CHAPTER 13 - REACTOR FACILITIES SOURCE INFORMATION

LIST OF TABLES

1.0 INTRODUCTION

Tech Area V operations and activities are extensive, and they generally support DOE research by using nuclear reactors to produce medical isotopes and to test weapons components. More specifically, Tech Area V capabilities include:

- Unique near-fission spectrum radiation environments for testing a wide variety of technologies, including high neutron fluence or pulsed high neutron doses for testing weapon electronic subsystems and components.
- Production of medical isotopes, including molybdenum-99 (Mo-99) and related isotopes used in nuclear medicine and in research applications.
- Potential for pulsed and long-term, steady-state reactor operation to support neutron irradiation and radiography experiments to test the long-term effects of radiation on experimental devices.
- A wide diversity of gamma irradiation experiments with gamma (high-energy photon) radiation, including experiments to test weapon electronic component hardness and survivability and to certify components.
- Research and testing on the radiation effects on organic materials and material properties as well as mixed environment testing (for example, steam and radiation or heat and radiation experiments, and gamma radiation experiments on nonpathogenic organic material as part of the chemical and biological agent defeat program).
- Reactor safety studies, including reactor criticality experiments and advanced reactor fuel development research for the Nuclear Regulatory Commission.

Tech Area V includes experimental and engineering nuclear reactors, shielded facilities for working with radioactive materials, and various support facilities. Approximately 100 people work in Tech Area V. The major Tech Area V facilities include:

- Sandia Pulsed Reactor Facility
- Annular Core Research Reactor Facility

- Gamma Irradiation Facility
- New Gamma Irradiation Facility
- Hot Cell Facility

The Sandia Pulsed Reactor Facility went into operation in 1961. The primary mission of the facility was and continues to be the production of high neutron fluence or pulsed high neutron doses for the testing of materials, electronic subsystems, and components. The facility also simulates neutron and gamma radiation effects to certify weapon components for hostile environments and supports critical reactor experiments for other programs.

Since 1967, the Annular Core Research Reactor Facility has provided test capability for defense radiation effects and other advanced nuclear technology experiment capabilities for DOE and the Nuclear Regulatory Commission. In 1996, the Annular Core Research Reactor Facility was transferred to the DOE Office of Nuclear Energy, Science, and Technology for the production of Mo-99, whose daughter, technetium-99 (Tc-99m), is used in nuclear medicine applications. A strong potential exists for expanding the range of isotopes that the facility produces to include a broader range of medical isotopes and various research and industrial isotopes. The long-term, steady-state operation of the reactor for isotope production allows the associated use of the reactor for neutron irradiation and radiography experiments.

The Hot Cell Facility has supported a number of activities for DOE and the Nuclear Regulatory Commission since 1962. In 1996, the Hot Cell Facility was transferred to the DOE Office of Nuclear Energy, Science, and Technology for the production of medical isotopes such as Mo-99. Stainless steel targets that are coated with uranium and irradiated in the Annular Core Research Reactor Facility will be transferred to the Hot Cell Facility, where the isotopes will be extracted in the shielded hot cells with remote manipulators.

The Gamma Irradiation Facility provides test cells for the irradiation of experiments with high-intensity Co-60 gamma ray sources, and it has been in operation since 1962. The Gamma Irradiation Facility is a DOE hazard category 3 nuclear facility. A new facility to house the Gamma Irradiation Facility (the new Gamma Irradiation Facility) is being designed and is scheduled for construction in Tech Area V in the near future. This new facility will replace the existing Gamma Irradiation Facility and will greatly expand the current Gamma Irradiation Facility test capabilities.

2.0 SANDIA PULSED REACTOR FACILITY SOURCE INFORMATION

2.1 Purpose and Need

The Sandia Pulsed Reactor Facility is a facility for operating SNL's fast-burst reactors, SPR-II and SPR-III. These reactors provide unique near-fission spectrum radiation environments for testing a wide variety of technologies that support both defense and nondefense activities. The primary mission of the facility is to produce high neutron fluence or pulsed high neutron doses for the testing of electronic subsystems and components. Critical experiments may be conducted in the facility to support other programs (Estes, 1995; Miller, 1998).

2.2 Description

The Sandia Pulsed Reactor Facility contains the reactor control room, reactor building, and necessary auxiliary equipment and buildings to support reactor operations. Also, several storage vaults, which are integral units in adjacent buildings, are available for the storage of the reactor and fissionable and radioactive materials. The reactor building, referred to as the Kiva, is a large, thick-walled, steel-reinforced concrete structure in the shape of a cylinder with an outside diameter of about 12 m (39 ft), covered with a hemispherical shell. Access to the reactor building is provided by a concrete and steel door, 2.64 m by 2.64 m (8.67 ft by 8.67 ft), which remains closed for most operations. Experiment support facilities, including the Reactor Maintenance Building and the instrument rooms, are adjacent to the reactor building. Concrete plugs in the southeastern portion of the reactor building wall and in the concrete and steel door can be removed to provide a beam of neutrons. The reactor control room, housed in a standard type of metal and concrete block structure, is about 61 m (200 ft) northeast of the reactor building. All electrical (instrumentation and power) circuits are in a system of underground conduits between the control room and reactor building. Control for critical experiments may be located in the Reactor Maintenance Building adjacent to the Kiva.

The SPR-II is a fast-pulse (or fast-burst) reactor with a bare, unreflected, and unmoderated cylindrical assembly of 93 percent enriched U-235 with 10 weight-percent molybdenum (U-10 Mo) to ensure gamma-phase stabilization of the fuel. The cylindrical core consists of six stacked fuel rings divided at its horizontal mid-plane; the upper three rings are stationary, and the lower three rings move over a 5.08-cm (2-in.) range. The movable lower half core, known as the “safety block,” provides the maximum shutdown mechanism for terminating operations. Three control rods and one pulse rod are accommodated by four vertical holes in the core. Additional holes are provided for steel bolts that secure the two core halves. A central cavity (or “glory hole”) extending through both core halves is the primary experiment location. An aluminum-framed reactor support structure houses the various fuel drive mechanisms and position monitors.

SPR-III uses an unmoderated cylindrical assembly of solid uranium metal enriched to 93 percent U-235 with 10 weight-percent molybdenum. The SPR-III core consists of 18 stacked fuel rings mechanically fastened into two groups of nine rings each. The masses of the individual rings vary between 6.8 kg and 15.4 kg (15 lb and 34 lb). The core support structure holds the nine upper rings stationary, and high-strength bolts mechanically fasten together the nine lower rings. This lower assembly, known as the safety block, is attached to an electromechanical drive mechanism. The safety block, which is normally either fully inserted or withdrawn, is not used for fine control. Instead, four reflector-type control devices are used; three of the devices are used for control, and the fourth is the pulse element. The control elements establish a critical configuration of the core. The control element drives are standard electromechanical drive assemblies that use a rack-and-pinion drive and an electrical clutch (armature) that transfers power to the drive and that disengages upon a loss of power. The pulse element is electromagnetically driven to achieve the high rates of reactivity insertion required.

The SPR-III “glory hole” measures about 17 cm (6.7 in.) in diameter and is the primary experiment location; however, experiments may be placed around the periphery of the reactor. Normally, an aluminum decoupling shroud containing boron-10 is placed over the reactor. This shroud serves two main functions:

- It provides a confinement space for the nitrogen cooling gas.
- It decouples the core from low-energy neutrons that are scattered back toward the core from the reactor room walls, experiments, or other hardware.

SPR-III can be operated at steady-state power levels; however, the capability of the nitrogen cooling system and administrative restrictions effectively limits power and total energy generated in a given period. Normally, steady-state power operations are limited to a maximum of 10 kW, although higher power levels can be achieved.

The Sandia Pulsed Reactor Facility also has the capability to utilize beam ports that pass through the Sandia Pulsed Reactor Kiva to transport neutron fluences to experiments set up outside the reactor building.

Building 6592 within the Sandia Pulsed Reactor Facility compound houses a number of cobalt, cesium, and californium sources. The cobalt and cesium sources are used to provide a low dose rate gamma radiation environment for testing of electronic devices and other devices. The californium source is used in conjunction with a vacuum chamber for heavy ion testing.

Other Tech Area V facilities and personnel provide capability and support to prepare and handle experiment packages both before and after the irradiation that is performed in the Sandia Pulsed Reactor Facility. Examples include the shielded work area in Building 6597 and glove boxes in other Tech Area V locations.

(Estes, 1995; Miller, 1998)

2.3 Program Activities

Table 13-1 shows the program activities at the Sandia Pulsed Reactor Facility.

