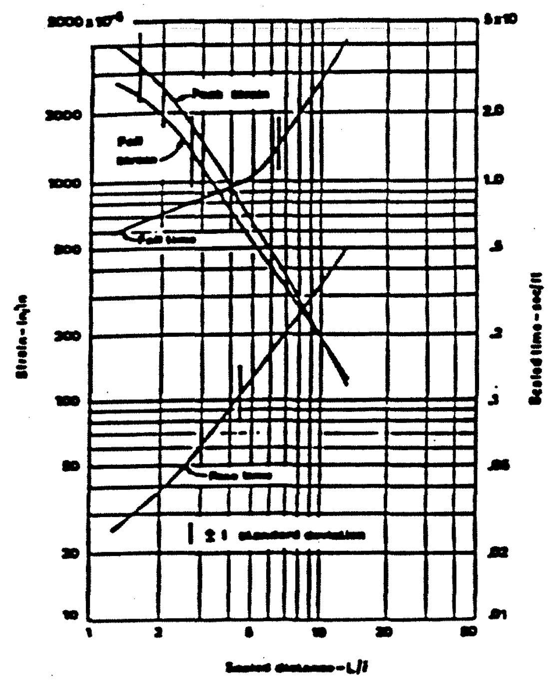

Figure 4. Strain Data, sandstone — from Duvall and Atchison[4]

would have E of the order 1.8 for any explosive type.

Therefore, we will assume that the crater develops at the charge depth, and has a breakout angle determined experimentally, as discussed in the next section.

2.5 Crater Breakout

Duvall and Atchison,[4] besides determining strain relationships discussed earlier, investigated the relationship between charge depth and the shape and size of the crater for various explosives and rock types. They indicated that, depending on rock type, there are characteristic breakout angles, ϕ, such that the crater floor becomes flatter (the angle becomes higher) as the rock type becomes more brittle:

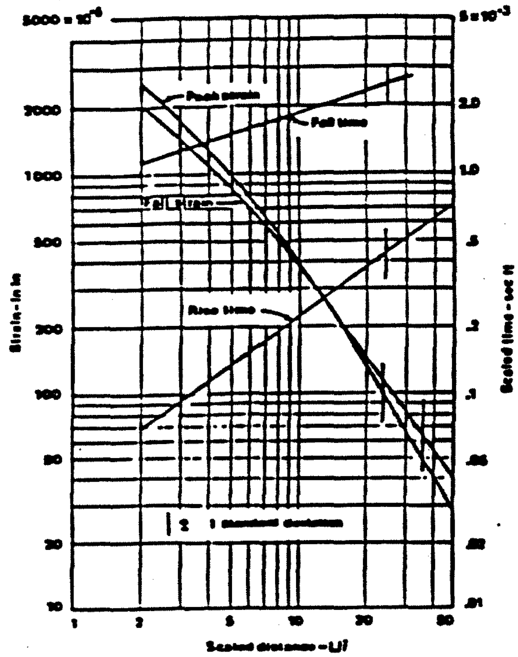

Figure 5. Strain Data, chalk — from Duvall and Atchison[4]

TABLE 1. Crater angles for various materials

Rock Type	Crater Angle ϕ (° from Vertical)
Marlstone	112
Chalk	121
Sandstone	130
Granite	152

The crater radius R_t can be determined from the depth D of the charge (given the above assumptions) and the breakout angle:

$$D \times \tan\frac{\phi}{2} = R_t \qquad (10)$$

If we assume granite, $\tan\frac{\phi}{2}$ is about 4, and for marlstone, 1.5. In an unconsolidated material, it is more likely to be like the marlstone data, and for depths of 10 feet or less, breakout will be of the order of 15 feet from the charge. In a brittle material like granite, the breakout will be of the order of 40 feet. Extra large charges will simply throw more material

