BSC

Design Calculation or Analysis Cover Sheet

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Attachment A: Explosion Analysis for a Diesel Fuel Bulk Storage Tank	6

RECORD OF REVISIONS

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00A	Initial issue. Supersedes a previously issued analysis to update information used to screen potential hazards from nearby industrial or military hazards to the repository structures, systems, and components important to safety.	~~58~~ 55 DJ 2/2/08	~~A-8~~ A-6	R.J. Garrett [signature] 1/31/08	S.F. Deng [signature] 01/31/08	M.V. Frank [signature] 1/31/08	M.R. Wisenburg [signature] 1/31/08

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ACRONYMS AND ABBREVIATIONS

Acronyms

BEEF	Big Explosives Experimental Facility
BLM	U.S. Bureau of Land Management
CMF	Cask Maintenance Facility
DAF	Device Assembly Facility
DOE	U.S. Department of Energy
EOL	End of Line Facility
EPA	U.S. Environmental Protection Agency
GROA	geologic repository operations area
HLW	high-level radioactive waste
JASPER	Joint Actinide Shock Physics Experimental Research
LFL	lower flammable limit
NEMOF	Nevada Energetic Materials Operations Facility
NPL	National Priorities List
NRC	U.S. Nuclear Regulatory Commission
NRL	Nevada Rail Line
NTS	Nevada Test Site
NTTR	Nevada Test and Training Range
REMY	Rail Equipment Maintenance Yard
TNT	trinitrotoluene
UFL	upper flammable limit

ACRONYMS AND ABBREVIATIONS (Continued)

Abbreviations

BTU	British Thermal Unit
F	Fahrenheit
ft	foot
kg	kilogram
kPa	kilopascal
KT	kilotonne
lb	pound
lbm	pound-mass
lbmol	pound-mole
MJ	megajoule
psi	pounds per square inch
R	Rankine

1. PURPOSE

The purpose of this analysis is to determine if activities, hazards, or accidents at industrial or military operations in the vicinity of the repository may result in event sequences that produce radiological exposures to workers or offsite individuals during the preclosure period. In *Monitored Geologic Repository External Events Hazards Screening Analysis* (Ref. 2.2.1, Sections 6.4.22 and 6.4.33 [DIRS 174235]), it was determined that hazards from nearby industrial or military activities may be applicable to the repository during the preclosure period. Hazards identified by this analysis will be considered, if required, in the preclosure safety analysis for event sequence identification, event sequence categorization, and the determination of doses resulting from potential releases of radioactive material.

This analysis meets the requirements of the *Yucca Mountain Review Plan, Final Report* (Ref. 2.3.1, Section 2.1.1.3 [DIRS 163274]), for the determination of the potential for nearby industrial or military hazards that must be included as an event sequence initiator in the development of event sequences for the repository.

This analysis only considers issues related to preclosure radiological safety. Issues important to waste isolation as related to the impact from nearby industrial or military installations will be considered, if required, in the repository performance assessment.

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2.4 DESIGN OUTPUTS

This document may be used as input for other calculations, analyses, and/or other Yucca Mountain Project documents, including the license application.

3. ASSUMPTIONS

3.1 ASSUMPTIONS REQUIRING VERIFICATION

There are no assumptions requiring verification in this analysis.

3.2 ASSUMPTIONS NOT REQUIRING VERIFICATION

3.2.1 Facilities and Operations

Assumption–The facilities and operations described in this document are assumed to be representative of those present at the time of repository operation, and it is assumed that no inappropriate nonrepository facility or operations will be allowed within a 5-mile radius of the repository site during the preclosure operational period.

Rationale–The Yucca Mountain repository is located on lands administered by the federal government (i.e., the Nevada Test Site (NTS)), the U.S. Bureau of Land Management (BLM)), and the Nevada Test and Training Range (NTTR)) and are surrounded by a federal land withdrawal area. A land withdrawal area is federal property set aside for the exclusive use of a federal agency (i.e., the repository site is set aside for the U.S. Department of Energy (DOE)). A 5-mile radius from the repository is totally within the proposed land withdrawal area for the Yucca Mountain repository. Therefore, it is appropriate to assume that no inappropriate nonrepository facilities or operations are allowed within the 5-mile radius during operations of the repository.

3.2.2 Diesel Fuel Bulk Storage Tank Explosion

Assumption–The assumptions in Table 1 were used for the purpose of conservatively estimating the hazards associated with a diesel fuel vapor cloud explosion in a diesel fuel bulk storage tank at the Rail Equipment Maintenance Yard (REMY).

Rationale–These assumptions are appropriate to provide for a conservative and bounding calculation of the hazards associated with a diesel fuel bulk storage tank explosion.

Table 1. Assumptions Used for Quantitative Evaluation of a Diesel Fuel Bulk Storage Tank Explosion

Number	Assumption	Rationale
3.2.2.1	A vapor cloud explosion is assumed to occur within the vapor space of the diesel storage tank, regardless of the ignition source.	Vapor cloud explosions may occur in unconfined areas, although some degree of congestion is still required. Vapor cloud explosions can only occur in relatively large gas clouds (Ref. 2.2.2, p. 49 [DIRS 169507]). An ignition source will be required to ignite such a vapor cloud; none will be specified. Instead, the event is simply assumed to occur such that the no-damage overpressure distance can be calculated.
3.2.2.2	The pressure in the vapor space above the tank is approximately atmospheric pressure, assumed to be 14.73 psi.	Storage tanks used to store diesel fuel in bulk are vented. Therefore, the vapor mixture in the vapor space above the liquid in the tank will not be pressurized.
3.2.2.3	The temperature in the vapor space above the liquid in the storage tank is assumed to be approximately 140°F (600°R), which is the flash point typical for a low-sulfur diesel fuel blend (Ref. 2.2.3, p. 2 [DIRS 182837]).	The flash point of a liquid corresponds roughly to the lowest temperature at which the vapor pressure of the liquid is just sufficient to produce a flammable mixture at the lower limit of flammability (Ref. 2.2.4, p. 5-31 [DIRS 170847]). For this reason, the flash point was chosen as the temperature of the diesel fuel–air vapor mixture within the tank. This assumption is conservative and bounding.
3.2.2.4	The diesel fuel vapor concentration is conservatively assumed to be the upper flammable limit (UFL) for diesel fuel, which is 7.0%.	The UFL and lower flammable limit (LFL) for diesel fuel will vary depending on the concentrations of the components that comprise the grade of the fuel. A typical LFL for a low-sulfur diesel fuel is 0.9 %; the UFL for this blend is 7.0% (Ref. 2.2.3, p. 2 [DIRS 182837]). As described in Section A.6, to provide a bounding quantity of diesel fuel in the diesel fuel–air vapor mixture (for which the trinitrotoluene [TNT] equivalent is calculated, the UFL concentration of 7.0% is assumed.
3.2.2.5	The space filled by the diesel fuel vapor is conservatively assumed to be equivalent to the tank capacity (i.e., 50,000 gal).	Under normal circumstances the diesel fuel storage tank will have liquid in the tank; above the liquid a vapor mixture of diesel fuel and air will occupy the remainder of the tank (which will include the freeboard area above the liquid). In order to conservatively calculate a bounding TNT equivalent of the diesel fuel vapor in the storage tank, the vapor mixture is assumed to occupy the equivalent volume of the liquid capacity of the tank (i.e., 50,000 gal).

Table 1. Assumptions Used for Quantitative Evaluation of a Diesel Fuel Bulk Storage Tank Explosion (Continued)

Number	Assumption	Rationale
3.2.2.6	The molecular weight of diesel fuel is assumed to be equivalent to that of JP-5 jet fuel: 170 lb/lbmol.	As described in Section A.5, the molecular weight of diesel varies with carbon and hydrogen content. Jet fuel JP5, which is in the same family of gas oils or fuel oils as diesel, has a similar specific gravity and heat of combustion (0.83 and 43.0 MJ/kg, respectively (Ref. 2.2.5, p. A-36 [DIRS 165080]) as compared to a typical blend of diesel fuel (0.83 to 0.86) (Ref. 2.2.3, p. 4 [DIRS 182837]) and 44.4 MJ/kg (Ref. 2.2.6, p. 3-6 [DIRS 174827]), respectively. The molecular weight for JP5 is reported to be 170 lb/lbmol (Ref. 2.2.5, p. A-36 [DIRS 165080]); this value is assumed for diesel fuel.
3.2.2.7	Is assumed that there is sufficient oxygen in the air present in the vapor space to ensure complete combustion of the diesel fuel vapor present.	This conservative assumption provides for a maximum TNT equivalent value. In reality imperfect combustion occurs during accidental fires and explosion incidents, mainly due to turbulence, lack of adequate oxidizer supply, and other factors that produce free carbon (i.e., smoke) particles, carbon monoxide, etc. (Ref. 2.2.2, p. 45 [DIRS 169507]).
3.2.2.8	The value for η, the empirical explosion efficiency used in equation A-1, is assumed to be 0.03.	The quantitative evaluation of the effects of a diesel fuel vapor explosion inside of a bulk storage tank performed in Attachment A requires the knowledge of the efficiency of the explosion, as shown in Equation A-1. The value of the explosion efficiency depends on the method used to determine the contributing mass of fuel (Ref. 2.2.7, p. 165 [DIRS 156781]). A value of 0.03 is adequate when the explosion is investigated based on the quantity of fuel present in the vapor cloud, which is the approach followed in Attachment A. The efficiency of the explosion is dependent on the reactivity of the material, with higher reactivity giving a higher efficiency. Highly reactive materials are assigned higher efficiencies: an efficiency of 10% for diethyl ether, 5% for propane, and 15% for acetylene (Ref. 2.2.7, p. 165 [DIRS 156781]). Therefore, a nominal efficiency of 3%, a value of 5% for a sensitivity case, and a bounding case of 100% appear adequate for the quantitative evaluation in Attachment A.

NOTES: LFL = lower flammable limit; TNT = trinitrotoluene; UFL = upper flammable limit.

Source: Original

4. METHODOLOGY

4.1 QUALITY ASSURANCE

As determined from Section 2.1.C.1.1 of the *Quality Management Directive* (Ref. 2.1.1 [DIRS 184596]), the activity under which this analysis was developed is subject to the repository Quality Assurance Program requirements because this analysis examines hazards that may be applicable to items important to safety, as defined by 10 CFR 63.2, and it is part of the preclosure safety analysis. Therefore, the approved version of this document is designated as QA: QA. This analysis is prepared in accordance with *Calculations and Analyses* (Ref. 2.1.2) and *Preclosure Safety Analysis Process* (Ref. 2.1.3).

4.2 USE OF SOFTWARE

The operating environment used in writing this analysis included the use of Microsoft® Word 2003 software installed on a Dell OPTIPLEX 745 personal computer. The operating system used on this computer is Microsoft Windows XP Professional. The use of Microsoft® Word software is classified as Level 2 software usage per Attachment 12 of *Software Management* (Ref. 2.1.4, Attachment 12). No software (approved for quality assurance work or commercially available) was used for any calculation in this analysis. The formulas used in this analysis are presented in sufficient detail in Section 6.5 and Appendix A at the point of use to allow an independent check to reproduce or verify the results.

4.3 CRITERIA

Industrial and military activities that meet the NUREG-0800 (Ref. 2.3.2) Sections 2.2.1 and 2.2.2 [DIRS 183492]) proximity criteria (described in Section 4.4) must be evaluated for potential hazards that could lead to event sequences. As defined in 10 CFR 63.2 (Ref. 2.3.3, Section 63.2 [DIRS 180319]), an event sequence includes one or more initiating events and associated combinations of repository system component failures that could potentially lead to exposure of individuals to radiation (including nuclear criticality). Category 1 event sequences are those event sequences that are expected to occur one or more times before permanent closure; Category 2 event sequences are other event sequences that have at least one chance in 10,000 of occurring before permanent closure of the repository (Ref. 2.3.3, Section 63.2 [DIRS 180319]). Event sequences stemming from industrial and military activity hazards can be considered to be Beyond Category 2 if their event sequence frequency is less than 10^{-6} per year. Beyond Category 2 event sequences can be screened from further consideration. The duration of the preclosure period for the subsurface facilities is a 100-year period of operation (Ref. 2.2.8, Section 2.2.2.7 [DIRS 182131]).

4.4 METHOD

The U.S. Nuclear Regulatory Commission (NRC) governs the licensing of the repository to receive and possess high-level radioactive waste (HLW, as promulgated in 10 CFR Part 63). These regulatory requirements do not define a distance from the repository within which all facilities and operations must be identified and analyzed for potential impact on preclosure operations. Therefore, this analysis uses the approach that is defined in NUREG-0800 (Ref.