Table 13-1. Program Activities at the Sandia Pulsed Reactor Facility

Program Name	**Activities at the Sandia Pulsed Reactor**	**Category of Program**	**Related Section of the *SNL Institutional Plan***
Experimental Activities	The Sandia Pulsed Reactor Facility currently houses the SPR-II and SPR-III and is also used for reactor-critical experiments. The last critical experiment was the Particle Bed Critical Assembly, used for research on space thermal propulsion. Other critical assemblies designed included the experiment critical for the Advanced Neutron Source and a critical for assessing spent-fuel burnup reactivities. The SPRs are unmoderated, fast-burst reactors capable of pulse and limited steady-state operation. The reactors are designed to produce a neutron spectrum very similar to the fission spectrum. The primary experiment chambers are central cavities that extend through the cores. Experiments may also be placed around the reactors. Beam ports are used to transport neutron fluences outside the Kiva for other experimental needs. SPR-III is used primarily for high-neutron-fluence or pulsed, high-dose testing of electronic devices. SPR-II is similar, but with a slightly shorter pulse.	Programs for the Department of Energy	Section 6.1.1.1
Performance Assessment Science and Technology	Provide source of pulsed high-energy radiation to simulate neutron and gamma radiation effects and provide data for certifying weapons and components for hostile environments.	Programs for the Department of Energy	Section 6.1.1.1

2.4 Operations and Capabilities

The Sandia Pulsed Reactor Facility reactors are operated by means of a reactor control system. The reactor control system is a manually operated system by which the operator controls important functions related to reactor operation. This system consists of the electrical circuitry, switches, and indicators necessary for control and surveillance of the fuel, the neutron source, the Kiva ventilation system, various timers, the Kiva shield doors, and the cooling system of the reactor.

Neutron pulses are produced by means of the following sequence of events. First, the safety block is raised to the “up” position. The control elements are then raised (“inserted”) to achieve a delayed critical condition and the worth of the pulse element is measured. The safety block and pulse element are then lowered. Following some additional control element corrections necessary to produce the desired pulse size and to compensate for temperature-induced reactivity changes, the safety block is run “up” in fast mode and the pulse element is driven up to initiate the pulse. The pulse is terminated by the negative temperature coefficient of reactivity from thermal expansion. Shutdown is accomplished when the safety block “breaks away” from the stationary upper fuel block due to either mechanical shock from the pulse or thermal expansion of the fuel, and the safety block falls by gravity to the down position. Gaseous nitrogen is used to provide a cooling medium for the reactors and to prevent oxidation of the fuel plates at elevated temperatures.

A plant protection system limits or prevents damage to the fuel by shutting down the reactor in the event that preestablished limits are exceeded during certain delayed tail, steady-state, or low-level pulse operations. These operations may not result in sufficient fuel expansion to cause the safety block to “break away.” The protection system uses four signals in two independent (redundant) channels to simultaneously release both the control elements and the safety block, which then drop by gravity to their down positions.

(Estes, 1995; Miller, 1998)

2.5 Hazards and Hazard Controls

Operation of SPR-II and SPR-III involves the possibility of an accidental release of radioactive fission products to the environment. This release constitutes primarily a worker hazard. Several potential accidents have been analyzed for which releases could occur. The only other major hazard associated with the Sandia Pulsed Reactor Facility is the 6,500 gal of liquid nitrogen that are contained in an outdoor storage tank, which represents a potential hazard to the onsite environment.

The following are hazard controls at the Sandia Pulsed Reactor Facility:

- Control interlocks protect against operational errors and prevent operation of the reactors unless specific required conditions have been met. Though not part of the protection system, the interlocks play an important role in achieving the safety objectives of the reactors by ensuring that:

    - The reactors are properly positioned.

    - Instrumentation for shutdown is available before a reactor operation can be started.

- A definite sequence is followed in establishing a critical reactor configuration in measuring the static and dynamic reactivity characteristics of an experiment and in achieving a superprompt critical pulse.

- In addition to the strong negative temperature coefficient, inherent reactor characteristics act to place the SPR-II and SPR-III reactors in a subcritical configuration. These characteristics are:

    - The mechanical shock forces induced by the pulse, which cause the safety block to break away from the holding armature and free-fall to a full-out position.

    - The thermal expansion of the fuel due to its rise in temperature, which can also cause the safety block to break away from the holding armature.

- The reactor can be shut down by either one of two protection channels that initiate shutdown signals to the actuating devices for the control elements and safety block.

- The plant protection system shuts down the reactor in the event that preestablished limits are exceeded during certain delayed-tail, steady-state, or low-level pulse operations.

(Estes, 1995; Miller, 1998)

2.6 Accident Analysis Summary

2.6.1 Selection of Accidents Analyzed in Safety Documents

The Sandia Pulsed Reactor Facility is a test and research facility. In many experiments, the reactor cannot be thought of as independent of the experiment. In light of this highly coupled feature, the accident analyses for SPR-II and SPR-III fulfill a twofold purpose:

- To evaluate the safety of the reactor system by studies of the response of the plant to disturbances in process variables and to postulated malfunctions or failures of equipment.

- To account for the process and equipment changes associated with research facilities.

The accident analyses provide guidance and a framework (in terms of accident consequences) for judging future potential accident situations. Then, for example, the effect on the system of a newly proposed experiment and its particular accident potentials can be judged (in terms of the consequences of the accidents already analyzed) through a qualitative analogy related to system safety.

For convenience, disturbances in process variables and postulated malfunctions or failures of equipment can be thought of in terms of two broad classes of increasingly severe accident consequences. The first class:

- Leads to no radioactive release (beyond those experienced in routine operation).

- Does not induce fuel failures in excess of those expected during routine operation.

- Does not lead to a breach of a barrier to fission product release.

- Does not require operation of any engineered safety features.

- Does not lead to significant radiation exposures off site.

- Does not propagate to cause a more serious event.

The second class:

- Leads to small or moderate radioactive release.

- May induce fuel failures in excess of those expected in routine operation.
- May lead to a breach of fuel barrier to fission product release.

However, the second class does not require interruption or restriction of the public or private domain and does not propagate to cause a more serious event.

The situations analyzed in the safety analysis report of the Sandia Pulsed Reactor Facility are listed below. The abnormal situations that lead to no radioactive release are as follows:

- Loss of normal AC power
- Experiment movement at power
- External forces
- External missile penetration of the reactor building
- Uncontrolled insertion of one control element
- Inadvertent criticality during loading or maintenance
- Fission foil vaporization
- Blocked ventilation system
- Detonation of uncontained explosives
- Fire affecting the reactor facility (not the reactor building)
- Detonation of fully contained explosives experiment

The abnormal situations that can lead to small to moderate radioactive releases from the facility are as follows:

- Fire in the reactor building
- Total-worth pulse element insertion during period measurement
- Inadvertent movement of experiment during wait period
- Inadvertent criticality on startup
- Control element misadjustment before pulse element insertion
- Failure of a fissionable experiment

Except for the fissionable experiment failure, these abnormal occurrences involve unplanned superprompt critical pulses (0.25$ and 0.40$ superprompt critical pulses for SPR-III, and 0.16$ and 0.25$ superprompt critical pulses for SPR-II). Some fuel melting would occur for the smaller superprompt critical pulses, and substantial fuel melting would be expected for the larger superprompt critical pulses. Because the results of the analysis for radioactive release accidents depend on the definition of the exclusion area, the exclusion area is the area within a radius of 3,000 m (1.9 mi) of the reactor facilities. This radius represents the distance from the reactor site over which SNL can exercise administrative control.

Although the six accidents listed above lead to some radioactive release inside the exclusion area, none of the doses is significant. None of these events requires any disruption, interruption, or restriction of normal public or private activity.

2.6.2 Analysis Methods and Assumptions

The accident analysis for the Sandia Pulsed Reactor Facility uses a deterministic approach. Specific accidents are analyzed for potential worst-case consequences without regard for their likelihood of occurrence.

The superprompt critical pulses associated with the analyzed accidents result in partial melting of the core fuel with the release of contained fission products. No credit is taken in the analyses for high-efficiency particulate air (HEPA) filtering of the fission products released to the reactor building. Thus, a release to the environment of all fission products released to the reactor building is assumed.

The FISSP/CLOUD codes (see Bonzon and Rivard, 1970) calculate the downwind dose from fission product release events. The fission product inventory and release code, FISSP, evaluates the radioactivity history of fission products released to the atmosphere following the postulated accident. This is done in a three-step chronological process. First, the fission product inventory is calculated for an arbitrary power history. Second, an excursion is assumed that releases specified fractions of the fission product inventory to the atmosphere in a puff (instantaneous) release. Third, the radioactivity history of the released fission products is calculated. The fission product transport and dose calculation code, CLOUD, evaluates downwind dose (both internal and external) based on an instantaneous point source release model. The meteorological parameters correspond to strong inversion conditions, which provide maximum dose conditions. These doses are estimated to be accurate within a factor of two for total dose calculation resulting from either uranium or plutonium fissioning.

2.6.3 Summary of Accident Analysis Results

The whole-body doses at the exclusion area boundary (3,000 m) resulting from these accidents are shown in Table 13-2. These doses are based on conservative calculations, with the highest doses being factors of 20 (SPR-III) and 27 (SPR-II) lower than the offsite evaluation guideline of 25 rem whole-body dose.

Table 13-2. **Maximum Whole-Body Doses at Exclusion Area Boundary (in Rem)**

Accident	SPR-II	SPR-III
Fire in the reactor building	0.018	0.054
Total-worth pulse element insertion during period measurement	0.9	1.2
Inadvertent criticality on startup	0.018	0.054
Inadvertent movement of experiment during wait period	0.9	1.2
Control element misadjustment before pulse element insertion	0.9	1.2
Failure of a fissionable experiment	0.00003	0.00009

(Estes, 1995; Miller, 1998)

2.7 Reportable Events

Table 13-3 lists the occurrence reports for the Sandia Pulsed Reactor Facility over the past five years.