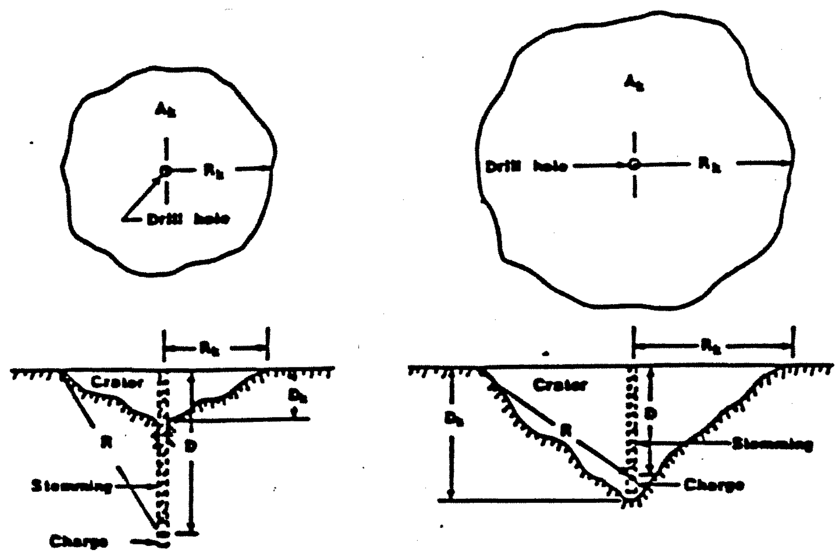

Figure 6. Plan and section drawings of crater variables — Duvall and Atchison[4]

into the air (providing other hazards), but should not substantially change the breakout.

3. Development of Guidelines

3.1 Introduction

There are two basic concerns for the impact of the detonations on the monitoring well:

- The disruption of the well casing due to propagation of the detonation crater through the well casing.
- The crushing of the well due to the strain wave propagated from the detonation.

We will consider three cases to address those two concerns:

Case I — We will use Equation 10 to determine likely distances for disruption of the well casing due to crater breakout. This would only occur near the surface.

The basis for the results is in Section 2.5.

Case II — We will use Equation 8 to determine distances for possible collapse of the pipe from the peak particle velocity calculations in Figure 1.

The basis for the results is in Section 2.3.1.

Case III We will use Equation 9 to determine distances for possible collapse of the pipe from the direct strain measurements shown in Figures 2 through 5.

The basis for the results is in Section 2.3.2.

The following section outlines the general assumptions on which the guidelines are based, and criteria for each of the cases described above.

3.2 Assumptions

The following assumptions are made, based upon information obtained from HALLIBURTON NUS and assuming worst-case conditions.

- The detonations of the explosive will be at depths ≤10 feet
- The detonations will occur in "unconsolidated geologic formations" or similar materials.

  This assumes that, in general, the material in which the detonations occur does not itself need to be blasted to be excavated. ☞ If this assumption is not valid, such as if the detonations are to occur in solid granite, we will need to have more information about the material properties of the material in which the detonations are to take place.
- The most critical *and* the weakest part of the wells are the wound screens; the collapse strength is of the order of schedule 5 casing for both the stainless steel and PVC pipe.
- We will assume that this most critical point is at the same depth as the charge. Therefore the distance of the well from the detonation point, as measured on the surface (plan view) is the basis of the calculations for cube-root scaled distance

3.3 Guidelines for Safe Distances from Explosive Detonations

The request for proposal was for well siting for permutations of all the following elements:

- Various Explosive Weights
  - 50 pounds
  - 100 pounds
  - 500 pounds
  - 1000 pounds
  - 5000 pounds
  - 10,000 pounds
- Detonation in Different Geological Formations
  - Unconsolidated Material
  - Solid Rock
- Different Well Materials
  - Stainless Steel
  - PVC

We now use the equations developed earlier, the assumptions from the last section, and the elements above to determine the appropriate guidelines. The following tables show the appropriate material properties:

TABLE 2. Compressive strength of the different pipe materials.

Material	Strength — σ (psi)
Stainless Steel Screen	129
PVC Screen	79

These values are quite close — we will assume a value of 100 psi.