2.3.2) Sections 2.2.1 and 2.2.2 [DIRS 183492]), which specifies the identification of all facilities and activities within 5 miles of a nuclear power plant. In particular, Sections 2.2.1 and 2.2.2 of NUREG-0800 address the identification of potential hazards in the vicinity of a nuclear power plant site and provide methodology that can be applied to other nuclear facilities (e.g., the repository). NUREG-0800 also specifies that facilities and activities at greater distances be analyzed if they have the potential for affecting features important to radiological safety. This methodology involves identifying facilities within specified criteria, describing these facilities, describing the nature and extent of the activities conducted, and providing statistical data with respect to hazardous materials used at the facilities. The NRC staff review criteria in Section 2.2.1 of NUREG-0800 include the following:

1 The staff will review the site and its vicinity for the presence of transportation facilities and routes, including airports and airways, roadways, railways, pipelines, and navigable bodies of water. The staff will evaluate the data provided in the safety analysis report to confirm that the report adequately describes the locations of, and distances to, industrial, military, and transportation facilities in the vicinity of the plant and that the information provided is in agreement with data obtained from other sources, when available.

2. The staff will review the site and its vicinity for the presence of industrial activities, such as fixed manufacturing, processing, and storage facilities. The review should include all identified facilities and activities within 8 kilometers (5 miles) of the plant. The reviewer should be especially alert to any potentially hazardous activities in close proximity to the plant because an extensive variety of activities can have damage potential at ranges under about 1 kilometer (0.62 miles). Facilities and activities at distances greater than 8 kilometers (5 miles) should be considered if they have the potential for affecting plant safety-related features.

3. The staff will review the specific information relating to types of potentially hazardous material used, stored, or transported in the vicinity of the site—including distance, quantity, and frequency of shipment—to eliminate as many of the potential accident situations as possible by inspection, based on past review experience.

Hazards from an aircraft crash and from objects or ordnance falling from aircraft are evaluated in two separate analyses: *Frequency Analysis of Aircraft Hazards for License Application* (Ref. 2.2.9 [DIRS 180112]), and *Identification of Aircraft Hazards* (Ref. 2.2.10 [DIRS 181770]). Therefore, they are not considered in this analysis.

Initiating events may be screened from further consideration if they have a frequency that is less than 10^{-6} per year (i.e., are categorized as Beyond Category 2 events) (Section 4.3) or if they have no impact on the repository due to the combination of the event magnitude (e.g., minimal overpressure, temperature) and distance from the repository.

The types of hazards that are considered in this analysis include explosions, fires, and chemical releases that could potentially lead to event sequences. In the case of explosion overpressure, specific evaluations are performed to demonstrate that these events can be screened from further event sequence consideration based on their inability to cause a radiological release (Section 6.5 and Appendix A). If a hazard that could lead to an event sequence is identified, further analysis of the event sequence (including the categorization of the event sequences as Category 1, Category 2, or Beyond Category 2) will be performed in a more detailed preclosure safety analysis.

5. LIST OF ATTACHMENTS

	Number of Pages
Attachment A. Explosion Analysis for a Diesel Fuel Bulk Storage Tank	~~8~~ 6

6. BODY OF CALCULATION

The following sections of the analysis consider nearby industrial and military facilities and nearby transportation routes in the vicinity of the repository facilities.

6.1 INPUTS

The inputs shown in Table 2 are used to perform the quantitative evaluation of the pressure pulse generated by the combustion of diesel fuel in a storage tank at the REMY.

Table 2. Inputs Used for Quantitative Evaluation of a Fuel Tank Explosion

Input	Numerical Value/Characteristic	Source	Comment
Tank capacity	50,000 gal	(Ref. 2.2.11 [DIRS 181033])	Fifty thousand gallons of diesel fuel for locomotive use will be located at the southern end of the REMY.
Atmospheric pressure	101,325 Pa; equivalent to or 14.73 psi	(Ref. 2.2.12, p. F-335 [DIRS 128733])	This input is appropriate because the vapor cloud in the fuel tank will be at atmospheric pressure. The value given is the atmospheric pressure at sea level, which overestimates the actual normal pressure at the repository, which is higher in elevation. This approach conservatively increases the number of moles of gas that participate in the explosion.
Diesel fuel flash point	>140°F	(Ref. 2.2.3, p. 2 [DIRS 182837])	This value varies depending on the grade of diesel fuel; this value is typical of those reported in literature.
Diesel fuel upper and lower flammable limits	LFL = 0.9%; UFL = 7.0%	(Ref. 2.2.3, p. 2 [DIRS 182837])	These values vary depending on the grade of diesel fuel; these values are typical of those reported in literature.
Gas constant	8.31 J/(kmol); equivalent to 10.73 sq ft psi $°R^{-1}$ $lbmol^{-1}$	(Ref. 2.2.12, p. F-249 [DIRS 128733])	This value is used to calculate the number of moles of fuel vapor contained in the tank, using the ideal gas law, which is an appropriate approximation of the behavior of gases for the quantitative evaluation provided in Attachment A.
Heat of combustion of TNT	1943 BTU/lb	(Ref. 2.2.7, p. 160 [DIRS 156781])	This value is the lower bound of a range of TNT heat combustions given in AIChE (Ref. 2.2.7, p. 160 [DIRS 156781]). By taking the lower value of the range, the vapor cloud in the storage tank has a calculated equivalent TNT mass greater than if a higher value from the range was used, based on the use of this value in Equation A-1. The use of this value is conservative.
Heat of combustion of diesel fuel	44.4 MJ/kg (equivalent to 19,089 BTU/lb)	(Ref. 2.2.6, p. 3-6 [DIRS 174827])	This value varies depending on the grade of diesel fuel; this value is typical of those reported in literature.

NOTE: 1 J = 9.4782E-4 BTU and 1 lb = 0.4536 kg; LFL = lower flammable unit; TNT = trinitrotoluene; UFL = upper flammable unit.

Source: Original

6.2 APPLICATION OF NUREG-0800 PROXIMITY CRITERIA

NUREG-0800 (Ref. 2.3.2, Sections 2.2.1 and 2.2.2 [DIRS 183492]) specifies that the site and its vicinity be reviewed for the presence of industrial activities, such as fixed manufacturing, processing, and storage facilities. The review includes all identified facilities and activities within 5 miles of the plant. Furthermore, it is stated that facilities and activities at distances greater than 5 miles be considered if they have the potential for affecting plant safety-related features.

6.2.1 Surface Facilities

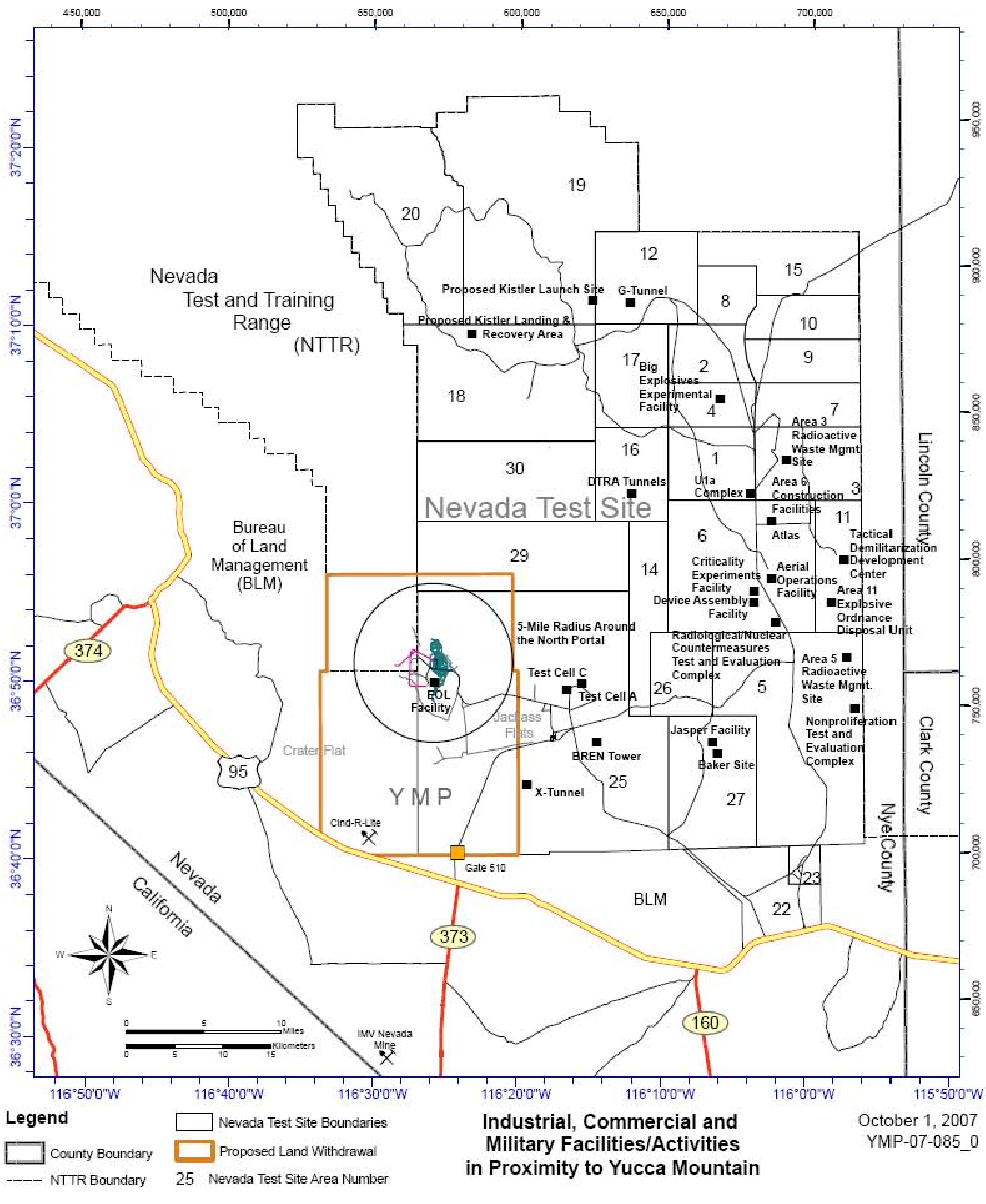
When applying the NUREG-0800 criterion, both surface and subsurface facilities have been considered. Figure 1 shows the relationship between the repository surface facilities and the industrial and military activities in proximity to the repository site.

A 5-mile radius has been drawn around the repository area based on the location of the repository North Portal. Figure 1 shows that the 5-mile radius surrounding the surface facilities is encompassed by the proposed land withdrawal area. The land withdrawal for the repository establishes a buffer zone that provides a minimum standoff distance from activities on the NTS. The proposed land withdrawal area is described in *Environmental Baseline File for Land Use* (Ref. 2.2.13, Section 2.1.1 [DIRS 104993]). The land use on the NTS was determined from the *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada* (Ref. 2.2.14, pp. 3-14 to 3-15 [DIRS 101811]).

The distance from the North Portal to the closest point on the site boundary with the NTS is approximately 5 miles. The surface geologic repository operations area (GROA) (defined as surface and subsurface areas where HLW handling activities are conducted) (Ref. 2.3.3, Section 63.2 [DIRS 180319]) is more than 4 miles from the site boundary with the NTS.

The area within the 5-mile radius of the surface facilities includes parts of the NTTR, Area 25 of the NTS, and public lands managed by the BLM. The only nonrepository facilities planned to be located within the 5-mile radius during the repository preclosure period are the REMY (also known as the End-of-Line (EOL) facility and the Cask Maintenance Facility (CMF). These facilities are evaluated in Section 6.4.

Active mine locations illustrated in Figure 1 were determined from *Major Mines of Nevada 2005, Mineral Industries in Nevada's Economy* (Ref. 2.2.15, Section VI [DIRS 178690]). The location of the Cinder-R-Lite mining operation was determined from *Environmental Baseline File for Land Use* (Ref. 2.2.13, p. 5 [DIRS 104993]).



NOTE: The purpose of this figure is to illustrate the location of the 5-mile radius relative to the North Portal and surrounding industrial and military facilities. No accuracy of information is intended or implied.

Figure 1. Industrial, Commercial, and Military Facilities and Activities in Proximity to Yucca Mountain

6.2.2 Subsurface Facility

There are no preclosure safety issues associated with industrial/military activities and the Subsurface Facility.

6.3 APPLICATION OF NUREG-0800 PLANT AFFECTING CRITERIA

NUREG-0800 (Ref. 2.3.2, Sections 2.2.1 and 2.2.2 [DIRS 183492]) states that potential hazards in the vicinity of the site should be reviewed. This review focuses on potential external hazards or hazardous materials that are present or may reasonably expected to be present during the projected lifetime of the proposed plant. It is stated that the review should include the presence of military and industrial facilities, such as fixed manufacturing, processing, and storage facilities. This area of review includes onsite storage facilities for materials such as compressed or liquid hydrogen, liquid oxygen, and propane.

As stated previously, the area within a 5-mile radius of the surface facilities includes parts of the NTTR, Area 25 of the NTS, and public lands managed by the BLM. The REMY and CMF are the only facilities identified to be located within the 5-mile radius of the repository. A description of the REMY and CMF and their potential to impact the repository is provided in Section 6.4.