Table 13-3. **Occurrence Reports for the Sandia Pulsed Reactor**

Report Number	Title	Category	Description of Occurrence
ALO-KO-SNL-6000REACT-1993-0005	Discovery of Cracked Fuel Plates	1C	During routine inspection, two annular fuel plates were observed to show cracking.
ALO-KO-SNL-7000-1997-0002	Violation of Procedures Resulting in Unauthorized Removal of Operations Control Padlock and Entry Into Radiation Boundary Area Outside of SPR Facility	1F	A radiation boundary area was entered during a protective force exercise. No one was exposed to radiation.

2.8 Scenarios for Impact Analysis

In all of the scenarios for impact analysis in this section, base year values are for fiscal year (FY) 1996 unless otherwise noted.

2.8.1 Activity Scenario for Test Activities: Irradiation Tests

2.8.1.1 Alternatives for Test Activities: Irradiation Tests

Table 13-4 shows the alternatives for irradiation tests at the Sandia Pulsed Reactor Facility.

Table 13-4. Alternatives for Test Activities: Irradiation Tests

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
30 tests	100 tests	100 tests	100 tests	200 tests

2.8.1.2 Assumptions and Actions for the "Reduced" Values

The "reduced" alternative for testing in the Sandia Pulsed Reactor Facility assumes that 30 tests would be conducted, which is approximately 30 percent of the capacity of the "no action" baseline. This alternative assumes that while testing is reduced, a large number of test operations will still be required. This assumption is based on actual facility utilization during the "no action" baseline timeframe of calendar years 1996 and 1997.

In addition to the testing capability of the Sandia Pulsed Reactor Facility, the facility may be used to conduct other operations that require enhanced security for significant quantities of special nuclear materials. The "reduced" alternative assumes that none of these activities would be conducted.

2.8.1.3 Assumptions and Rationale for the "No Action" Values

The "no action" alternatives for the base year, FY2003, and FY2008 for testing in the Sandia Pulsed Reactor Facility assume that the facility is operated at nearly full capacity for a single shift operation. This assumption is based on actual facility utilization during the "no action" baseline timeframe of calendar years 1996 and 1997. Tests that are conducted in the Sandia Pulsed Reactor Facility range from activities that require a few hours to set up and complete to more extensive test series that require more than a month to complete. This alternative assumes that approximately 100 tests are conducted each year.

The "no action" alternative also assumes that the SPR-IIIM reactor would be fueled and become fully operational to enhance the testing capability of the Sandia Pulsed Reactor Facility during the timeframe between the baseline year and the year 2003. In addition, modifications to the Sandia Pulsed Reactor Facility would be made to enhance its combined environments capability, such as the addition of x-ray and electron beam accelerators or radioisotopic sources. A reactor-critical experiment may be conducted during this period.

In addition to the testing capability of the Sandia Pulsed Reactor Facility, the facility may be used to conduct other operations that require enhanced security for significant quantities of special nuclear materials. All of the "no action" values assume that less than five such activities would be conducted each year and that such activities do not significantly impact the utilization of resources, the generation of waste, or the emission of hazardous or radioactive materials from the facility.

2.8.1.4 Assumptions and Actions for the "Expanded" Values

The "expanded" alternative for testing in the Sandia Pulsed Reactor Facility assumes that the facility is operated at full capacity for a two-shift operation. This would allow approximately 200 tests per year and would require additional staff relative to the "no action" base year.

In addition to the testing capability of the Sandia Pulsed Reactor Facility, the facility may be used to conduct other operations that require enhanced security for significant quantities of special nuclear materials. The "expanded" alternative assumes that less than 20 such activities would be conducted each year and that such activities would not increase the utilization of resources, the generation of waste, or the emission of hazardous or radioactive materials from the facility.

The "expanded" alternatives also assumes that a new SPR-IV reactor may become operational in the 2004 to 2008 timeframe to meet DP mission requirements. However, no funding or environmental coverage is currently in place.

2.8.2 Material Inventories

2.8.2.1 Nuclear Material Inventory Scenarios

2.8.2.1.1 Nuclear Material Inventory Scenario for Plutonium-239

Alternatives for Plutonium-239 Nuclear Material Inventory **-** Table 13-5 shows the alternatives for Pu-239 inventory at the Sandia Pulsed Reactor Facility.

Table 13-5. Alternatives for Plutonium-239 Nuclear Material Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
53 g	53 g	10,000 g	10,000 g	10,000 g

Operations That Require Plutonium-239 **-** The inventory of Pu-239 is from past experiments conducted at Tech Area V. Amounts given are the current inventory in dense-pack storage. Pu-239 inventories may increase slightly in FY2003 for Pu-239 coupon tests. SPR-IV may have the ability to test larger Pu-239 coupons up to and including a full unit. This type of test could occur under the "no action" alternative in the FY2008 timeframe. Up to 10,000 g of Pu-239 may be in the facility for testing and storage purposes. This estimate of 10,000 g is believed to be well within criticality limits of the storage facility.

***Basis for Projecting the "Reduced" and "Expanded" Values* -** The amounts projected for the "reduced" alternative are the same as the amounts present in the "no action" base year because no additional tests are anticipated. The amounts projected in the "expanded" alternative provide for additional amounts that may be present in the facility for testing and storage purposes.

2.8.2.1.2 Nuclear Material Inventory Scenario for Enriched Uranium

***Alternatives for Enriched Uranium Nuclear Material Inventory* -** Table 13-6 shows the alternatives for the enriched uranium inventory at the Sandia Pulsed Reactor Facility.

Table 13-6. Alternatives for Enriched Uranium Nuclear Material Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
550 kg	550 kg	900 kg	550 kg	1,000 kg

Operations That Require Enriched Uranium - See "2.4 Operations and Capabilities," and "2.8.1 Activity Scenario for Test Activities: Irradiation Tests." The following are explanations of the values under the "no action" alternative:

- The value for the base year includes SPR-II (approximately 150 kg, including spare plates) and SPR-III (approximately 350 kg, including spare plates), plus 50 kg of U-235 currently stored in dense-pack storage.

- The value for FY2003 includes the "no action" base year value plus SPR-IIIM, at approximately 350 kg.

- The value for FY2008 includes SPR-II (approximately 150 kg including spare plates) plus 50 kg of U-235 currently stored in the dense-pack storage facility plus SPR-IIIM (approximately 350 kg). This value assumes disposition of SPR-III to an enriched uranium recovery program.

***Basis for Projecting the "Reduced" and "Expanded" Values* -** The value for the "reduced" alternative includes SPR-II (approximately 150 kg, including spare plates) plus SPR-III (approximately 350 kg, including spare plates) plus 50 kg of U-235 currently stored in the dense-pack storage facility (same as the "no action" base year value).

The value for the “expanded” alternative includes SPR-II (approximately 150 kg, including spare plates), 50 kg of U-235 currently stored in the dense-pack storage facility, SPR-IIIM (approximately 350 kg), SPR-IV at approximately 450 kg (conservative). This value assumes disposition of SPR-III to an enriched uranium recovery program (same as the FY2008 value).

2.8.2.2 Radioactive Material Inventory Scenarios

The Sandia Pulsed Reactor Facility has no radioactive material inventories.

2.8.2.3 Sealed Source Inventory Scenarios

2.8.2.3.1 Sealed Source Inventory Scenario for Cf-252

Alternatives for Cf-252 Sealed Source Inventory **-** Table 13-7 shows the alternatives for the Californium-252 (Cf-252) sealed source inventory at the Sandia Pulsed Reactor Facility.

Table 13-7. Alternatives for Cf-252 Sealed Source Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
31 µCi	31 µCi	31 µCi	50 µCi	100 µCi

Operations That Require Cf-252 **-** Operations that require Cf-252 include heavy ion testing in Building 6592.

Basis for Projecting the “Reduced” and “Expanded” Values **-** The “reduced” alternative assumes no reduction from the “no action” base year. The “expanded” alternative assumes a modest increase in test capability.

2.8.2.3.2 Sealed Source Inventory Scenario for Co-60

Alternatives for Co-60 Sealed Source Inventory **-** Table 13-8 shows the alternatives for the Co-60 inventory at the Sandia Pulsed Reactor Facility.

Table 13-8. Alternatives for Co-60 Sealed Source Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
1.5 Ci	1.5 Ci	2,000 Ci	2,000 Ci	2,000 Ci

Operations That Require Co-60 - Low-dose gamma irradiation of electronics and other devices use Co-60 sources of a few Curies or less. FY2003 and FY2008 include an increase in the inventory of Co-60 to provide additional combined environments test capability for the Sandia Pulsed Reactor Facility.

Basis for Projecting the "Reduced" and "Expanded" Values - The "reduced" alternative assumes no reduction from the "no action" base year. The "expanded" alternative assumes a modest increase in test capability.

2.8.2.3.3 Sealed Source Inventory Scenario for Cs-137

Alternatives for Cs-137 Sealed Source Inventory - Table 13-9 shows the alternatives for the Cs-137 sealed source inventory at the Sandia Pulsed Reactor Facility.