TABLE 3. Material properties for Unconsolidated Material and Solid Rock

Material	c_L (ft/s)	c_L (in/sec)	E (psi)
Unconsolidated Material (Soil)	800	9600	10^4
Solid Rock (sandstone)	5000	60,000	10^6

We will now consider each of the cases described above.[3]

Case I Solving Equation 10, and assuming that the distance is ≤10 feet:

TABLE 4. Crater distances for detonation ≤10 feet

Material	Distance (ft)
Unconsolidated	15
Granite	40

For depths of detonation *greater* than 10 feet:

TABLE 5. Crater distances for detonation >10 feet

Material	Distance (ft)
Unconsolidated	1.5×*Depth*
Granite	4×*Depth*

Case II We will solve Equation 8 for the case of soil and sandstone, with the material properties from Table 3.

3. All distances calculated are rounded to the nearest foot.

TABLE 6. Distances calculated from peak particle velocity — Soil

Weight (pounds)	Distance (ft)
50	4
100	5
500	9
1000	11
5000	19
10,000	23

TABLE 7. Distances calculated from peak particle velocity — Sandstone

Weight (pounds)	Distance (ft)
50	12
100	15
500	25
1000	31
5000	53
10,000	67

The values from the pipe embedded in sandstone are clearly more conservative. Since we do not have information about the embedding material, we would recommend using Table 7.

Case III We now consider the approach using the direct strain measurements. Given the stress σ and values of E for soil and sandstone from the material parameters and Equation 9, we come up with values of strain as follows:

TABLE 8. Strain calculated from sandstone and soil

Embedding Material	Strain (microstrains — 10^{-6})
Soil	10,000
Sandstone	100

If we refer to any of the figures 2 through 5, we see that these values span the whole range of strain determined. A possible way to narrow this down is to determine actual failure strains for the pipe, and then not to have to assume material properties of the rock and use the strain method. However, we would consider that the method of Case II should give appropriate results.

4. Summary

Therefore, we can summarize the results as follows, as noted in the Executive Summary:

- For depths of charge less than 10 feet, and for detonation in unconsolidated material, the distance should be greater than 15 feet in all cases to avoid disruption due to cratering.
- If the charge is greater than 100 pounds, use the distances calculated in Table 7.

- If charges are at depth greater than 10 feet, consult Table 5 for the appropriate crater distances, and also use Table 7.
- If charges are detonated in solid rock, use the "granite figure from Table 4 or 5 as appropriate.

We have not used any "safety factor" because we believe that the conservative nature of the assumptions used are probably sufficient; however, you may modify these results to satisfy concerns you may have.

If you have any questions on this, please feel free to call.

Respectfully submitted,

VIBRA-TECH ENGINEERS, INC.

Douglas A. Anderson, Ph.D.
Research Geophysicist

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APPENDIX C

OBODM MODELING INFORMATION

Table C-1. Comparison of Alternative Models for OB/OD Sources

Capability Evaluation Criteria	OBODM	INPUFF	ISCST	ADORA
Instantaneous sources	Yes	Yes	No	Yes
Quesi-continuous sources	Yes	Yes	No	Yes
Intermittent sources	Yes	Yes	Yes	Yes
OB/OD-specific model	Yes	No	No	Yes
Internal OB/OD emission factors/model	Yes	No	No	Yes
Topography	Yes	Yes	Yes	Yes
Annual sequential meteorology	Yes	No	Yes	
Long-term concentrations (≥24 hrs)	Yes	Yes	Yes	
Short-term concentrations (≥1 hr)	Yes	Yes	Yes	Yes
Acute concentrations (< 1 hr)	Yes	Yes	No	Yes
Dry depositions	No	Yes	Yes	
Wet depositions	No	No	Yes	
Gravitational settling	Yes	Yes	Yes	
Depletion	No	Yes	Yes	
Refined cloud behavior	No	No	No	Yes
EPA model	No (Army)	Yes	Yes	No (commercial)
Comprehensive documentation	No	Yes	Yes	Proprietary
Ease of use	No	Yes	Yes	Yes

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