The area outside of the 5-mile radius includes the balance of the proposed land withdrawal area, the balance of the NTS, U.S. Air Force land, and BLM land (Figure 1). The proposed land withdrawal area extends an additional 2 miles to the west and 8 miles to the south. The NTS extends over 30 miles to the north and over 20 miles to the east of the proposed land withdrawal area (Figure 1). The U.S. Air Force land is part of the NTTR, which extends over 50 miles to the north of the withdrawal area (Ref. 2.2.16 [DIRS 158638]). The BLM land extends beyond the proposed land withdrawal area to the west and south and includes U.S. Highway 95, the major route between Las Vegas and Reno, Nevada. The potential for transportation accidents affecting repository safety-related features is discussed in Section 6.3.5.

A description of the NTS facilities and activities and their potential to impact the repository is provided in Section 6.3.1. Hazards from an aircraft crash and from objects or ordnance falling from aircraft associated with the NTTR are covered in two separate analyses, *Frequency Analysis of Aircraft Hazards for License Application* (Ref. 2.2.9 [DIRS 180112]), and *Identification of Aircraft Hazards* (Ref. 2.2.10 [DIRS 181770]). Reference 2.2.9 demonstrates that aircraft hazards do not pose a significant risk to relevant repository surface facilities.

6.3.1 Nevada Test Site Facilities and Activities

The NTS is approximately 1,350 square miles (Ref. 2.2.14, p. 4-5 [DIRS 101811]), one of the largest restricted access areas in the United States. Established as the Atomic Energy Commission on-continent proving ground, the NTS has seen more than four decades of nuclear weapons testing. Ever since the nuclear weapons testing moratorium in 1992, and under the direction of the DOE, use of the NTS has diversified to include many other programs (e.g., chemical spill testing, emergency response training, conventional weapons testing, waste management studies, and environmental technology studies).

6.3.1.1 Defense Programs

6.3.1.1.1 Stockpile Stewardship

Among the major responsibilities of the DOE at the NTS and the Tonopah Test Range is the continued stewardship of the nation's nuclear weapons stockpile. Stockpile stewardship includes nuclear weapons testing and science-based weapons experimentation to ensure the safety, reliability, and performance of the nation's nuclear stockpile. The research and development of the technologies required for stockpile management are included under stockpile management. Experiments and tests have been conducted in Areas 1 through 10 for smaller yield devices and in Areas 18 through 20 for the higher yield devices (Figure 1) (Ref. 2.2.14, p. A-3 [DIRS 101811]). The closest of these locations is Area 6, which is approximately 15 miles from the repository. The most common method of weapons testing used is to emplace a test device at the bottom of a vertically drilled hole. Another method involves the placement of a test device within a tunnel that has been mined horizontally to a location that was sufficiently deep to provide containment (Ref. 2.2.14, p. A-3 [DIRS 101811]).

There is an unlikely possibility of a limited return to underground nuclear testing (Ref. 2.2.14, p. A-1 [DIRS 101811]). The potential impact from underground nuclear weapons testing includes ground motions imparted to the region during such a test. Data evaluated for over 14 years of testing concluded that the data and associated analyses demonstrate that ground motions at Yucca Mountain from nuclear tests have been at levels lower than would be expected from moderate to large earthquakes in the region. Thus, nuclear tests would not control seismic criteria for the repository (Ref. 2.2.17, Abstract [DIRS 103273]), and the event would be bounded by the earthquake event.

In addition to direct ground motion effects of underground nuclear explosions, there is also a potential hazard from secondary seismic effects. Secondary effects are associated with coseismic strain release attributed to the release of tectonic strain, aftershocks due to tectonic strain release, and events due to the collapse of cavities created by the explosion. Beyond 3 to 6 miles of even the largest underground nuclear explosion (greater than 1 megaton, there was no evidence of significant secondary seismic effect associated with the test (Ref. 2.2.14, p. 5-24 [DIRS 101811]).

6.3.1.1.2 Stockpile Management

Stockpile management includes the hands-on day-to-day functions and operations involved in maintaining the nuclear weapons stockpile, which includes assembly, disassembly, modification, and maintenance of nuclear weapons; quality assurance testing of weapons components; and the interim storage of nuclear weapons and components.

Pantex stockpile management operations could be transferred to the NTS (Ref. 2.2.14, p. A-17 [DIRS 101811]). New facilities would be centered near the Device Assembly Facility (DAF) in Area 6. These facilities would be necessary to disassemble nuclear weapons; modify, maintain, and monitor nuclear weapons; perform quality assurance testing of weapons components; assemble nuclear weapons; and store special nuclear materials. No activities or potential accidents associated with disposal have been identified that would impact the repository (Ref. 2.2.14, p. 5-137 [DIRS 101811]).

6.3.1.1.3 Nuclear Emergency Response

The DOE/Nevada Emergency Management Program is administered by the DOE/Nevada Emergency Management and Nonproliferation Division. The program is comprised of a number of separate but related emergency response programs. These nuclear emergency response programs include the following (Ref. 2.2.14, pp. A-11 to A-12 [DIRS 101811]):

- Nuclear Emergency Search Team
- Federal Radiological Monitoring and Assessment Center
- Aerial Measuring System
- Accident Response Group
- Radiological Assistance Program
- Internal Emergency Management Program.

None of these activities are expected to have an adverse impact on the repository.

6.3.1.1.4 Device Assembly Facility

The DAF is a multistructure facility (located in Area 6, more than 20 miles from the repository site) in which nuclear devices and high explosives can be assembled, disassembled or modified, staged, and component tested (Ref. 2.2.14, pp. A-4 and A-6 to A-7 [DIRS 101811]) (Figure 1). It is constructed primarily of heavy steel-reinforced concrete. The facility is earth-covered with a minimum of 5 ft of compacted earth overlay, leaving only one exterior wall. Assembly cells are designed to absorb the energy of an explosive blast to prevent propagation of the explosion into other structures within the facility. Each assembly cell is designed and tested to undergo an explosion from a maximum high explosive device without injury to personnel outside of the cell (Ref. 2.2.14, pp. A-4 and A-6 to A-7 [DIRS 101811]). This design reduces the potential impacts that could occur during an accident. Hence, no impact is expected at the repository from operations or events at the DAF.

6.3.1.1.5 Area 27 Complex

The Area 27 Complex has been the primary facility for the assembly of nuclear device test assemblies for the nuclear test program. The Area 27 complex is the alternate assembly facility to the DAF. The complex, which is about 20 miles from the repository site, houses kilogram quantities of special nuclear materials and up to several thousand pounds of various types of high explosives (Ref. 2.2.14, p. A-8 [DIRS 101811]) (Figure 1). Although the primary assembly buildings are of conventional construction, the adequacy of safety of the Area 27 Complex has been demonstrated over the years by a number of safety analyses, safety evaluations, and hazards analyses (Ref. 2.2.14, p. A-7 [DIRS 101811]), and an explosion would be highly unlikely. The maximum reasonably foreseeable radiological defense program accident at the NTS would be a nonnuclear explosion involving high explosives in an Area 27 nuclear weapons storage bunker, which has the probability of occurrence of 10^{-7} (1 in 10,000,000) per year (Ref. 2.2.14, p. 5-46 [DIRS 101811]).

6.3.1.1.6 Joint Actinide Shock Physics Experimental Research

The Joint Actinide Shock Physics Experimental Research (JASPER) Facility is also located in the Area 27 Complex. The JASPER Facility conducts shock physics experiments on special nuclear materials and other actinide materials using a two-stage, light–gas gun to shoot projectiles at target materials. A high-energy electrical pulse ignites a propellant in the breech of the gun. Hot gases from the burning propellant drive a piston down a pump tube, compressing the low-molecular-weight gas. At a predetermined pressure, the gas breaks a rupture valve and enters the narrow barrel, propelling a projectile housed in the barrel toward the target. The projectile impacts the target, producing a high-pressure shock wave that excites and propagates through the target. Diagnostic equipment measures properties of the shocked material inside the target. A description of this facility is contained in the *Supplement Analysis for the Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada* (Ref. 2.2.18, pp. 3-1 and 3-3 [DIRS 162638]). Although the JASPER Facility is categorized as a radiological facility because radionuclides are used as target materials in experiments, the supplement analysis for the NTS determined that the worst consequence to the environment would be minor local contamination (Ref. 2.2.18, p. 5-4 [DIRS 162638]). The risks to the repository would be negligible for activities or events that occur at the JASPER Facility.

6.3.1.1.7 U-1a Complex/Lyner Complex

The U-1a Complex (or Lyner Complex) was originally designed as a site to test low-yield nuclear devices. It has been converted to the testing of conventional high explosives as well as dynamic experiments, subcritical experiments, and hydrodynamic tests. Hydrodynamic tests are dynamic, integrated systems tests of mock-up nuclear packages during which the high explosives are detonated and the resulting motions and reactions of materials and components are observed and measured (Ref. 2.2.14, p. A-7, 8 [DIRS 101811]). The Lyner Complex consists of a mined shaft (U-1a, a drilled hole (U-1g, a connecting mined tunnel, and surface facilities. The complex is located west of the Mercury Highway in Yucca Flat, more than 20 miles from the repository (Figure 1). Dynamic experiments performed in this facility may include the use of special nuclear materials, but the experiments remain subcritical (i.e., no self-sustaining nuclear reaction would occur) (Ref. 2.2.14, p. A-9 [DIRS 101811]). Tests performed at this facility or events associated with this facility would have no impact on the repository.

6.3.1.1.8 Big Explosives Experimental Facility

The Big Explosives Experimental Facility (BEEF, located in Area 4 (Figure 1)), is one of the nation's premier hydrodynamic research and development testing facilities. It consists of two underground bunkers, one aboveground structure containing primary diagnostic facilities (including radiography, and three blast-protective enclosures that allow for diagnostic assessment equipment (Ref. 2.2.18, p. 3-4 [DIRS 162638]). Typical experiments involve 8,000 lbs or more of conventional high explosives in a variety of configurations (Ref. 2.2.14, p. A-11 [DIRS 101811]). The facility is capable of up to a 70,000-pound TNT-equivalent physics experiment to study and investigate explosive characteristics, impacted materials, and high-explosives pulsed power (Ref. 2.2.18, p. 3-4 [DIRS 162638]). The activities associated with the BEEF tests are not anticipated to impact facilities surrounding the tests and will have no impact on repository facilities, which are located more than 20 miles away (Section 6.5).

6.3.1.1.9 Nevada Energetic Materials Operations Facility

The Nevada Energetic Materials Operations Facility (NEMOF) is a staging and storage facility for explosives used at the BEEF and at the JASPER Facility. The NEMOF is located at the Area 27 Complex (Ref. 2.2.18, p. 3-3 [DIRS 162638]). Activities or events at this facility would have no impact on the repository.

6.3.1.1.10 Atlas Facility

The Atlas pulse power machine, designed to perform pulsed-power experiments on macroscopic targets (Ref. 2.2.19, p. 10 [DIRS 162459]), was relocated from Los Alamos National Laboratory to the NTS in 2004. The Atlas system requires a heavy industrial high-bay building equipped with a heavy-duty gantry crane to house the capacitor bank and user support facilities. A concrete building was built in Area 6 to house the machine. The building was designed to the requirements for a low-hazard nonnuclear facility (Ref. 2.2.19, p. 5 [DIRS 162459]). The targets of the Atlas machine are larger than those that are possible when using lasers and other currently available equipment. Pulsed-power systems deliver intense bursts of electrical energy by charging a large capacitor bank to a high voltage, then releasing the stored electrical energy in a short, single-cycle pulse of current through a cylindrical metal liner surrounding the test sample. The liner then implodes forcefully upon the sample. This facility was successfully tested on July 27, 2005 (Ref. 2.2.20 [DIRS 178688]). The experiments involving the Atlas pulse power machine would not impact the repository because of the distance between the repository and Area 6 (Figure 1).

6.3.1.1.11 Modern Pit Facility

The central core of a nuclear weapon is referred to as a pit. The NTS was one of five candidates for construction of a plutonium pit facility. This facility would provide manufacturing capabilities to temporarily store and fabricate new pits, to modify existing pits, and to recertify pits as part of the Stockpile Stewardship and Management Program (Ref. 2.2.18, p. 3-8 [DIRS 162638]). On January 28, 2004, the DOE/National Nuclear Security Administration announced that it was indefinitely postponing any decision on how it would obtain a large capacity pit manufacturing facility. The DOE/National Nuclear Security Administration is now planning to prepare *Supplement to the Stockpile Stewardship and Management Programmatic Environmental Impact Statement—Complex 2030*. Because this supplement will analyze alternatives for plutonium-related activities that include pit production, the DOE canceled the *Supplemental Programmatic Environmental Impact Statement on Stockpile Stewardship and Management for a Modern Pit Facility* (Ref. 2.3.4, Summary [DIRS 182929]).