Table 13-9. Alternatives for Cs-137 Sealed Source Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
2.6 Ci	2.6 Ci	2.6 Ci	2.6 Ci	10 Ci

Operations That Require Cs-137 - Operations that require Cs-137 include low-dose gamma irradiation of electronics and other devices.

Basis for Projecting the "Reduced" and "Expanded" Values - The "reduced" alternative assumes no reduction from the "no action" base year. The "expanded" alternative assumes a modest increase in test capability.

2.8.2.4 Spent Fuel Inventory Scenarios

The Sandia Pulsed Reactor Facility has no spent fuel inventories.

2.8.2.5 Chemical Inventory Scenarios

The Sandia Pulsed Reactor Facility has no inventories of chemicals of concern.

2.8.2.6 Explosives Inventory Scenario for Bare UNO 1.1

2.8.2.6.1 Alternatives for Bare UNO 1.1 Explosives Inventory

Table 13-10 shows the alternatives for bare UNO 1.1 explosives inventory at the Sandia Pulsed Reactor Facility.

Table 13-10. Alternatives for Bare UNO 1.1 Explosives Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 g	1,000 g	1,000 g	1,000 g	1,000 g

2.8.2.6.2 Operations That Require Bare UNO 1.1

See Section 2.8.2.6.3, “Basis for Projecting the 'Reduced' and 'Expanded' Values.”

2.8.2.6.3 Basis for Projecting the “Reduced” and “Expanded” Values

Occasionally, test items containing explosives are present in the Sandia Pulsed Reactor Kiva. Past tests indicate a typical maximum amount of explosives in the Kiva does not exceed 1,000 g of TNT-equivalent explosives.

Significantly higher levels of explosives are sometimes present within the Sandia Pulsed Reactor security perimeter. (Significantly higher levels do not necessarily equate to “maximum” levels.) These higher amounts of explosives are allowed only if they will not pose a hazard to the Sandia Pulsed Reactor Facility reactor assemblies housed in the Kiva.

2.8.2.7 Other Hazardous Material Inventory Scenarios

The Sandia Pulsed Reactor Facility has no inventories on hazardous materials that do not fall into the categories of nuclear or radioactive material, sealed sources, spent fuel, explosives, or chemicals.

2.8.3 Material Consumption

2.8.3.1 Nuclear Material Consumption Scenarios

Nuclear material is not consumed at the Sandia Pulsed Reactor Facility.

2.8.3.2 Radioactive Material Consumption Scenarios

Radioactive material is not consumed at the Sandia Pulsed Reactor Facility.

2.8.3.3 Chemical Consumption Scenarios

Information initially provided for this section resides in the Facility Information Manager database and will be made available to the analysts responsible for preparing the sitewide environmental impact statement.

2.8.3.4 Explosives Consumption Scenarios

Explosives are not consumed at the Sandia Pulsed Reactor Facility.

2.8.4 Waste

2.8.4.1 Low-Level Radioactive Waste Scenario

2.8.4.1.1 Alternatives for Low-Level Radioactive Waste at the Sandia Pulsed Reactor

Table 13-11 shows the alternatives for low-level radioactive waste at the Sandia Pulsed Reactor Facility.

Table 13-11. Alternatives for Low-Level Radioactive Waste

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
440 kg	440 kg	440 kg	440 kg	900 kg

2.8.4.1.2 Operations That Generate Low-Level Radioactive Waste

Low-level radioactive waste in the form of personal protective equipment (PPE) is generated at the Sandia Pulsed Reactor when personnel enter the Kiva for work. The values presented in this section are estimates based on previous experience.

2.8.4.1.3 General Nature of Waste

The dominant radionuclides include mixed fission products.

2.8.4.1.4 Waste Reduction Measures

Personnel avoid introducing unnecessary materials into the Kiva and use dry mopping techniques to avoid liquid wastes.

2.8.4.1.5 Basis for Projecting the “Reduced” and “Expanded” Values

This value for the “reduced” alternative is based on the generation of 24 bags per year of personal protective equipment; each bag is about 40 lb. The value for the “expanded” alternative is based on the generation of 50 bags per year of personal protective equipment, each of which is about 40 lb.

2.8.4.2 Transuranic Waste Scenario

2.8.4.2.1 Alternatives for Transuranic Waste at the Sandia Pulsed Reactor

Table 13-12 shows the alternatives for transuranic waste at the Sandia Pulsed Reactor Facility.

Table 13-12. Alternatives for Transuranic Waste

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 ft^3	0 ft^3	2 ft^3	2 ft^3	5 ft^3

2.8.4.2.2 Operations That Generate Transuranic Waste

Sandia Pulsed Reactor Facility activities that generate transuranic waste could include Los Alamos National Laboratory (LANL) and Lawrence Livermore National Laboratory (LLNL) plutonium weapon tests performed at the Sandia Pulsed Reactor. The waste generation estimates are based on historical experience. The values presented in this section are estimates based on previous experience.

2.8.4.2.3 General Nature of Waste

The waste could include personal protective equipment, decontamination materials, and plutonium samples.

2.8.4.2.4 Waste Reduction Measures

No waste reduction measures exist.

2.8.4.2.5 Basis for Projecting the “Reduced” and “Expanded” Values

The “reduced” alternative assumes no tests; the “expanded” alternative assumes increased Defense Programs weapons test activities.

2.8.4.3 Mixed Waste

2.8.4.3.1 Low-Level Mixed Waste Scenario

Alternatives for Low-Level Mixed Waste at the Sandia Pulsed Reactor - Table 13-13 shows the alternatives for low-level mixed waste at the Sandia Pulsed Reactor Facility.

Table 13-13. Alternatives for Low-Level Mixed Waste

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
4 ft^3	4 ft^3	4 ft^3	4 ft^3	14 ft^3

Operations That Generate Low-Level Mixed Waste **-** Low-level mixed waste is potentially generated at the Sandia Pulsed Reactor Facility when cameras used in the Kiva are replaced. The potential hazardous component is lead solder. The values presented in this section are estimates based on previous experience.

General Nature of Waste **-** The potential hazardous component is lead, and the dominant radionuclides are fission products of short irradiation time.

Waste Reduction Measures - Nonhazardous materials are used when possible.

Basis for Projecting the "Reduced" and "Expanded" Values **-** Test activities for the "reduced" alternative would result in the generation of about 4 ft^3 (0.5 drum) of mixed waste. Test activities for the "expanded" alternative would result in the generation of about 14 ft^3 (1 drum) of mixed waste.

2.8.4.3.2 Transuranic Mixed Waste Scenario

Alternatives for Transuranic Mixed Waste at the Sandia Pulsed Reactor - Table 13-14 shows the alternatives for transuranic mixed waste at the Sandia Pulsed Reactor Facility.

Table 13-14. Alternatives for Transuranic Mixed Waste

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 ft^3	0 ft^3	2 ft^3	2 ft^3	5 ft^3

Operations That Generate Transuranic Mixed Waste **-** Sandia Pulsed Reactor activities that generate transuranic waste could involve Los Alamos National Laboratory and Lawrence Livermore National Laboratory plutonium weapon tests performed at the Sandia Pulsed Reactor Facility. The values presented in this section are estimates based on previous experience.

General Nature of Waste **-** The waste could include personal protective equipment, decontamination materials, and plutonium samples.

Waste Reduction Measures - No waste reduction measures are required.

Basis for Projecting the "Reduced" and "Expanded" Values **-** The "reduced" alternative assumes no tests; the "expanded" alternative assumes increased Defense Programs test activity.

2.8.4.4 Hazardous Waste Scenario

2.8.4.4.1 Alternatives for Hazardous Waste at the Sandia Pulsed Reactor

Table 13-15 shows the alternatives for hazardous waste at the Sandia Pulsed Reactor Facility.

Table 13-15. Alternatives for Hazardous Waste

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
7 ft^3	7 ft^3	14 ft^3	14 ft^3	30 ft^3

2.8.4.4.2 Operations That Generate Hazardous Waste

Hazardous waste is generated during routine maintenance activities and may include batteries and metal halide of sodium vapor lamps. The values presented in this section are estimates based on previous experience.

2.8.4.4.3 General Nature of Waste

The waste includes batteries and hazardous bulbs.

2.8.4.4.4 Waste Reduction Measures

Nonhazardous materials are used whenever possible.

2.8.4.4.5 Basis for Projecting the "Reduced" and "Expanded" Values

A limited number of tests would result in the generation of about one drum per year of hazardous waste for the "reduced" alternative. For the "expanded" alternative, doubling the number of tests per year would result in approximately twice the amount of hazardous waste per year relative to the number of tests in the "no action" alternatives.

2.8.5 Emissions

2.8.5.1 Radioactive Air Emission Scenario for Ar-41

2.8.5.1.1 Alternatives for Ar-41 Emissions at the Sandia Pulsed Reactor

Table 13-16 shows the alternatives for argon-41 (Ar-41) emissions at the Sandia Pulsed Reactor Facility.

Table 13-16. Alternatives for Ar-41 Emissions

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
2.85 Ci	9.5 Ci	9.5 Ci	9.5 Ci	30.0 Ci

2.8.5.1.2 Operations That Generate Ar-41 Air Emissions

Irradiation of experiments (components) causes the activation of the air in the Kiva.

2.8.5.1.3 General Nature of Emissions

The emissions are gaseous in nature.

2.8.5.1.4 Emission Reduction Measures

No emission reduction measures exist.

2.8.5.1.5 Basis for Projecting the “Reduced” and “Expanded” Values

The value for the “reduced” alternative is based on 30 tests per year. The baseline value is based on emissions from operations conducted in 1996 and 1997. Other “no action” values are based on 100 tests and assume the same emissions as 1996 and 1997. The value for the “expanded” alternative is based on 200 tests per year.

2.8.5.2 Chemical Air Emissions

Information on an extensive list of chemicals was obtained from the SNL/NM Chemical Inventory System (CIS). For the air emissions analysis, the entire annual inventory of these chemicals was assumed to have been released over a year of operations for each specific facility (i.e., the annual inventory was divided by facility operating hours). The emissions from this release were then subjected, on a chemical-by-chemical basis, to a progressive series of screening steps for potential exceedances of both regulatory and human health thresholds. For those chemicals found to exceed this screening, process knowledge was used to derive emission factors. The emission factors for these chemicals were then modeled using the U.S. Environmental Protection Agency's *Industrial Source Complex Air Quality Dispersion Model, Version 3*. The results of this modeling are discussed as part of the analysis in support of the SNL/NM site-wide environmental impact statement.

2.8.5.3 Open Burning Scenarios

The Sandia Pulsed Reactor Facility does not have outdoor burning operations.

2.8.5.4 Process Wastewater Effluent Scenario

The Sandia Pulsed Reactor Facility does not generate process wastewater.

2.8.6 Resource Consumption

2.8.6.1 Process Water Consumption Scenario

The Sandia Pulsed Reactor Facility does not consume process water.

2.8.6.2 Process Electricity Consumption Scenario

The Sandia Pulsed Reactor Facility does not consume process electricity.

2.8.6.3 Boiler Energy Consumption Scenario

The Sandia Pulsed Reactor Facility does not consume energy for boilers.

2.8.6.4 Facility Personnel Scenario

2.8.6.4.1 Alternatives for Facility Staffing at the Sandia Pulsed Reactor

Table 13-17 shows the alternatives for facility staffing at the Sandia Pulsed Reactor Facility.

Table 13-17. Alternatives for Facility Staffing

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
8 FTEs	10 FTEs	12 FTEs	10 FTEs	17 FTEs

2.8.6.4.2 Operations That Require Facility Personnel

Normal facility operations require personnel to maintain the facility and its authorization basis and operational documentation and to conduct tests and experiments. The personnel staffing level for all years in the “no action” alternative assumes that the staffing and level of operations represented in the baseline year (full facility utilization for a single-shift operation) are continued. In addition, two additional FTEs are assumed for the FY2003 timeframe to bring SPR-IIIM on line.

2.8.6.4.3 Staffing Reduction Measures

There are no personnel reduction measures other than those proposed for the “reduced” alternative.

2.8.6.4.4 Basis for Projecting the “Reduced” and “Expanded” Values

The “reduced” alternative assumes that the number of tests conducted is reduced to 30 percent of the “no action” level. Hence, enough staff to maintain the facility in operational status and to conduct a reduced number of tests is estimated to be eight FTEs. The “expanded” alternative also assumes that a second shift of staff would be required to run additional tests and experiments. Hence, the staffing level is increased to 15 operations and support staff. The “expanded” alternative also assumes that two additional FTEs (relative to the base year) are needed to design, procure, and install SPR-IV.

2.8.6.5 Expenditures Scenario

2.8.6.5.1 Alternatives for Expenditures at the Sandia Pulsed Reactor

Table 13-18 shows the alternatives for expenditures at the Sandia Pulsed Reactor Facility.

Table 13-18. Alternatives for Expenditures

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
$0	$0	$5 million	$0	$6 million

2.8.6.5.2 Operations That Require Expenditures

For Tech Area V facilities, SNL/NM has included only cost expenditures for projected major capital improvements. No labor costs are included in these projections. The nonnuclear portions of the SPR-IIIM reactor assembly have already been fabricated, and it is estimated that the fuel will be procured from Oak Ridge National Laboratory at a cost of approximately $2 million in the FY2003 timeframe. Combined environment upgrades to the facility, such as a flash x-ray accelerator, are also included at $3 million.

2.8.6.5.3 Expenditure Reduction Measures

No expenditure reduction measures exist.

2.8.6.5.4 Bases for Projecting the “Reduced” and “Expanded” Values

There are no major procurements addressed for the “reduced” alternative because this alternative assumes that existing facilities are used. The future years in the “no action” alternative address expected growth in facility testing capabilities.

The “expanded” alternative assumes that the cost to procure the SPR-IV reactor in the FY2008 time frame is $6 million.

3.0 GAMMA IRRADIATION FACILITY SOURCE INFORMATION

3.1 Purpose and Need

The Gamma Irradiation Facility provides test cells for the irradiation of experiments with high-intensity gamma ray sources. It is assumed that the new Gamma Irradiation Facility will be operational prior to 2003; the original Gamma Irradiation Facility is assumed to be operational for the baseline scenario only (Sandia National Laboratories, 1996; Miller, 1998).

3.2 Description

The Gamma Irradiation Facility is located in Building 6588, where it shares the highbay with the Annular Core Research Reactor. The main features of the Gamma Irradiation Facility are the deep water pool and two dry irradiation cells. An equipment room directly to the east of the highbay contains three of the Gamma Irradiation Facility support subsystems:

- The hydraulic pump equipment for raising and lowering the cell shield doors.
- The water recirculation system for maintaining the purity of the pool water.
- The water makeup subsystem for replenishing water lost from the pool, which is primarily by evaporation.

To the south and outside of the highbay is the Gamma Irradiation Facility cell exhaust system. Although this system contains a high-efficiency particulate air (HEPA) filter, it is not intended to mitigate the release of radioactive materials, but to ensure that ozone created during an irradiation is vented outside through the exhaust stack.

The Gamma Irradiation Facility pool is a rectangular, reinforced-concrete structure with a stainless-steel liner. The pool depth is 16 ft, it is mostly below ground, and it has a berm of approximately 3 ft above floor level. The pool's dimensions are 8 ft by 14.5 ft, and it has an exposed surface area of 65 ft^2 and a total water volume of approximately 13,000 gal.

The Gamma Irradiation Facility pool stores spare fuel elements for the Annular Core Research Reactor. Valved pass-through ports, which are located approximately 8 ft below the surface of the reactor and Gamma Irradiation Facility pools, serve to transfer fuel elements between the two facilities. Information regarding this alternate function of the Gamma Irradiation Facility pool and water system is included in Sandia National Laboratories (1996).

The dry cells contain an open area of 7 ft by 8 ft, which is surrounded by dense concrete walls and ceiling of 3.7 ft thickness. Between the cells, a dense concrete wall of 2 ft thickness, with a depleted uranium plate on each side of the wall, enhances radiation shielding between the cells. The ceiling height is 8.5 ft. Each cell is set up for specific experimental purposes; the south cell is set up for the high-intensity adjustable cobalt array, and the north cell is set up for the panoramic, rectangular, and circular source arrays.

In addition to the standard features of the Gamma Irradiation Facility, the following enhance the facility's capabilities:

- A source elevator system to lift sources from the pool into cells that allows programmable, timed termination of the run.
- Shielded windows in each cell for viewing the raising and lowering of the source and for observing test components during irradiations.
- Manipulators in each cell for handling sources or experiments.
- Rails on the pool floor for easy transfer of source carts.
- A overhead bridge crane with drives of 15-ton and 5-ton capacities, which is shared with the Annular Core Research Reactor.
- A large, roll-up door for direct access to the highbay.

The radioactive sources that the Gamma Irradiation Facility uses are pins of cobalt-60 (Co-60) that are sealed in stainless-steel cladding with welded end caps. Stainless steel is used as cladding because of its high strength and resistance to corrosion in water. Table 13-19 includes an inventory of sources and source strengths.

Table 13-19. Gamma Irradiation Facility Source Inventory as of July 1, 1995

Batch	Source Type	Number of Pins	Current Strength (Ci)	Current Usage
1	Co-60	64	54,300	North Gamma Irradiation Facility
2	Co-60	16	41,600	South Gamma Irradiation Facility High-Intensity Adjustable Cobalt Array
3	Co-60	10	13,200	Rectangular Cobalt Array
Total		107	109,100	

The Gamma Irradiation Facility and Annular Core Research Reactor share a storage/transfer pool (STP). Materials stored in the STP to support the Gamma Irradiation Facility are addressed in this section. Fuel elements and other material that are stored in the STP to support operation of the Annular Core Research Reactor are addressed in "6.0 ANNULAR CORE RESEARCH REACTOR FACILITY (MO-99) SOURCE INFORMATION" and "5.0 ANNULAR CORE RESEARCH REACTOR FACILITY (DP) SOURCE INFORMATION."

(Sandia National Laboratories, 1996; Miller, 1998)

3.3 Program Activities

Table 13-20 shows the program activities at the Gamma Irradiation Facility.