6.3.1.1.12 Technical Area 18 Capabilities

The NTS was selected for relocation of materials and equipment from Technical Area 18 of the Los Alamos National Laboratory. Principal activities conducted at Technical Area 18 involve research in and the design, development, construction, and application of experiments on nuclear criticality. The western section of the Device Assembly Facility, located in Area 6, is now designated the Criticality Experiments Facility and is being retrofitted and reconfigured to accommodate the materials and equipment from Technical Area 18 (Ref. 2.2.21 [DIRS 178759]).

This location is more than 20 miles from the repository site (Figure 1). The results of the final environmental impact statement issued for the relocation indicated that the impact of an accident at the facility would be a minimal radiation dose to noninvolved workers (at Technical Area 18) and the maximally-exposed off-site individual (Ref. 2.2.22, p. 5-68 [DIRS 162639]). However, because the distance between Technical Area 18 and the repository site is greater than 20 mile, no impact would be expected to the repository site from any activities or occurrences at Technical Area 18.

6.3.1.1.13 Damaged Nuclear Weapons Program in G-Tunnel

The U-12g Tunnel, also known as the G-Tunnel, is located approximately 25 miles from the repository in Area 12 of the NTS (Figure 1). As part of the nuclear weapons disposition program, the G-Tunnel is being rehabilitated to make the tunnel safe for the programs and infrastructure necessary for staging and minimal assessment of a damaged nuclear weapon (Ref. 2.2.18, p. 3-7 [DIRS 162638]). Because of the distance between the G-Tunnel and the repository site, no impact would be expected to the repository site from any activities or occurrences at the G-Tunnel.

6.3.1.1.14 Next Generation Radiographic Facility; Next Generation Magnetic Flux Compression Generation Facility

Activities at proposed facilities (e.g., the Next Generation Radiographic Facility and the Next Generation Magnetic Flux Compression Generation Facility) would involve the use of conventional high explosives and subcritical masses. The Next Generation Radiographic Facility would be used for the investigation of the dynamics of metals subjected to the forces of a high-explosive detonation. The Next Generation Magnetic Flux Compression Generation Facility could support experiments that could make 100 to 1,000 MJ of electrical energy available to power experiments. Typical proposed experiments could involve 10,000 lbs or more conventional high explosives in a variety of configurations. Conceptual descriptions of these proposed facilities imply that the quantities of high explosives to be used in the experiments would be bounded by the quantity of 70,000 lbs for the BEEF (Ref. 2.2.14, pp. A-15 to A-16 [DIRS 101811]). Experiments with subcritical masses would be designed to remain subcritical (Ref. 2.2.14, p. A-15 [DIRS 101811]). Activities or events at these facilities would have no impact on the repository.

6.3.1.1.15 Storage and Disposition of Weapons-Usable Fissile Material

Two proposed options for the long-term storage of weapons-usable fissile material and disposition of surplus weapons-usable fissile material have been investigated. One option involves the construction of either a new plutonium storage facility or a new plutonium storage facility and a highly enriched uranium storage facility. These facilities would be located near the DAF. The other option is to utilize one of the horizontal event tunnels as the monitored storage site. The selected tunnel would have a new drift driven off the existing main access drift and would be dedicated to the storage of the device pits or other special nuclear material. These storage activities would not impact the repository (Ref. 2.2.14, p. A-18 [DIRS 101811]).

6.3.1.1.16 Other Potential Future Projects

Advance accelerator applications would involve the construction of an Accelerator-Driven Test Facility at the NTS (in either Area 22 or Area 25). This facility would comprise two components, an advanced high-energy accelerator that would provide protons to experimental facilities and a subcritical multiplier that would include a spallation target. The Advanced Hydrotest Facility is proposed to incorporate advanced technology that is needed to infer the nuclear performance (e.g., criticality, cavity shape, mix) of primaries from nonnuclear tests. The facility would include a broad array of diagnostics for dynamic testing with special nuclear materials and would broadly support national security concerns, including the displacement of potential proliferant or terrorist weapons (Ref. 2.2.18, p. 3-8 [DIRS 162638]). The construction of these facilities at the NTS is speculative at this time and, therefore, no analysis for these facilities is included in this report.

6.3.1.2 Waste Management Program

The primary mission of the NTS Waste Management Program is to serve as a low-level waste disposal facility in support of the DOE. The NTS provides disposal capability for NTS-generated waste and other DOE-approved waste generators. The NTS waste management activities are conducted in four primary areas: Areas 3, 5, 6, and 11 (Ref. 2.2.14, p. A-19 [DIRS 101811]).

6.3.1.2.1 Area 3 Radioactive Waste Management Site

The Area 3 Radioactive Waste Management Site includes seven subsidence craters created from underground nuclear weapons tests (Figure 1). Bulk low-level waste is disposed of in these subsidence craters (Ref. 2.2.14, p. A-23 [DIRS 101811]). The site encompasses approximately 128 acres of land and two support buildings located within the allocated boundaries of the facility. No activities or potential accidents associated with this site have been identified that would impact the repository.

6.3.1.2.2 Area 5 Radioactive Waste Management Site

The Area 5 Radioactive Waste Management Site is located in an area northwest of Frenchman Lake. The site encompasses 732 acres of allocated land. Low-level and mixed waste are stored on pads and disposed of via shallow land burial in pits and trenches (Ref. 2.2.14, p. A-23 [DIRS 101811]) (Figure 1). No activities or potential accidents associated with this site have been identified that would impact the repository.

6.3.1.2.3 Area 6 Waste Management Operations

Polychlorinated biphenyl wastes are stored in accordance with the Toxic Substance Control Act and State of Nevada regulations in Area 6 (Figure 1). Low-level and mixed waste effluent generated by Nevada Environmental Management and Defense Program activities are treated at the Liquid Waste Treatment System facilities. The hydrocarbon landfill is a Class II disposal site with a State of Nevada permit. The landfill is used for the sole purpose of discarding hydrocarbon-burdened soil, septic sludge, and debris (Ref. 2.2.14, p. A-25 [DIRS 101811]). No activities or potential accidents associated with this operation have been identified that would impact the repository.

6.3.1.2.4 Area 11 Explosive Ordnance Disposal Unit

The Area 11 Explosive Ordnance Disposal Unit is a thermal treatment unit rather than a disposal unit (Figure 1). Explosive ordnance wastes, regulated as characteristic reactive hazardous wastes under the Resource Conservation and Recovery Act of 1976 (Ref. 2.3.5, [DIRS 103936]), are detonated at the Explosive Ordnance Disposal Unit. The Explosive Ordnance Disposal Unit was first used in 1965 and continues to operate as a permitted Resource Conservation and Recovery Act treatment unit. The Explosive Ordnance Disposal Unit consists of a detonation pit surrounded by an earthen pad (approximately 25 by 100 ft) and ancillary equipment, including a bunker and an electric shock box. The Explosive Ordnance Disposal Unit has a maximum operating capacity to treat 100 lbs per hour or an annual capacity of 4,100 lbs. The Explosive Ordnance Disposal Unit has an unofficial buffer zone of approximately 503 acres in a circular area (Ref. 2.2.14, p. A-25 [DIRS 101811]). Because the Explosive Ordnance Disposal Unit is more than 20 miles from the repository and because of the limited amounts of explosive material handled in this disposal unit, this facility is not expected to impact the repository.

6.3.1.3 Environmental Restoration Program

Environmental restoration is the process by which contaminated DOE sites and facilities are identified and characterized and how existing contamination is contained (or removed and disposed of) to allow for beneficial reuse of the property. Toxic materials from this program are not transported in the vicinity of the repository (Ref. 2.2.14, Section A.3 [DIRS 101811]).

Environmental restoration projects are ongoing at the NTS (Ref. 2.2.14, pp. A-31 to A-36 [DIRS 101811]). Controlled explosive demolition has been used in the demolition of part of Test Cell A and is being considered for use in demolition of other facilities that were part of the nuclear rocket development program (Ref. 2.2.23, p. 2 [DIRS 181233]). These facilities are located outside of the proposed land withdrawal area and are more than 5 miles from the repository. No significant impact to the repository is postulated from the characterization, monitoring, decontamination and decommissioning, and other cleanup activities associated with these environmental restoration projects.

6.3.1.4 Non-defense Research and Development Program

The DOE has historically supported a variety of research and development activities at the NTS in cooperation with universities, industry, and other federal agencies (Ref. 2.2.14, p. A-37 [DIRS 101811]).

6.3.1.4.1 Alternative Energy

A Solar Energy Enterprise Zone facility concept is being advanced by a consortium of federal, state, and local entities, along with the solar power industry. The intent of this effort is to develop, finance, and construct one or more solar power production plants in southern Nevada. Proposed technologies for the facility include photovoltaic systems, parabolic-trough solar thermal systems, power tower systems, and parabolic dish systems (Ref. 2.2.14, pp. A-40 to A-41 [DIRS 101811]). No impact to the repository is postulated from this facility or facilities.

6.3.1.4.2 Nonproliferation Test and Evaluation Complex

The DOE Nonproliferation Test and Evaluation Complex (formerly known as the Hazardous Materials Spill Center and, before that, as the Spill Test Facility) is located approximately 25 miles from the repository in Area 5 on the eastern edge of the NTS (Figure 1). This facility is designed to test large- and small-scale releases of hazardous and toxic materials and biological simulants in a controlled environment. The facility is available to private companies to conduct experiments. It is designed to test both large- and small-scale hazardous and toxic materials in a controlled environment, including wind tunnel testing. The facility consists of a control facility, a wind tunnel, meteorological and camera towers, a tank farm and spill area, and a personal safety equipment building. The site is composed of four test areas (Ref. 2.2.14, pp. A-37, A-38 [DIRS 101811]). Most of the tests are performed when the wind is blowing to the northeast from a bearing of 225°. This bearing is allowed to vary up to 90° for small tests (Ref. 2.2.24, Section 1.2.4.1 [DIRS 170069]; (Ref. 2.2.25, Figure 2-1 [DIRS 178689]). Based on the distance between the Nonproliferation Test and Evaluation Complex and the repository, no impact to the repository is expected.

The release of biological simulants and low concentrations of chemicals is also permitted at various locations within the NTS. Releases are also conducted at Test Cell C in Area 25 (Figure 1) in addition to releases at the Nonproliferation Test and Evaluation Complex (Ref. 2.2.26, Section 3.2.4 [DIRS 176801]; (Ref. 2.2.27, Section 3.2.5 [DIRS 182285]).

Exclusion and buffer areas are established for the chemical tests conducted outside of the Nonproliferation Test and Evaluation Complex. Access and administrative controls for personnel entering these areas during tests provide protective measures for worker exposure control. No impacts are expected to involved workers, noninvolved workers, or members of the public (Ref. 2.2.25, Section 3.6 [DIRS 178689]).

6.3.1.4.3 Alternative Fuels Demonstration Projects

Although the NTS does not have the refueling infrastructure to support alternative-fueled vehicles, the DOE has converted sixteen of its vehicles at the NTS to run on compressed natural gas. These vehicles would be stationed in Las Vegas and would shuttle between the Nevada Operations Office and the NTS (Ref. 2.2.14, p. A-38 [DIRS 101811]). A vehicle explosion is bounded by operations at the BEEF and other NTS high-explosive test facilities. Therefore, this project would have no impact on the repository. Construction of a compressed natural gas fueling facility was proposed at the NTS, where alternative fuels and associated technologies may be studied (Ref. 2.2.14, p. A-42 [DIRS 101811]). Facilities at the NTS used for alternative fuel projects would be at least 5 miles from the repository and would have no impact on the repository.

6.3.1.4.4 Environmental Management and Technology Development Project

The goal of the Environmental Management and Technology Development Project office is to conduct a research and technology development program that is focused on overcoming major obstacles to progress in cleaning up the DOE sites that involves the best talent in the DOE and the international science communities. Five major remediation and waste management areas are the focus of the Environmental Management and Technology Development Project (Ref. 2.2.14, p. A-39 [DIRS 101811]):

- Contamination plume control and remediation
- Mixed waste characterization, treatment, and disposal
- High-level tank remediation
- Landfill stabilization
- Facility transitioning, decommissioning, and final disposition.

No impact to the repository is postulated from the control, remediation, characterization, treatment, disposal, stabilization, decommissioning, or dispositioning activities associated with this project.

6.3.1.4.5 Environmental Research Park

The National Environmental Research Program was established in 1972 by the DOE in response to recommendations by citizens, scientists, and members of Congress to set aside land for ecosystem preservation and study. The NTS Environmental Research Park was established in 1992. Areas of research involving the environmental research park include, but are not limited to, habitat reclamation, hydrogeologic systems, radionuclide transport, ecological change, waste management, monitoring processes, remediation, and characterization (Ref. 2.2.14, pp. A-39 to A-40 [DIRS 101811]). No impact to the repository is postulated from the activities associated with the research park.