Table 13-20. Program Activities at the Gamma Irradiation Facility

Program Name	Activities at the Gamma Irradiation Facility	Category of Program	Related Section of the *SNL Institutional Plan*
Experimental Activities	The Gamma Irradiation Facility consists of two adjoining irradiation cells with Co-60 sources that provide a variety of radioactive source geometries for irradiating experiments. The Gamma Irradiation Facility is used mainly for radiation testing of electronic components in satellite and weapon systems, dosimetry calibration, and studies of radiation damage to materials.	Programs for the Department of Energy	Section 6.1.1.1

Table 13-20. Program Activities at the Gamma Irradiation Facility (Continued)

Program Name	Activities at the Gamma Irradiation Facility	Category of Program	Related Section of the *SNL Institutional Plan*
Performance Assessment Science and Technology	Conduct hostile (gamma radiation) environmental testing to evaluate effects on weapons.	Programs for the Department of Energy	Section 6.1.1.1
Office of Nuclear Energy, Isotope Production and Distribution	The Isotope Production Program will use the Gamma Irradiation Facility for underwater transfer of material from the reactor to transfer casks. The Gamma Irradiation Facility will also store reactor fuel and other radioactive components.	Programs for the Department of Energy	Section 6.1.7.2

3.4 Operations and Capabilities

High-intensity gamma ray sources irradiate experiments in the Gamma Irradiation Facility. When experiments are not being irradiated, the radioactive sources are safely stored in the deep water pool under the cell. Cable-driven elevators raise and lower sources between the pool floor and a predetermined position inside the dry irradiation cell. When a test is not in progress, workers can access the inside of a cell by way of a large hydraulically driven elevator door to set up test units and connect instrumentation. After the setup is complete, the cell is cleared of personnel, the door is closed, and the source is raised for a predetermined amount of time. Experiments are typically irradiated at high dose rates (50 to 300 kilorads/hour) and for short to intermediate durations lasting less than a day. However, irradiation durations of several days are sometimes required for high-dose tests. During irradiation, personnel can position sources or experiments as necessary with remote manipulators and monitor the source movement and the irradiation process through a shielded window.

Types of experiments previously performed in the cells of the Gamma Irradiation Facility cover numerous disciplines and components:

- Electronic component hardness, survivability, and certification testing for military and commercial applications

- Degradation testing of weapon components

- Testing of radiation effects on material properties

- Testing of radiation effects on organic materials (sludge irradiation)

- Material and component testing for nuclear reactor accident tests
- Mixed environment testing (steam, heat, caustic environments, and radiation)

(Sandia National Laboratories, 1996; Miller, 1998)

3.5 Hazards and Hazard Controls

The Gamma Irradiation Facility is a hazard category 3 facility as defined by U.S. Department of Energy (1992) and does not present a significant hazard to the public, the environment, or the Tech Area V site. The Gamma Irradiation Facility presents a significant hazard only to the operations personnel and others in the immediate vicinity of the irradiation cells and the pool. The main hazard associated with the facility is the potential for inadvertent exposure of operations personnel to the high-intensity radioactive sources. Table 13-21 lists the hazards associated with Gamma Irradiation Facility operations and the prevention or mitigation features that serve as hazard controls.

Table 13-21. Gamma Irradiation Facility Hazard Prevention and Mitigation Features

Hazard	Prevention and Mitigation Features
Exposure to ionizing radiation source	• Fail-safe electronic control system with safety interlocks • Periodic maintenance and checks of control system • Operator training, including Gamma Irradiation Facility operator certification • Controls on bypass operation • Radiation monitoring with remote area monitoring system and a daily operability check
Exposure to ionizing radiation from contamination of pool	• Radiation monitoring with a remote area monitoring system in pool area and in equipment room where deionizers are located, including a daily operability check • Continuous polishing of waterthrough deionizers • Periodic surveillance of makeup system
Airborne radiation	• No radioactive material other than test units and sealed sources used • HEPA filters act as backup to prevent releases to environment • Remote area monitoring systems continuously monitor facility
Ozone	• Forced delay in opening of cell door after irradiation of experiments • Separate ventilation system for the cell that eliminates ozone within a few minutes after source drops into the pool
Cranes, hoists and rigging	Safety training

(Sandia National Laboratories, 1996; Miller, 1998)

3.6 Accident Analysis Summary

No credible accident scenario has been identified that could result in a dispersal of radioactive source material. Although a leak may occur in the cladding of a source pin, the contents would only be released slowly to the pool water or possibly contaminate the inside of the irradiation cells. The continuous radiation monitoring of a remote area monitoring system on the pool water demineralizer or the periodic water samples taken from the pool would detect such a leak immediately.

The worst-case, unmitigated accident for the Gamma Irradiation Facility is a direct exposure of a facility worker to an unshielded source that consists of a number of Co-60 pins. Because of the high source intensities (50 kCi to 100 kCi) routinely used, a facility worker could receive a significant dose. This accident could result from two possible scenarios:

- In accident scenario one, the water has leaked out of the Gamma Irradiation Facility pool. With no water to shield him from the source, the Gamma Irradiation Facility operator looks over the edge of the pool and is exposed to the total inventory (assumed maximum of 190 kCi of Co-60) at a distance of 4 m for a period of 10 seconds before he realizes the danger and returns to a safe position. The dose rate is approximately 240 rems per minute, and the total dose received would be approximately 40 rems. Loss of Gamma Irradiation Facility pool water does not result in damage to the sources or release of any radioactivity.

- In accident scenario two, a 100-kCi source is exposed in a cell when the shield door is lowered. The Gamma Irradiation Facility operator is exposed to the source at a distance of 3 m for a period of 10 seconds before he realizes the danger and returns to a safe position. The dose rate is approximately 220 rems per minute and the total dose received would be slightly less than 40 rems.

The radiological consequences of these accident scenarios assume no credit for the many prevention and mitigation features that are designed into the Gamma Irradiation Facility and the administrative controls for operation of the facility. As a consequence, both accidents would result in a worker dose that is a significant fraction (approximately 20 percent) of the radiological evaluation guidelines (Sandia National Laboratories, 1996). Because of the hazard controls, the likelihood of occurrence for these accidents is considered less than 10^{-4} per year.

No detailed accident analysis has been performed for the existing Gamma Irradiation Facility. However, a detailed analysis has been performed for the new Gamma Irradiation Facility (yet to be constructed) as reported in Boldt *et al.* (1995). Because the dry irradiation facilities of the new Gamma Irradiation Facility are very similar in operation to the existing Gamma Irradiation Facility, the accident analysis of the existing Gamma Irradiation Facility can be modeled closely after the analysis used in the preliminary safety analysis report of the new Gamma Irradiation Facility. The risk analysis performed for the new Gamma Irradiation Facility determined that a source handling accident is the mitigated accident with the most risk because sources are moved manually and the potential for human error can never be fully eliminated.

By applying this determination to the existing Gamma Irradiation Facility, a reasonable estimate can be made of the worst-case mitigated consequence. Handling operations that involve lifting a radioactive source are normally limited to a single pin at a time. If a 10 kCi pin were lifted out of the water, the expected dose rate would be approximately 22 rads per minute at 3 m. Although this represents a high dose rate, it provides time for mitigative actions prior to injurious doses to personnel. A ten-second exposure, which is the time assumed to take a corrective action, would result in a total acute dose of about 4 rems. The likelihood of occurrence of this accident is considered to be greater than 10^{-4} per year but less than 10^{-2} per year.

(Sandia National Laboratories, 1996; Miller, 1998)

3.7 Reportable Events

The Gamma Irradiation Facility has had no occurrences within the past five years.

3.8 Scenarios for Impact Analysis

In all of the scenarios for impact analysis in this section, base year values are for FY1996 unless otherwise noted.

3.8.1 Activity Scenario for Test Activities: Tests

3.8.1.1 Alternatives for Test Activities: Tests

Table 13-22 shows the alternatives for tests at the Gamma Irradiation Facility.

Table 13-22. Alternatives for Test Activities: Tests

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 hours	1,000 hours	0 hours	0 hours	8,000 hours

3.8.1.2 Assumptions and Actions for the "Reduced" Values

The "reduced" alternative for testing in the Gamma Irradiation Facility assumes that the facility is not irradiating test packages. The impact of the "reduced" scenario relative to the baseline is a slightly reduced level of staffing.

3.8.1.3 Assumptions and Rationale for the "No Action" Values

The "no action" alternative for testing in the Gamma Irradiation Facility assumes that the facility is irradiating test packages in one of the two available test cells for 1,000 test-hours (approximately 40 days of continuous irradiation in a single cell) per year. The key consumable resource in the Gamma Irradiation Facility is the radioisotope sources that provide the gamma radiation necessary to conduct the tests. The radioactivity of these radioisotope sources diminishes over time regardless of whether or not tests are being conducted. Hence, the number of test hours assumed in the "no action," "reduced," and "expanded" alternatives has no impact on the depletion of the radioisotope sources. It is assumed that the new Gamma Irradiation Facility will be operational prior to 2003; therefore, this facility is assumed to be operational for the year only.

3.8.1.4 Assumptions and Actions for the "Expanded" Values

The "expanded" alternative for testing in the Gamma Irradiation Facility assumes that the facility is irradiating test packages in each of the two available test cells for 4,000 test-hours per year (approximately 165 days of continuous irradiation in a single cell). The impact of the expanded scenario relative to the baseline is an increased level of staffing.

3.8.2 Material Inventories

3.8.2.1 Nuclear Material Inventory Scenarios

3.8.2.1.1 Nuclear Material Inventory Scenario for Depleted Uranium

Alternatives for Depleted Uranium Nuclear Material Inventory - Table 13-23 shows the alternatives for the depleted uranium inventory at the Gamma Irradiation Facility.

Table 13-23. Alternatives for Depleted Uranium Nuclear Material Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
13,600 kg	13,600 kg	13,600 kg	13,600 kg	13,600 kg

Operations That Require Depleted Uranium - Depleted uranium is placed within the irradiation cells to provide shielding from gamma radiation. A portion of the depleted uranium shielding material is permanently affixed to the cell walls. The remainder is in the form of depleted uranium bricks that can be placed at essentially any desired location within the cells.

Current plans do not include a transfer of the depleted uranium shielding materials to the new Gamma Irradiation Facility.

Basis for Projecting the "Reduced" and "Expanded" Values - The requirement for shielding material is independent of the level of facility utilization.

3.8.2.2 Radioactive Material Inventory Scenarios

The Gamma Irradiation Facility has no radioactive material inventories.

3.8.2.3 Sealed Source Inventory Scenario for Co-60

3.8.2.3.1 Alternatives for Co-60 Sealed Source Inventory

Table 13-24 shows the alternatives for the Co-60 sealed source inventory for the Gamma Irradiation Facility.

Table 13-24. Alternatives for Co-60 Sealed Source Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
108,000 Ci	108,000 Ci	0 Ci	0 Ci	108,000 Ci

3.8.2.3.2 Operations That Require Co-60

Co-60 sources are the primary radioactive sources that comprise Gamma Irradiation Facility irradiation capability. The "no action" base year represents sources in the facility at that time. A new Gamma Irradiation Facility has been designed and will be constructed prior to FY2003; therefore, the "no action" FY2003 and FY2008 timeframes assume that the Co-60 sources from the existing Gamma Irradiation Facility will be transferred to the new Gamma Irradiation Facility or stored in the Gamma Irradiation Facility with no usage.

3.8.2.3.3 Basis for Projecting the "Reduced" and "Expanded" Values

See "3.8.1 Activity Scenario for Test Activities: Tests."

3.8.2.4 Spent Fuel Inventory Scenarios

The Gamma Irradiation Facility has no spent fuel inventories.

3.8.2.5 Chemical Inventory Scenarios

The Gamma Irradiation Facility has no inventories of chemicals of concern.

3.8.2.6 Explosives Inventory Scenario for Bare UNO 1.1

3.8.2.6.1 Alternatives for Bare UNO 1.1 Explosives Inventory

Table 13-25 shows the alternatives for bare UNO 1.1 explosives inventory at the Gamma Irradiation Facility.

Table 13-25. Alternatives for Bare UNO 1.1 Explosives Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 g	0 g	0 g	0 g	500 g

3.8.2.6.2 Operations That Require Bare UNO 1.1

The “no action” FY2003 and FY2008 timeframes assume that all Gamma Irradiation Facility activities occur in the new Gamma Irradiation Facility.

3.8.2.6.3 Basis for Projecting the “Reduced” and “Expanded” Values

The reduced alternative assumes the “no action” base year value.

Occasionally, test items containing explosives are present in the Gamma Irradiation Facility**.** Current administrative limits allow up to 500 g of TNT-equivalent explosives; therefore, the “expanded” alternative assumes that this amount is present in the facility.

3.8.2.7 Other Hazardous Material Inventory Scenarios

The Gamma Irradiation Facility has no inventories of hazardous materials that do not fall into the categories of nuclear or radioactive material, sealed sources, spent fuel, explosives, or chemicals.

3.8.3 Material Consumption

3.8.3.1 Nuclear Material Consumption Scenarios

Nuclear material is not consumed at the Gamma Irradiation Facility.

3.8.3.2 Radioactive Material Consumption Scenarios

Radioactive material is not consumed at the Gamma Irradiation Facility.

3.8.3.3 Chemical Consumption Scenarios

Information initially provided for this section resides in the Facility Information Manager database and will be made available to the analysts responsible for preparing the sitewide environmental impact statement.

3.8.3.4 Explosives Consumption Scenarios

Explosives are not consumed at the Gamma Irradiation Facility.

3.8.4 Waste

3.8.4.1 Low-Level Radioactive Waste Scenario

3.8.4.1.1 Alternatives for Low-Level Radioactive Waste at the Gamma Irradiation Facility

Table 13-26 shows the alternatives for low-level radioactive waste at the Gamma Irradiation Facility.

Table 13-26. Alternatives for Low-Level Radioactive Waste

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
56 ft^3	56 ft^3	0 ft^3	0 ft^3	126 ft^3

3.8.4.1.2 Operations That Generate Low-Level Radioactive Waste

Low-level waste in the form of resins and personal protective equipment (PPE) is generated during operation of the Gamma Irradiation Facility. The resins to maintain Gamma Irradiation Facility pool purity for out years are listed on the Annular Core Research Reactor descriptions. The pool is maintained for reactor fuel storage.

3.8.4.1.3 General Nature of Waste

The Gamma Irradiation Facility resins are potentially contaminated with radionuclides introduced to the pool water from shipping casks that are contaminated with materials such as Co-60 and cesium-137 (Cs-137). Levels may be less than detectable or very low. There is generally no detectable contamination associated with the personal protective equipment; however, some contamination may result from the depleted uranium shielding.

3.8.4.1.4 Waste Reduction Measures

Use of the resins for water purification results in water recycling and reduced use.

3.8.4.1.5 Basis for Projecting the “Reduced” and “Expanded” Values

Under the “reduced” scenario, the facility is kept operational but no testing (irradiation) is performed. Waste volume includes 12 ft^3 of resins and 44 ft^3 (six drums per year) of personal protective equipment.

The “expanded” scenario includes continuous testing (irradiation) 24 hours per day, seven days per week. Waste volume includes 36 ft^3 of resins and 90 ft^3 (12 drums) of personal protective equipment.

3.8.4.2 Transuranic Waste Scenario

Transuranic waste is not produced at the Gamma Irradiation Facility.

3.8.4.3 Mixed Waste

3.8.4.3.1 Low-Level Mixed Waste Scenario

Low-level mixed waste is not produced at the Gamma Irradiation Facility.

3.8.4.3.2 Transuranic Mixed Waste Scenario

Transuranic mixed waste is not produced at the Gamma Irradiation Facility.

3.8.4.4 Hazardous Waste Scenario

3.8.4.4.1 Alternatives for Hazardous Waste at the Gamma Irradiation Facility

Table 13-27 shows the alternatives for hazardous waste at the Gamma Irradiation Facility.

Table 13-27. Alternatives for Hazardous Waste

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
7 ft^3	7 ft^3	0 ft^3	0 ft^3	14 ft^3

3.8.4.4.2 Operations That Generate Hazardous Waste

Hazardous waste is generated during routine facility maintenance at the Gamma Irradiation Facility.

3.8.4.4.3 General Nature of Waste

Hazardous waste generated at the Gamma Irradiation Facility includes batteries and hazardous bulbs or lamps (sodium vapor or metal halide).

3.8.4.4.4 Waste Reduction Measures

Nonhazardous materials are used whenever possible.

3.8.4.4.5 Basis for Projecting the “Reduced” and “Expanded” Values

For the “reduced” scenario, the Gamma Irradiation Facility is operational, but no testing (irradiation) is performed. Approximately one drum (7 ft^3) per year of hazardous waste is generated when, for example, bulbs are changed.

For the “expanded” scenario, the Gamma Irradiation Facility is operated continuously (24 hours per day, seven days per week). Approximately two drums of hazardous waste is generated each year.

3.8.5 Emissions

3.8.5.1 Radioactive Air Emissions Scenarios

Radioactive air emissions are not produced at the Gamma Irradiation Facility.

3.8.5.2 Chemical Air Emissions

Information on an extensive list of chemicals was obtained from the SNL/NM Chemical Inventory System (CIS). For the air emissions analysis, the entire annual inventory of these chemicals was assumed to have been released over a year of operations for each specific facility (i.e., the annual inventory was divided by facility operating hours). The emissions from this release were then subjected, on a chemical-by-chemical basis, to a progressive series of screening steps for potential exceedances of both regulatory and human health thresholds. For those chemicals found to exceed this screening, process knowledge was used to derive emission factors. The emission factors for these chemicals were then modeled using the U.S. Environmental Protection Agency's *Industrial Source Complex Air Quality Dispersion Model, Version 3*. The results of this modeling are discussed as part of the analysis in support of the SNL/NM site-wide environmental impact statement.

3.8.5.3 Open Burning Scenarios

The Gamma Irradiation Facility does not have outdoor burning operations.

3.8.5.4 Process Wastewater Effluent Scenario

The Gamma Irradiation Facility does not generate process wastewater.

3.8.6 Resource Consumption

3.8.6.1 Process Water Consumption Scenario

3.8.6.1.1 Alternatives for Process Water Consumption at the Gamma Irradiation Facility

Table 13-28 shows the alternatives for process water consumption at the Gamma Irradiation Facility.