6.3.1.5 Work for Others Program

The Work for Others Program is hosted by the DOE and includes the shared use of certain NTS and Tonopah Test Range facilities and resources with other federal agencies for various military training exercises and research and development projects (Ref. 2.2.14, p. A-43 [DIRS 101811]).

6.3.1.5.1 Treaty Verification

Activities at the NTS and NTS support facilities throughout Nevada, including the Tonopah Test Range, have been, and will continue to be, impacted by implementation of current and future international arms control treaties. Treaties currently in effect or under negotiation include the following (Ref. 2.2.14, p. A-43 [DIRS 101811]):

- Threshold Test Ban Treaty
- Peaceful Nuclear Explosion Treaty
- Chemical Weapons Convention
- The Treaty on Open Skies.

There are no explosives or hazardous materials associated with the treaty verification projects (Ref. 2.2.14, Section A.5.1 [DIRS 101811]). No impact to the repository is postulated from the activities associated with treaty verification projects.

6.3.1.5.2 Nonproliferation

The policy of the United States is to resist the proliferation of weapons of mass destruction (e.g., nuclear, biological, chemical). In the past, seismic signatures and ground disturbances produced from underground nuclear weapons tests at the NTS have been analyzed to develop techniques and methods for detecting and evaluating underground nuclear tests worldwide. Additional nonproliferation-related experiments are currently using the unique capabilities of the Nonproliferation Test and Evaluation Complex for the development, characterization, and testing of remote sensors of chemical effluent (Ref. 2.2.14, pp. A-43 to A-44 [DIRS 101811]). No impact to the repository is postulated from nonproliferation activities.

6.3.1.5.3 Counter-Proliferation Research and Development

Counter-proliferation refers to U.S. Department of Defense efforts to combat the international proliferation of weapons of mass destruction. Because facilities for the development, production, and storage of these weapons are located below the ground, much of the research and development involves the detection, monitoring, and neutralization of buried targets. The tunnels and bunkers at the NTS provide ideal testing environments for a variety of counterproliferation research and development experiments. Experiments that use various remote imagery and sensory applications, in conjunction with NTS bunkers and tunnels, are conducted to develop techniques and methods to detect, characterize, and monitor buried objects. Such experiments involve both land-based and airborne operations. Experiments to develop various techniques for destroying or neutralizing weapons of mass destruction and buried objects, such as bunkers and tunnels, are also performed. These experiments involve the surface and below-ground detonation of conventional explosives in the immediate vicinity of the NTS and Tonapah Test Range bunkers and tunnels. Many of these activities are performed at the BEEF (Section 6.3.1.1) (Ref. 2.2.14, p. A-44 [DIRS 101811]). The activities associated with conventional high-explosives testing, surface dynamic experiments, and hydrodynamic tests are not anticipated to impact facilities surrounding these tests and, therefore, would not have any impact on repository facilities located 20 or more miles away (Figure 1 and Section 6.5).

6.3.1.5.4 Conventional Weapons Demilitarization

The demilitarization activity proposed for the NTS is a demonstration of technologies to destroy obsolete conventional munitions, pyrotechnics, and solid rocket motors by testing the technologies. The existing underground tunnels and facilities at the NTS could provide the opportunity to demonstrate environmentally sound methods of destruction/treatment of solid rocket motors, pyrotechnics, and other nonnuclear energetic materials. Such methods could include the use of specially designed pollution abatement systems that remove the gaseous combustion products from the air before release to the atmosphere and provide for containment and treatment of residual debris. For example, the Nonproliferation Test and Evaluation Complex in Area 5 could suffice for the demonstration of thermal treatment technologies for pyrotechnics, and a tunnel environment (e.g., X-Tunnel) would suffice for the demonstration technologies involving solid rocket motors or other conventional munitions (Figure 1). Using an NTS tunnel takes advantage of a known geologic cavern as well as the expertise of the NTS workforce in tunnel handling and firing of high explosives and in monitoring explosives in a contained environment (Ref. 2.2.14, p. A-45 [DIRS 101811]). Because the repository is approximately 10 miles from the X-Tunnel and approximately 25 miles from the Nonproliferation Test and Evaluation Complex, no impact is expected to the repository from these facilities or demilitarization activities.

6.3.1.5.5 Tactical Demilitarization Development Complex

The Tactical Demilitarization Development Complex is located more than 25 miles from the repository in Area 11 of the NTS (Figure 1). This facility was developed as a prototype of a portable burn facility to dispose of unneeded tactical military rocket motors. The prototype consists of a firing chamber, an exhaust gas holder, and an emission scrubber. Emissions are controlled by a baghouse, high-efficiency particulate air filters, and ultra high-efficiency filters. This facility was not used during 2004 and 2005 and is not intended to be used again as it is expected to be removed from the NTS air quality operating permit (Ref. 2.2.28, pp. 1 to 2 [DIRS 171946]; Ref. 2.2.26, Section 3.2.5 [DIRS 176801]; Ref. 2.2.27, Section 3.2.6 [DIRS 182285]).

6.3.1.5.6 Defense-Related Research and Development

Defense-related research and development activities at the NTS have included tests and training exercises employing a wide variety of weaponry (e.g., small arms, artillery, guns, aircraft, armored vehicles, rockets) as well as a variety of electronic, imagery, and sensory technologies including, but not limited to, infrared, lasers, and radar (Ref. 2.2.14, p. A-45 [DIRS 101811]). It is expected that explosions associated with these activities are bounded by operations at the BEEF and, therefore, have no impact on the repository. In addition, it is expected that any other defense-related research and development exercise would be of sufficient distance from the repository that the activity would not present a hazard to the repository.

6.3.1.5.7 Weapons of Mass Destruction Work for the U.S. Department of Justice

The NTS has been established as a U.S. Department of Justice/Office of State and Local Domestic Preparedness Support Center of Excellence for Training and Exercises. The mission of the Center is to develop and implement a national program to enhance the capacity of state and local agencies to respond to weapons of mass destruction terrorist incidents through coordinated training, equipment acquisition, technical assistance, and support for state and local exercise planning. As a result, NTS personnel have been involved in providing training to state and local first responders at the NTS (Ref. 2.2.18, Section 3.1.5.2 [DIRS 162638]). It is expected that any training exercises would be of sufficient distance from the repository that the activities would not present a hazard to the repository.

6.3.1.5.8 Defense Threat Reduction Agency Hard Target Defeat Tunnel Program

The purpose of this program is to develop and demonstrate capabilities and technologies to hold at risk and defeat military missions protected in tunnels and other deeply buried hardened facilities. The testing program demonstrates the capability to detect, identify, and characterize the target and then disrupt, neutralize, or destroy the tunnel target. The Defense Threat

Reduction Agency evaluates alternative capabilities with various platforms against a variety of tunnel complexes constructed at the NTS that represent different world geologic compositions (Ref. 2.2.18, Section 3.1.5.2 [DIRS 162638]). The Defense Threat Reduction Agency tunnels are located in Area 16, approximately 15 mi from the repository (Figure 1). No impact is expected to the repository from this program.

6.3.1.5.9 U.S. Military Development and Training in Tactics and Procedures for Counterterrorism Threats and National Security Defense

U.S. Department of Defense organizations take advantage of the NTS restricted access and remote high desert terrain in the west and northwest for developing realistic scenarios expected to be encountered in specific mission profiles, including the following (Ref. 2.2.18, Section 3.1.5.2 [DIRS 162638]):

- Direct action live-fire takedown of high-fidelity target test beds
- Low-altitude fixed and rotary wing desert flight training and technique development
- Remote area advanced personnel overland navigation techniques
- Development and field testing of special-use military hardware, including new ordnance and vehicles
- Development and field testing of unmanned air vehicles
- Overland movement through rugged terrain to assess fatigue and war-fighter capability.

As mentioned in Section 4.4, hazards from an aircraft crash and from objects or ordnance falling from aircraft are evaluated in two separate analyses: *Frequency Analysis of Aircraft Hazards for License Application* (Ref. 2.2.9 [DIRS 180112]), and *Identification of Aircraft Hazards* (Ref. 2.2.10 [DIRS 181770]). Therefore, they are not considered in this analysis. Any other training or tactics event involving a U.S. Department of Defense organization associated with this type of operation would be of sufficient distance from the repository such that no impact to the repository is expected.

6.3.1.5.10 Aerial Operations Facility

An Aerial Operations Facility has been constructed on the southeast side of Yucca Lake in Area 6 (Figure 1). The purpose of this facility is to construct, operate, and test a variety of unmanned aerial vehicles. Tests include, but are not limited to, airframe modifications, sensor operation, and onboard computer development. A small, manned chase plane is used to track the unmanned aerial vehicles. The facility includes an asphalt runway that is approximately 5,200 ft long. Commercial aviation fuel is used in the test vehicles (Ref. 2.2.29, Section 2.1 [DIRS 173221]).

Again, as mentioned in Section 4.4, hazards from an aircraft crash and from objects or ordnance falling from aircraft are evaluated in two separate analyses: *Frequency Analysis of Aircraft Hazards for License Application* (Ref. 2.2.9 [DIRS 180112]), and *Identification of Aircraft*

Hazards (Ref. 2.2.10 [DIRS 181770]). Therefore, they are not considered in this analysis. Any other hazard associated with this facility (e.g., fire, explosion) would be of sufficient distance from the repository such that no impact to the repository is expected.

6.3.1.6 Miscellaneous New Missions and Facilities

6.3.1.6.1 National Center for Combating Terrorism

The National Center for Combating Terrorism provides a comprehensive, coordinated, and integrated venue for combating terrorism, including research, development, testing, and evaluation exercises; training; intelligence support; and a comprehensive, fully-integrated system of facilities and capabilities to meet a wide range of requirements for combating terrorism. Users of the Center include federal, state, and local agencies; institutions; and private entities involved in aspects of combating terrorism. The National Center for Combating Terrorism uses the unique capabilities of the NTS to provide the following (Ref. 2.2.18, Section 3.1.6 [DIRS 162638]):

- Comprehensive capabilities to support a broad range of user needs for combating terrorism
- A variety of test beds for research, development, testing, and evaluation
- A variety of facilities and scenarios for training and exercises
- The technology to capture data and develop lessons learned
- High-technology, field-ready products and services
- A remote location with restricted access.

The National Center for Combating Terrorism utilizes facilities and structures located throughout the NTS. Numerous industrial complexes are used for training and exercises; these facilities also provide a capability for complex testing and evaluation. Urban search and rescue capabilities have also been added to some of the complexes. One complex has been improved to include mock border crossings, a cargo portal test track, and a container port shipping yard with gantry crane, all for radiological testing. The town of Mercury contains a mock chemical, biological, radiological, and nuclear explosive laboratory; the Exercise Management Center; and other support facilities (Ref. 2.2.31, p. 11 [DIRS 178760]). Although training exercises may be held at industrial complexes located in Area 25 (i.e., beyond the 5-mile radius around the repository site, these training activities are of sufficient distance from the repository that no impact to the repository is expected.

6.3.1.6.2 Radiological/Nuclear Countermeasures Test and Evaluation Complex

Construction of a Radiological/Nuclear Countermeasures Test and Evaluation Complex is ongoing at the NTS. The complex is located in Area 6, south of the Device Assembly Facility, approximately 20 miles from the repository (Figure 1). The purpose of the complex is to conduct a wide variety of testing and evaluation activities related to combating terrorism.

Specifically, the complex would encompass the following activities (Ref. 2.2.32, Section 2.1 [DIRS 178761]):

- Prototype detector testing and evaluation
- Systems testing and evaluation
- Performance standards validation
- Demonstration of prototype detectors, systems, and performance standards
- Verified threat demonstration
- Concept of operations evaluation and verification
- Training.

As currently conceived, the Radiological/Nuclear Countermeasures Test and Evaluation Complex would include up to eight venues supported by a common infrastructure. These eight venues would include the following (Ref. 2.2.32, Section 2.1.1 [DIRS 178761]):

- Port of Entry-Primary
- Port of Entry-Secondary
- Airport Inspections Facility
- Active Interrogation Facility
- Environmental Test Facility
- Sensor Test Track
- High-Speed Road
- Training Facility.

When fully operational, this facility is anticipated to be classified as a Hazard Category 2 Nuclear Facility. Radioactive materials that could be used at these facilities could include up to 50 kg of highly enriched uranium and other special nuclear material components in various shapes and sizes, up to several kilograms each. The special nuclear material would be solid metal and encased in nonradioactive metal cladding. Nonspecial-nuclear-material radioactive sources would be in either solid or liquid form. Short half-life isotopes are typically used for medical purposes but would not be used for those purposes at the complex (i.e., they would not be administered to people or animals). All radioactive materials would be sealed or encased in metal cladding. None of the activities at the complex would involve the release of radioactive materials (Ref. 2.2.32, Section 2.1.2.3 [DIRS 178761]).

A source vault consisting of two portable steel armor storage magazines would be required to support operations. It is expected that the source vault would house a variety of nonspecial-nuclear-material radioactive sealed sources. The majority of those would be exempt quantities of check sources such as ^{60}Co, ^{137}Cs, ^{152}Eu, ^{133}Ba, ^{90}Sr, and 241Am that are exempt from management under 10 CFR Part 835 (Ref. 2.3.12 [DIRS 183853]). In addition, accountable quantities of these sources and small quantities of uranium and plutonium would be held in the source vault. These sources would need to be readily available to personnel for checking the operation and calibrating of instruments in the complex. Special nuclear material would be stored at the DAF, transported to the Radiological/Nuclear Countermeasures Test and Evaluation Complex when needed, and returned to storage at the DAF at the completion of the activities (Ref. 2.2.32, Section 2.1.2.3 [DIRS 178761]).

One of the eight venues that comprise the Complex, the Active Interrogation Facility, would provide a realistic test environment for development of active interrogation systems for the detection of highly enriched uranium, special nuclear material, or fissile materials. In addition to accelerator-produced radiation fields, a vertical shaft would be located in the middle of the integral roadway, allowing the emplacement of a high-activity neutron-emitting radionuclide. The neutron beam would be able to sweep across moving containers on the integral roadway. Shielding and exclusion areas would be established to protect personnel from receiving unsafe radiation doses. In addition, the very high radiation area would be surrounded with a chain link fence with an active interlock system for immediate accelerator shutdown if the gate is opened during operation. All radiation areas would be posted and marked. Warning lights would be active when accelerators are in operation (Ref. 2.2.32, Section 2.1.1 [DIRS 178761]).

Although not part of the current proposed project, future additions to the facilities could include venues such as a short length of full-scale railroad line which would run parallel to the high-speed road and a seaport facility including shipping containers, a gantry crane, a mock cargo ship, and a mock urban area (Ref. 2.2.32, Section 2.1.1 [DIRS 178761]).

The proposed construction and operation of the Radiological/Nuclear Countermeasures Test and Evaluation Complex will not have any impact on the activities or personnel at the Yucca Mountain Project (Ref. 2.2.32, Section 5.1.1 [DIRS 178761]). There is sufficient displacement between the Complex and the repository to preclude any hazard. In addition, administrative and engineering controls will be implemented to ensure that the probability of occurrence of potential accidents and hazards associated with the Complex is low (Ref. 2.2.32, Section 7.0 [DIRS 178761]).

6.3.1.7 Missile Launches

The last Army Tactical Missile System launch at the NTS was conducted in Area 26 (Figure 1) in June 2000. No launches are expected in the near future, and because this launch was the last for the program, there are no forecasts for future ground-to-ground missile testing (Ref. 2.2.10, Section 6.5 [DIRS 181770]). Therefore, no hazard to the repository is expected from missile launch operations.

6.3.1.8 Site Support Activities

No site support activities (e.g., utilities, communications, transportation systems, existing support facilities both on-site and off-site) identified in the *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada* (Ref. 2.2.14, Sections A.6 and A.6.1 through A.6.4 [DIRS 101811]) are expected to impact the repository.

6.3.2 Bureau of Land Management Activities

There were no hazards identified within the 5-mile radius of the repository on BLM land.

6.3.3 Potentially Hazardous Commercial Operations

6.3.3.1 Pipelines and Fuel Tanks

There are no liquid petroleum pipelines or natural gas pipelines within the land withdrawal area for the repository, and no construction of a pipeline would be permitted within the land withdrawal area of the repository. There may be propane tanks and gasoline tanks on the NTS used for refueling vehicles, none of which would be located within 5 miles of the repository. A 50,000-gal diesel fuel storage tank will be located at the southern end of the REMY (i.e., outside of the GROA and outside of the repository site) (Ref. 2.2.11 [DIRS 181033]). The hazards associated with this fuel storage tank are discussed in Section 6.4 and Appendix A.

6.3.3.2 Commercial Rocket Launch and Retrieval

Kistler Aerospace Corporation proposed to launch low-earth-orbit satellites using a reusable two-stage vehicle (Ref. 2.2.33, p. 1-1 [DIRS 162033]). A potential launch site and landing and recovery area are proposed to be located in Areas 18 and 19 at the NTS (Figure 1) (Ref. 2.2.33, p. 2-1 [DIRS 162033]). This space vehicle launch project at the NTS is in the formative stages; there are no constructed or operational facilities. The Federal Aviation Administration prepared and issued an Environmental Assessment evaluating launches from the NTS (Ref. 2.2.33, p. 1-1 [DIRS 162033]), and the Federal Aviation Administration Associate Administrator for Commercial Space Transportation issued a Finding of No Significant Impact (Ref. 2.3.6 [DIRS 158421]) for this activity. In July 2003, Kistler voluntarily filed to reorganize under Chapter 11 bankruptcy (Ref. 2.2.34 [DIRS 169260]). In 2006, Rocketplane Limited, Inc., and Kistler Aerospace merged to form Rocketplane Kistler. The National Aeronautics and Space Administration (NASA) selected Rocketplane Kistler to receive partial funding to provide delivery services to the International Space Station under the Commercial Orbital Transportation Services initiative (Ref. 2.2.35, p. 4 [DIRS 180406]).

Rocketplane Kistler expects to operate the K-1 reusable launch vehicle from two launch sites: Spaceport Woomera in South Australia and a site in the United States that is yet to be determined. Kistler Aerospace received authorization from the Australian government to begin construction of launch facilities in April 1998 and held a groundbreaking ceremony at the site several months later. The launch pad design is complete, and Rocketplane Kistler will conduct its initial K-1 flights and commercial operations from Woomera. Although an agreement was signed with the Nevada Test Site Development Corporation to permit Kistler to occupy a segment of the NTS for its launch operations, and the environmental review process was completed for the project in 2002, the company is currently examining other options for a domestic launch site, including Cape Canaveral Air Force Station (Ref. 2.2.35, p. 24 [DIRS 180406]). A detailed flight hazards analysis would be conducted as part of a safety review under the auspices of the Federal Aviation Administration before a determination is made on whether to license any launch activities at the NTS or any other location in the United States. Therefore, at this time, no hazards associated with the launch of commercial rockets are expected to affect the repository.

6.3.3.3 Sand and Gravel Industrial Quarrying

There are no sand and gravel operations within the 5-mile radius of the repository, and activities with a significant adverse impact on the repository will not be permitted within the land withdrawal area. Any earth-disturbing operations outside the land withdrawal area will not affect water flow patterns in the vicinity of the repository.

6.3.3.4 Mineral Exploration, Mining, and Ore Processing

There are no mining claims over the repository block. Public Land Order 6802 (Ref. 2.3.7 [DIRS 102872]; (Ref. 2.2.13, p. 2 [DIRS 104993]) was granted by the BLM with an expiration date of 1990 and was extended by Public Land Order 7534 until 2010 (Ref. 2.3.8 [DIRS 162056]). These Public Land Orders preclude the staking of mining claims over the repository block.

The IMV Nevada Mine, operating in Nye County in southern Amargosa Valley, is the only major mine in the vicinity of Yucca Mountain (Ref. 2.2.15, Section VI [DIRS 178690]). Although this mine is beyond the 5-mile radius of the repository site, it will employ truck transportation for mine supplies along U.S. Highway 95 and State Highway 373. These transportation corridors are sufficiently distant from the repository site (i.e., greater than 10 miles; Figure 1) that no impact from transportation events relating to mining traffic is expected to occur.

The Cind-R-Lite Company owns approximately 200 acres of land and a patented mining claim at the southern edge of the land withdrawal area (Figure 1). This operation is the only private property within the proposed land withdrawal area (Ref. 2.2.13, Section 2.1.1 [DIRS 104993]). This operation extracts material from the cinder cone at that location for the manufacture of lightweight concrete blocks. This operation is approximately 7 miles from the repository site (Ref. 2.2.16 [DIRS 158638]); therefore, no impact is expected at the repository from Cind-R-Lite operations.

There are currently unpatented mining claims at the southern edge of the land withdrawal area (Ref. 2.2.13, p. 5 [DIRS 104993]). They are outside the 5-mile radius of the repository site. If these unpatented claims were to commence operations, no impact would be expected from operations at these locations.

There are numerous small mining, milling, and exploration operations in southern Nevada. None of these operations, other than those described in the previous paragraphs, are within the proposed land withdrawal area. No impact is expected to the repository from operations at these sites.

The *Yucca Mountain Site Description* (Ref. 2.2.36, Sections 3.6.2 through 3.6.5 [DIRS 169734]) describes results of investigations in the Yucca Mountain area that address natural resources and their economic potential. Although the region surrounding Yucca Mountain contains deposits of potentially economic amounts of these resources, the hydrothermal activity resulting in mineral deposits elsewhere did not extend to the Yucca Mountain area. This conclusion is based on studies of the mineralogy, petrography, and alteration of numerous rock samples, geophysical data, geologic mapping, remote sensing imagery, and results of chemical analyses, which, when combined, show no direct evidence for economic mineralization, as described in *Yucca Mountain Site Description*. The small, largely trace amounts of the minerals that were detected (e.g., tin, gold, uranium) are far below the concentrations or the volumes required for any consideration to be given to economic development.

It has been concluded in *Yucca Mountain Site Description* (Ref. 2.2.36, Sections 3.6.2 through 3.6.5 [DIRS 169734]) that the area studied contains no identifiable economic metallic mineral, energy (e.g., oil, gas, coal, or industrial mineral/rock resources. The area was also judged to have low or little potential for deposits of these resources that could be mined economically either at present or in the foreseeable future. Because of these conclusions, no mining activities are expected to commence within the 5-mile radius from the repository. In any case, DOE control over the land withdrawal area will ensure that inappropriate exploration, mining, and ore processing activities will be excluded from the land withdrawal area.

6.3.3.5 Petroleum Exploration and Refining

To date, no significant volumes of oil or gas have been found in southern Nevada or adjacent California and Arizona. The geologic conditions at Yucca Mountain indicate a low potential for the generation and accumulation of oil and gas. Previous scientific studies, conducted as part of the site characterization of Yucca Mountain, indicate that past geologic temperatures have been too high for oil and gas to cook from the surrounding rock during past geological periods. As a result, there is a low potential for oil deposits near the site (Ref. 2.2.37, Abstract, Section I [DIRS 100036]). Railroad Valley, approximately 120 miles north-northeast of Yucca Mountain, produced 93 percent of the oil production in Nevada between 1954 and 1992. The remaining oil production was from Pine Valley, approximately 190 miles north of Yucca Mountain. No significant natural gas resources have been discovered in Nevada. Geological testing of the repository site indicates that the potential for a commercial accumulation of oil and gas beneath Yucca Mountain is low (Ref. 2.2.37, Section IX [DIRS 100036]). Other energy resources such as tar sands, oil shale, and coal are not known to exist in the rocks underlying Yucca Mountain and have not been detected in any of the boreholes drilled in the area or recognized in outcrops in nearby areas. There is no potential for geothermal development in the area (Ref. 2.2.36, Sections 3.6.2 through 3.6.5 [DIRS 169734]). In the unlikely event that commercial deposits of oil or gas are found near Yucca Mountain, DOE control over the land withdrawal area will ensure that exploration and refining activities will not be close enough to the repository site to pose a hazard.

6.3.4 Industrial-Military Chemical Releases

The NTS could potentially have the capacity to release toxic and/or hazardous chemicals. In accordance with Regulatory Guide 1.78, Section 1.1 (Ref. 2.3.9 [DIRS 161986]), chemical releases may be discounted as negligible if they occur at distances greater than 5 miles from a site:

> Chemicals stored or situated at distances greater than 5 miles from the plant need not be considered because, if a release occurs at such a distance, atmospheric dispersion will dilute and disperse the incoming plume to such a degree that either toxic limits will never be reached or there would be sufficient time for the control room operators to take appropriate action. In addition, the probability of a plume remaining within a given sector for a long period of time is quite small.

The repository site is sufficiently distant from the areas of the NTS that may have the potential for toxic releases (all are located at distances greater than 5 miles from the repository) such that no significant impact is expected to result from any such releases at the NTS. No industrial sources for toxic or hazardous chemical releases are within 5 miles of the repository site. DOE control over the land withdrawal area will ensure that such sources will not be located close enough to the repository site to pose a hazard. A low-level radioactive waste landfill was operated from 1962 until 1992 near the town of Beatty in Nye County (Ref. 2.2.38, p. 12, Part Two [DIRS 162455]). Although the landfill closed to low-level radioactive waste generators, it continues to accept limited types and quantities of hazardous waste. The Beatty facility is of sufficient distance (approximately 20 miles) from the repository site such that no landfill events will impact the repository.

6.3.5 Transportation

6.3.5.1 Roads

Both U.S. Highway 95 and roads on the NTS are used to haul significant quantities of explosives, munitions, propellants, and hazardous and radioactive materials. At its closest point, U.S. Highway 95 is approximately 13 miles from the repository surface facilities (Ref. 2.2.16 [DIRS 158638]). Of the primary paved roads in the southern part of the NTS, Lathrop Wells Road is approximately 7 miles from, and the closest to, the repository surface facilities (Ref. 2.2.16 [DIRS 158638]). The Lathrop Wells Road, which traverses the southeastern area of the repository withdrawal area is used to support testing described in Section 6.3.1.5 (Ref. 2.2.14, p. 4-39 [DIRS 101811]). Even though some hazardous materials are transported onto the NTS via the Lathrop Wells Road for this testing, the transport vehicles will be at least 7 miles from the repository surface facilities (Figure 1) (Ref. 2.2.16 [DIRS 158638]).

6.3.5.2 Railroads

There are no transportation railroad lines within 20 miles of the repository surface facilities (Ref. 2.2.16 [DIRS 158638]).

The DOE will construct a new rail line to connect the GROA to commercial rail lines within the State of Nevada 1. The DOE will construct rail facilities to support repository operations. Two facilities are planned to be in the immediate vicinity of the site: the REMY and the CMF (Ref. 2.2.30, Section 6.0 [DIRS 180919]). These facilities are evaluated in Section 6.4.

The road and railroad transportation routes are sufficiently distant from the repository to preclude adverse effects of transportation accidents resulting from explosions, as discussed in Section 6.5. These distances are also sufficiently distant from the repository to preclude adverse effects of fires or toxic releases associated with transportation accidents (Section 6.3.4 provides a discussion of toxic and hazardous chemicals).

6.3.6 Environmental Reclamation

There are no U.S. Environmental Protection Agency (EPA) National Priorities List (NPL) (Superfund) sites within the 5-mile radius of the repository. The NPL is the list of national priorities among the known releases or threatened releases of hazardous substances, pollutants, or contaminants throughout the United States and its territories. The NPL is intended primarily to guide the EPA in determining which sites warrant further investigation (Ref. 2.2.39 [DIRS 183014]).

6.3.7 Interim Waste Storage

The possibility exists for interim storage of high-level radioactive waste by a private company during the repository preclosure period. It is expected that this storage will be far removed from the repository and may potentially occur within the State of Utah at the Private Fuel Storage Facility (Ref. 2.2.40 [DIRS 103436]). However, legal issues and opposition to the project may indefinitely delay the opening of this facility. Therefore, there is no impact.

6.4 EVALUATION OF APPLICATION OF NUREG-0800 PROXIMITY CRITERIA TO FACILITIES WITHIN THE 5-MILE SAFE DISTANCE

As previously mentioned in Section 6.2.1, the only nonrepository facilities planned to be located within the 5-mile radius of the surface facilities during the repository preclosure period are the CMF and the REMY.

Nevada Rail Line (NRL) trains carrying casks loaded with spent nuclear fuel, HLW, and general freight in support of GROA construction and ongoing support will operate from the NRL rail yard (to be located in either Caliente or Eccles) to the REMY (the EOL facility; Figure 1). The CMF (also known as the Fleet Management Facility) will be co-located adjacent to the REMY. The REMY and the CMF will be located adjacent to, but not inside the GROA, within the land withdrawal area, such that the REMY and CMF can receive site utility feeds provided by the GROA (Ref. 2.2.41, Section 3.1.16 [DIRS 176810]).

The REMY will include a rail yard, rail tracks to the GROA entrance, tracks that connect the REMY to the NRL rail yard, a spur track for fuel oil and locomotive fuel delivery, a locomotive fuel storage tank, a construction materials yard in support of GROA construction, and a light locomotive running repair facility. The locomotive diesel fuel storage tank will have a capacity of 50,000 gal and will be located at the far end (southern end) of the REMY, approximately

2 miles from the GROA (Ref. 2.2.11 [DIRS 181033]). Functions of the REMY will include the following (Ref. 2.2.30, Section 6.1 [DIRS 180919]):

- Termination of the NRL main track movement for loaded cask trains
- Rearrangement of trains for the delivery of loaded cask cars to the repository receiving and inspection area
- The holding of buffer cars
- Receipt (from the repository) and temporary storage of empty cask cars, casks on railcars, repair of railcars, and assembly of outgoing trains destined for the NRL staging yard
- Shuttling of empty cask cars and buffer cars to the CMF
- Receipt and delivery to the repository of waste packages, construction materials, and fuel oil
- A base to support escort cars and personnel associated with incoming (and possibly outgoing) cask train movements
- Location for railcar and locomotive light repair facility.

The general characteristics of the CMF include a 20-acre site of buildings and yards with rail tracks that connect to the REMY. Functions of the CMF include the following (Ref. 2.2.30, Section 1.6.1 [DIRS 180919]):

- Processing of the transportation casks to keep them road ready
- Maintenance of the correct cask internal equipment, including the associated transportation skids, impact limiters, lifting equipment, special tools, spare parts, and instrumentation
- Management of the transportation fleet, which would include cask cars, buffer cars, and escort cars
- Storage, maintenance, and out-processing of the fleet of personnel escort cars, buffer cars, cask railcars, and casks.

Upon arrival of a shipment of nuclear wastes at the REMY, the NRL operators will separate non-cask railcars from the rest of the shipment. These railcars, including buffer cars, line locomotives, and escort vehicles, will remain and will be staged at the REMY for inspection and servicing. These railcars and locomotives will be staged on outbound train queuing rail spurs. The REMY operators will notify site security and deliver the loaded cask railcars to the location inside of the preliminary inspection area but outside of the GROA. The GROA rail operators will operate GROA switch engines to move railcars into and out of the preliminary inspection area from the GROA (Ref. 2.2.44, Section A.3.1 [DIRS 183522]. The railcars and filled casks that pass through the REMY will be configured in accordance with the transportation regulations of 10 CFR Part 71 (Ref. 2.3.10, Section 71.73 [DIRS 181967]), including meeting the general standards, lifting and tie-down standards, and external radiation standards for all packages. In addition, casks must meet the requirements for normal conditions for transport described in 10 CFR 71.41 (Ref. 2.3.10, Section 71.41 [DIRS 181967]) and the hypothetical accident conditions specified in 10 CFR 71.73. The normal conditions of transport for which the package are evaluated include a range of temperature conditions, a specified free drop, a corner drop, the effects of a compressive load, and a penetration. Accident conditions the package must accommodate include a specified free drop, a dynamic crush, a free drop and puncture, the thermal loading associated with a hydrocarbon fuel-air fire with an average flame temperature of at least 800°C (1,475°F) for a period of 30 minutes, and water pressure equivalent to immersion under a head of water of at least 15 m (50 ft).

Due to the fact that the filled casks in the REMY will be configured in accordance with the transportation regulations of 10 CFR Part 71, no hazards associated with or involving the filled casks are expected to have an impact on the repository. A hazardous substance (e.g., diesel fuel) will be stored at the REMY. However, the diesel fuel storage tank will not be located adjacent to the rail yard. It will be located adjacent to a rail spur that connects to the yard (the tank car unloading track). In addition, a satellite Maintenance-of-Way Facility and an Administrative Office and Crew Change Facility are proposed to be constructed in an area between the diesel fuel storage tank and the rail yard (Ref. 2.2.30, Figure 6-A [DIRS 180919]). Therefore, loaded spent fuel casks temporarily staged in the REMY during railcar rearrangement activities will not be located near any hazardous substances in the REMY (such as diesel fuel) that might damage loaded spent fuel casks and compromise the containment of nuclear waste. Furthermore, access to diesel fuel in the storage tank will be limited to locomotives that are not attached to rail cars holding loaded spent fuel casks. Trains made up of buffer cars and railcars holding loaded spent fuel casks that are heading to the GROA will not travel down the rail spur adjacent to the diesel fuel storage tank.

An evaluation of the potential for an impact to the repository associated with an explosion involving the 50,000-gallon diesel fuel storage tank is provided in Appendix A. The safe distance from such an explosion, based on a maximum "no damage" overpressure of 1.0 pounds per square inch, was conservatively calculated to be less than 600 feet. Based on this evaluation, it was concluded that there are no hazards associated with this tank that could impact the repository. Any nearby loaded spent fuel casks would be configured in accordance with the transportation regulations of 10 CFR Part 71, and therefore, not be affected by an explosion or fire involving this tank. In addition, these casks would be located beyond the "no damage" overpressure distance of 600 feet from the storage tank. Therefore, no activities associated with the CMF or REMY have been identified that would impact the activities or operations at the repository.

6.5 PARAMETRIC EVALUATION OF POTENTIAL EXPLOSIVES

Several of the NTS facilities handle high-explosive materials (as described in Sections 6.3.1.1 and 6.3.1.2) and some types of events (e.g., transportation accidents, industrial accidents) may result in explosions. Explosions can occur in the NTS and explosions can occur because of transportation and industrial accidents. The overpressure generated by an explosion is a function of the amount of explosive material and the distance between the site of the explosion and the repository.

A methodology for evaluating the safe distance for overpressure from a postulated explosion is provided in Regulatory Guide 1.91, *Evaluations of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plants* (Ref. 2.3.11 [DIRS 103638]). This safe distance is based on a level of peak positive incident overpressure below which no significant damage would be expected. It is the judgment of the NRC staff (as described in Regulatory Guide 1.91) that, for the structures, systems, and components of concern, a pressure level of 1 psi (approximately 7 kPa) is appropriate. Based on experimental data on hemispherical charges of TNT, a safe distance can conservatively be defined by the following relationship (as described in Regulatory Guide 1.91):

$$R_{safe} \geq kW^{1/3} \qquad \text{(Eq. 1)}$$

where

R_{safe} = safe distance from explosion in feet; based on a maximum "no damage" overpressure of 1.0 psi

k = constant; equal to 45 when R_{safe} is in feet and W is in pound-mass of TNT

W = equivalent mass of TNT (pound-mass TNT).

Setting R_{safe} equal to the 5-mile criterion (26,400 ft) per NUREG-0800 (Ref. 2.3.2, Sections 2.2.1, 2.2.2 [DIRS 183492]) and rearranging Equation 1 to solve for W yields the "no damage" TNT mass limit shown in Table 3. Table 3 also includes the quantities of TNT required to exceed the "no damage" 1 psi overpressure limit at distances of up to 20 miles from the structures, systems, and components of concern in 5-mile increments.

In Table 3 it is seen that in order to exceed the "no damage" 1 psi overpressure limit at the 5-mile criterion distance, an explosion at the site would have to have a TNT-equivalent of greater than 2.0×10^8 lb or 92 KT. As a point of reference, the thermonuclear blast that created the Sedan Crater (1,280 ft in diameter, 320 ft deep) in Area 10 was rated at 104 KT (Ref. 2.2.42, p. 15 [DIRS 104885]), which is approximately the same maximum explosive power as at the 5-mile safe distance.

Table 3. Mass of TNT Required to Exceed Safe Distance from an Explosion

Distance from Explosion (R_{safe})	Pounds Mass of TNT (W)	Kilotonnes of TNT
5 miles	2.0×10^8	92
10 miles	1.6×10^9	730
15 miles	5.5×10^9	2,500
20 miles	1.3×10^{10}	5,900

NOTE: 1 kilotonne = 2,204,623 pounds mass; TNT = trinitrotoluene.

Source: Original

The TNT-equivalent quantity of 2.0×10^8 lb associated with the "no damage" 1 psi overpressure limit at the 5-mile criterion distance most likely exceeds any of the TNT inventories currently associated with NTS facilities and any transportation or industrial explosive sources and is highly likely to exceed any future TNT inventories. Thus, it is not anticipated that any explosion occurring on the site would affect the activities or operations at the repository site or lead to an event sequence.

7. RESULTS AND CONCLUSIONS

There are currently no existing or planned military or industrial activities that might be expected to produce event sequences with radiological releases that could impact offsite individuals or workers during the preclosure period of the repository based on screening to NUREG-0800 (Ref. 2.3.2, Sections 2.2.1, 2.2.2 [DIRS 183492]) guidance and 10 CFR Part 63 requirements.

The nearby industrial operations, transportation routes, and military operations on the NTS and Nellis Air Force Base were found to have no events and/or hazards that would affect the repository surface or subsurface facilities and operations. The remote location of the repository site (i.e., over 5 miles to NTS facilities, over 13 miles from any nearby industrial facilities, and over 25 miles from NTTR activities) and the absence of large explosive resources and/or sources of toxic or hazardous chemicals result in this conclusion.

Limitations on heavy industrial growth, combined with military operations tending towards reduced-scale testing and replacement of military operations with civilian business development, make these activities unlikely to impact the repository in the future.

ATTACHMENT A
EXPLOSION ANALYSIS FOR A DIESEL FUEL BULK STORAGE TANK

A1 PURPOSE

The purpose of this analysis is to provide an assessment of a potential explosion in the diesel fuel storage tank to be located in the REMY to determine if the tank is situated at a safe distance from the repository such that no event sequences result from such an explosion. The overpressure generated by such an explosion is a function of the amount of explosive material and the distance between the site of the deflagration and the repository.

A2 QUALITATIVE EVALUATION

The term *explosion*, in its most widely accepted sense, means a bursting associated with a loud, sharp noise and an expanding pressure front, varying from a supersonic shock wave to a relatively mild wind (Ref. 2.2.4, p. 4-17 [DIRS 170847]). A combustible vapor explodes under a very specific set of conditions. There are two explosive mechanisms that need to be considered when evaluating combustible vapors incidents: detonations and deflagrations. A detonation is a shock reaction where flames travel at supersonic speeds (i.e., faster than sound). Flames travel at subsonic speeds in a deflagration. It is generally recognized that vapor cloud explosions have flames that travel at subsonic speeds and are, therefore, technically classified as deflagrations but are still commonly referred to as explosions (Ref. 2.2.2, p. 48 [DIRS 169507]). Therefore, the postulated event in this analysis involves a vapor cloud explosion (deflagration) in the diesel fuel storage tank. The methodology provided in Regulatory Guide 1.91, *Evaluations of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plants* (Ref. 2.3.11 [DIRS 103638]) was used to evaluate the safe distance for overpressure from such a postulated deflagration.

A3 HYDROCARBON EXPLOSION

Hydrocarbon materials must first be in a vapor condition before combustion processes can occur. For any gaseous material this is an inherent property. Liquids, however, must have significant vapor emissions in order for flammable concentrations to be present for combustion processes to occur. Therefore, a hydrocarbon liquid release is nominally less dangerous than a gas release. Gases, by their nature, are immediately ignitable versus liquid releases that must vaporize to support combustion, and can produce a fast burning flame front that generates into an explosive force in confined areas. When an ignition source is brought into contact with a flammable gas or mixture of gases, a combustion chemical reaction will occur at the point of introduction, provided an oxidizer is present, normally oxygen (Ref. 2.2.2, p. 44 [DIRS 169507]).

The following elements must exist simultaneously in order for a deflagration to occur:

- A flammable mixture consisting of a fuel and oxygen, usually from air, or other oxidant
- A means of ignition
- An enclosure.

The term *flammable mixture* denotes that the fuel and oxygen components are intimately mixed and are each present at a concentration that falls within a flammable composition boundary characteristic of each system of fuel, oxygen, and inert material (inert gas or solid). Ignition of a flammable mixture occurs when a point source of sufficient energy achieves a temperature above the ignition temperature of the mixture. All incandescent sparks (e.g., mechanical, electrical, electrostatic) have sufficient temperature to cause ignition, but may lack sufficient energy to heat a minimal propagating mass to its ignition temperature. Should ignition of a flammable mixture occur within an enclosure, regardless of whether the enclosure has ventilation points, the internal pressure will increase as necessary to satisfy the non-steady state material balance equation. Some venting of the expanding combustion gases occurs through normal process openings, but these are usually too small to prevent the development of destructive pressures (Ref. 2.2.6, p. 15-3 [DIRS 174827]).

A4 TERM DEFINITIONS

Flammable Limits—The LFL is the minimum concentration of vapor to air below which propagation of a flame will not occur in the presence of an ignition source. The UFL is the maximum vapor to air concentration above which propagation of a flame will not occur. When the vapor-to-air ratio is somewhere between the LFL and the UFL, fires and explosions can occur. When the mixture happens to be in the intermediate range between the LFL and UFL, the ignition is more intense and violent than if the mixture were closer to either the upper or lower limits (Ref. 2.2.4, p. 5-32 [DIRS 170847]). The units of measure for UFL and LFL are percentages of the combustible material in air.

Flash Point—The flash point of a liquid corresponds roughly to the lowest temperature at which the vapor pressure of the liquid is just sufficient to produce a flammable mixture at the lower limit of flammability (Ref. 2.2.4, p. 5-31 [DIRS 170847]).

Heat of Combustion—A measure of the maximum amount of heat that can be released by the complete combustion of a unit mass of material (Ref. 2.2.4, p. 4-8 [DIRS 170847]).

A5 PROPERTIES OF DIESEL FUEL

Diesel fuel is a petroleum distillate which is in the gas-oil family of petroleum products; it falls between kerosene and light lubricating oil in the distillation process. The fraction of carbon is 85 to 88% and hydrogen is 11 to 14%; other elements are present only in minor amounts (Ref. 2.2.43, p. 732 [DIRS 171463]). In atmospheric burning, smoke production normally occurs. Several grades of diesel are produced, depending on the intended service. Diesel is sometimes referred to as Fuel Oil #2 (Ref. 2.2.2, p. 37 [DIRS 169507]). Due to the fact that the fraction of carbon and hydrogen varies, the molecular weight of diesel varies, depending on the grade.

A6 QUANTITATIVE EVALUATION

A quantitative evaluation is performed to investigate the extent of the damage that could be caused by an explosion. The scenario analyzed includes the ignition of vapors in a diesel fuel storage tank, regardless of the cause or source of ignition (Assumption 3.2.2.1). It is assumed that there is sufficient oxygen in the air present in the vapor mixture to act as an oxidizer and completely combust the diesel fuel present such that a bounding TNT-equivalent value is calculated for the deflagration (Assumption 3.2.2.7). No frequency of occurrence of this scenario is calculated.

With proper safety precautions and operating procedures, the occurrence of explosions in the vapor space of fixed-roof storage tanks is a very rare event. A frequency estimate of an explosion of once in every 1,000 years, per tank, has been stated. Explosive mixtures may exist in the vapor space of a tank unless precautions are taken. Any vapor will seek an ignition source, so prevention of ignition cannot be guaranteed (Ref. 2.2.2, pp. 155-156 [DIRS 169507]).

The method applied to calculate the potential damage of the explosion is based upon *Guidelines for Chemical Process Quantitative Risk Analysis* (Ref. 2.2.7 [DIRS 156781]). Damage produced by an explosion to structures and process equipment of a facility are dependent on the overpressure generated by the explosion (Ref. 2.2.7, Tables 2.18a and 2.18b [DIRS 156781]). To calculate the overpressure, the TNT method is used. This method postulates an equivalency between the flammable material and TNT, factored by an explosion efficiency term. This method is easy to use and has been applied for many chemical process quantitative risk analyses (Ref. 2.2.7, p. 159 [DIRS 156781]), although its validity is hindered by the fact that little correlation exists between the quantity of combustion energy involved in a vapor cloud explosion and the equivalent weight of TNT required to model its blast effects (Ref. 2.2.7, p. 165 [DIRS 156781]). However, for the purposes of this analysis, this method is appropriate because this quantitative assessment does not aim at providing refined values of the damage caused by a fuel tank explosion, but rather a reasonable estimate.

The following formula is used in the TNT-equivalent method (Ref. 2.2.7, pp. 159 and 160 [DIRS 156781]):

$$W = \frac{\eta \, M \, E_c}{E_{TNT}} \qquad \text{(Eq. A-1)}$$

where

W = equivalent mass of TNT, in pounds
η = empirical explosion efficiency (unitless)
M = mass of hydrocarbon, in pounds
E_c = heat of combustion of flammable gas, in British Thermal Units (BTUs) per pound
E_{TNT} = heat of combustion of TNT, in BTU per pound.

As mentioned in Section A3, hydrocarbon materials must first be in a vapor condition before combustion processes can occur. Consequently, the mass M of hydrocarbon is the mass of the diesel fuel in the diesel fuel-air vapor mixture in the storage tank. The diesel fuel-air vapor mixture is assumed to occupy a volume equal to the entire 50,000 gal tank capacity (Assumption 3.2.2.5). In reality, the tank will always have a quantity of liquid diesel fuel present, with the diesel fuel-air vapor occupying the volume above the liquid, including the tank freeboard volume. However, this assumption provides for a maximum value of the TNT-equivalent for the assumed deflagration. The temperature in the vapor space is assumed to be equivalent to a typical flash point of diesel fuel: 140°F (Assumption 3.2.2.3). The pressure in the vapor space is assumed to be atmospheric pressure, 14.73 psi, since large bulk storage tanks are normally vented (Assumption 3.2.2.2). The molecular weight of the diesel fuel is assumed to be 170 lb/lbmol (Assumption 3.2.2.6).

Using the ideal gas law (Ref. 2.2.12, p. F-249 [DIRS 128733]), n_{tot} is calculated as:

$$n_{tot} = \frac{PV}{RT} \quad \text{(Eq. A-2)}$$

where

n_{tot} = total mass of the diesel fuel–air vapor mixture, in pound-mole

P = pressure of diesel fuel–air vapor cloud, in pounds per square inch

V = volume of diesel fuel–air vapor cloud, in cubic feet

R = universal gas constant; in cubic feet pounds per square inch/(pound-mole °R) (Table 2)

T = temperature of diesel fuel–air vapor cloud, in °R

therefore

$$n_{tot} = \frac{(14.73\,\text{psi})(50{,}000\,\text{gal})(0.1337\,\text{ft}^3/\text{gal})}{(10.73\,\text{psift}^3/\text{lb-mole})(600\,^\circ\text{R})}$$

$$n_{tot} = 15.30\ \text{lb-mole}$$

To determine the quantity of diesel fuel in this mixture, M, it is conservatively assumed that the diesel fuel concentration is equal to the UFL for diesel fuel, which is typically 7.0% (Assumption 3.2.2.4). As described in Section A4, if the concentration of diesel fuel is in the intermediate range between the LFL and UFL, the ignition would more intense and violent than if the mixture were closer to either the upper or lower limits. However, to maximize the TNT-equivalent value, the upper limit is chosen. To calculate M, the following conversion equation is used:

$$M = c\, n_{tot}\, mw \quad \text{(Eq. A-3)}$$

where

M = mass of diesel fuel in the vapor, in pounds
n_{tot} = total mass of the diesel fuel–air vapor mixture, in pound-mole
mw = molecular weight of the diesel fuel, in pound pound-mole^{-1}
c = diesel fuel concentration percentage, in percent

therefore

$$M = (0.07)(15.30\ \text{lb-mole})(170\ \text{lb lb-mole}^{-1})$$

$$M = 182.07\ \text{lb}$$

Equation A-1 is then used to calculate the TNT-equivalent of a deflagration involving 182.07 lbs of diesel fuel in the vapor mixture. The values of the heat of combustion of TNT (E_{TNT}) and diesel fuel (*Ec*) are provided in Table 2. The value of the explosion efficiency is based on Assumption 3.2.2.8, with a nominal value of 3% (0.03, a sensitivity value of 5% (0.05, and a bounding case of 100% (1.0)).

For the nominal case:

$$W = \frac{\eta \; M \; E_c}{E_{TNT}} \qquad \text{(Eq. A-1)}$$

$$W = \frac{(0.03)(182.07 \text{ lb})(19{,}089 \text{ BTU lb}^{-1})}{1943 \text{ BTU lb}^{-1}}$$

W = 53.66 lb

Therefore, for the nominal case (η = 0.03), the equivalent mass of TNT, *W*, is calculated to be 53.66 lbs. For the sensitivity case (η = 0.05), the value is 89.44 lbs; for the bounding case (η = 1.0), the value is 1788.75 lbs.

Using the methodology described in Section 6.5 as provided in Regulatory Guide 1.91 (Ref. 2.3.11 [DIRS 103638]), the safe distance for overpressure from the postulated diesel fuel vapor deflagration in the bulk storage tank can be calculated. This distance is based on a level of peak positive incident overpressure below which no significant damage would be expected, which has conservatively been chosen as 1 psi (approximately 7 kPa). As described in Section 6.5, a safe distance can be conservatively be defined by the relationship in Equation 1:

$$R_{safe} \geq kW^{1/3} \qquad \text{(Eq. 1)}$$

where

R_{safe} = safe distance from explosion in feet; based on maximum “no damage” overpressure of 1.0 psi

k = constant; equal to 45 when R_{safe} is in feet and W is in pound-mass of TNT

W = equivalent mass of TNT (pound-mass TNT).

For the nominal case (TNT-equivalent of 53.66 lbs), the safe distance is calculated to be 169.73 ft. For the sensitivity case (89.44 lbs), this distance is 201.24 ft; for the bounding case (1788.75 lbs), the distance is 546.26 ft.

A7 CONCLUSION

Based on the qualitative evaluation of this hypothetical event, it is concluded that the safe distance for overpressure from the postulated diesel fuel vapor deflagration in the bulk storage tank, as established per the guidance in Regulatory Guide 1.91 (Ref. 2.3.11 [DIRS 103638]), would be on the order of several hundred feet. For the bounding (maximum) case, assuming that the entire tank is filled with vapor and a deflagration with 100% efficiency, the distance to the “no damage” overpressure of 1.0 psi was calculated to be less than 550 ft.