Table 13-28. Alternatives for Process Water Consumption

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
17,000 gal	17,000 gal	0 gal	0 gal	17,000 gal

3.8.6.1.2 Operations That Consume Process Water

The "no action" base year assumes that the evaporation rate of water in the facility pool is 17,000 gal per year to cool the radioactive sources. In years 2003 and 2008, it is anticipated that the radioactive sources in the Gamma Irradiation Facility will be transferred to the new Gamma Irradiation Facility. The Gamma Irradiation Facility pool will be used to store reactor fuel in the out years, and the water consumption is included in the Annular Core Research Reactor descriptions.

3.8.6.1.3 Consumption Reduction Measures

This section is not applicable.

3.8.6.1.4 Basis for Projecting the "Reduced" and "Expanded" Values

Under the "reduced" and "expanded" alternatives, there is no planned change in the number of radioactive sources relative to the "no action" alternative. Therefore, the amount of water used would not change in the "reduced" alternative.

3.8.6.2 Process Electricity Consumption Scenario

The Gamma Irradiation Facility does not consume process electricity.

3.8.6.3 Boiler Energy Consumption Scenario

The Gamma Irradiation Facility does not consume energy for boilers.

3.8.6.4 Facility Personnel Scenario

3.8.6.4.1 Alternatives for Facility Staffing at the Gamma Irradiation Facility

Table 13-29 shows the alternatives for facility staffing at the Gamma Irradiation Facility.

Table 13-29. Alternatives for Facility Staffing

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
2 FTEs	2 FTEs	0 FTEs	0 FTEs	3 FTEs

3.8.6.4.2 Operations That Require Facility Personnel

Under the "no action" base year, approximately 2 FTEs will be required to operate the facility and conduct scheduled tests. There are no personnel requirements for the "no action" alternative in FY2003 and FY2008 because the existing Gamma Irradiation Facility will be used to store reactor fuel for the Annular Core Research Reactor, and the personnel required are reflected in the Annular Core Research Reactor descriptions.

3.8.6.4.3 Staffing Reduction Measures

This section is not applicable.

3.8.6.4.4 Basis for Projecting the "Reduced" and "Expanded" Values

Under the "reduced" alternative, there will be no test irradiations; however, one FTE is necessary to maintain the facility.

Under the "expanded" alternative, one additional FTE would be required relative to the "no action" baseline to conduct additional tests.

3.8.6.5 Expenditures Scenario

3.8.6.5.1 Alternatives for Expenditures at the Gamma Irradiation Facility

Table 13-30 shows the alternatives for expenditures at the Gamma Irradiation Facility.

Table 13-30. Alternatives for Expenditures

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
$0	$0	$0	$0	$0

3.8.6.5.2 Operations That Require Expenditures

For Tech Area V facilities, SNL/NM has included only cost expenditures for projected major capital improvements. No labor costs are included in these estimates. It is anticipated that there will be no major expenditures outside standard maintenance in the Gamma Irradiation Facility. All new major expenditures will occur and are accounted for in the new Gamma Irradiation Facility.

3.8.6.5.3 Expenditure Reduction Measures

No expenditure reduction measures exist.

3.8.6.5.4 Basis for Projecting the "Reduced" and "Expanded" Values

This section is not applicable.

4.0 NEW GAMMA IRRADIATION FACILITY SOURCE INFORMATION

4.1 Purpose and Need

The new Gamma Irradiation Facility will provide a single structure for performing a wide variety of gamma irradiation experiments with various test configurations and at widely varying dose and dose rate levels. The Gamma Irradiation Facility will be divided into two types of irradiation facilities (in-cell dry and in-pool wet), based on the type of test to be performed.

4.1.1 In-Cell Dry Irradiation

The in-cell facilities are large, dry, shielded rooms in which irradiations are performed with a high-intensity gamma ray source located in the room. An elevator raises and lowers the source between the shielded location in the water pool and a predetermined position in the cell. Entry into the cells is through a shielded door at the end of an entry maze hallway, which prevents direct radiation emission from the cell. A pneumatically lifted, movable wall is part of the large gamma cell for passage of large test units that cannot be transported through the maze. Typical irradiations performed in these facilities are at high dose rates (100 to 1,000 kilorads per hour) and for short to intermediate durations that last less than a day.

4.1.2 In-Pool Wet Irradiation

In the in-pool facilities, radioactive sources are held in an irradiation fixture in a deep pool of water, where they remain stationary. Experiment canisters containing test units are immersed in the pool and positioned in preset locations in the irradiation fixture. Typical irradiations performed in these facilities are at moderate and low dose rates.

The Gamma Irradiation Facility will provide a capability to conduct numerous types of studies, including the following:

- Simultaneous thermal and radiation effects studies
- Degradation testing of weapon components
- Material and component testing for nuclear reactor accident tests
- Electronic component certification

- Electronic component hardness
- Survivability and certification tests for military and commercial applications
- Radiation effects on material properties
- Radiation effects on organic materials (such as food or sludge)
- Hazardous waste destruction
- Mixed environment testing (for example, steam and radiation or heat and radiation)

4.2 Description

The new Gamma Irradiation Facility building is a single-story structure located in the northeast quadrant of Tech Area V inside the security perimeter. The structure consists of a central highbay with an ancillary lowbay. The highbay houses three concrete test cells and a pool with a depth of 5.5 meters. The pool can store up to 2.4 MCi of Co-60 or an equivalent thermal source (40 kilowatts) of other gamma ray sources. The sources are in the form of pins and can be shared between the in-cell irradiation facilities and the in-pool irradiation facilities. Ancillary spaces in the highbay include offices, setup/light laboratories, and rest rooms. The adjacent lowbay contains the support equipment for the Gamma Irradiation Facility:

- Steam room for experiments
- Mechanical room for water treatment and ventilation systems
- Electrical room for all power distribution

The building highbay area totals approximately 1,060 gross m^2 with an additional 290 gross m^2 in the adjacent lowbay.

The new Gamma Irradiation Facility consolidates several existing SNL gamma sources into a single facility. The proposed facility may include sources relocated from the existing Gamma Irradiation Facility, which is a two-cell dry irradiator located in the Annular Core Research Reactor highbay in Tech Area V. The relocation satisfies the following objectives:

- Relieves congestion around both the Gamma Irradiation Facility and the Annular Core Research Reactor.
- Reduces the potential for exposure of operating staff to radiation.
- Facilitates personnel evacuation in an emergency.
- Frees space adjacent to the Annular Core Research Reactor for experimental work and reactor fuel storage.

The new Gamma Irradiation Facility will also include gamma sources relocated from the Low-Intensity Cobalt Array (LICA), which is located in SNL's Tech Area I. This consolidates gamma irradiation sources in a single dedicated facility in a remote area, reducing the potential for radiation exposure of nonoperations personnel. It provides a modern facility to satisfy SNL's continued need for high-intensity gamma environment testing for the foreseeable future.

(Boldt *et al*., 1995; Miller, 1998)

4.3 Program Activities

Table 13-31 shows the program activities at the new Gamma Irradiation Facility.

Table 13-31. Program Activities at the New Gamma Irradiation Facility

Program Name	Activities at the New Gamma Irradiation Facility	Category of Program	Related Section of the *SNL Institutional Plan*
In-Pool Irradiation	• Simultaneous thermal and radiation effects studies • Weapon components for degradation testing • Material/component testing for nuclear reactor accident tests • Electronic component certification	Major Programmatic Initiatives	None

Table 13-31. Program Activities at the New Gamma Irradiation Facility (Continued)

Program Name	Activities at the New Gamma Irradiation Facility	Category of Program	Related Section of the *SNL Institutional Plan*
In-Cell Irradiation	• Electronic component hardness, survivability, and certification tests for military and commercial applications • Radiation effects on material properties • Radiation effects on organic materials (such as food or sludge) • Hazardous waste destruction • Mixed environment testing (for example, steam and radiation or heat and radiation)	Major Programmatic Initiatives	None

4.4 Operations and Capabilities

Whereas the new Gamma Irradiation Facility has all of the features of the existing Gamma Irradiation Facility or LICA facilities, it also has many enhanced features that make the new Gamma Irradiation Facility a unique irradiation facility. The new Gamma Irradiation Facility has three irradiation cells, with one cell sufficiently large to accommodate large components (such as space vehicles or military vehicles):

- The east cell is a 5.5-m by 9.1-m experiment cell with two source elevators and a 5.5-m-wide movable wall for access by large vehicles.
- The south cell is a 3.0-m by 3.0-m irradiation cell for use with high-intensity adjustable cobalt array for rapidly adjustable sources arrays.
- The north cell is a 3.0-m by 3.0-m high-fidelity cell with lead-lined walls to reduce backscatter.

The following is a list of the general features and enhanced capabilities available in the new Gamma Irradiation Facility:

- High-strength radioactive sources with up to 2.4 MCi of Co-60 inventory
- Configurable radiation sources to provide various shapes for the source array (for example, point, planar, or circular)

- Shielded windows for experiment observation during irradiation
- Remote manipulators for experiment or source handling
- In-pool irradiation fixtures for various experiment configurations
- Steam room for thermal cycling following radiation exposures
- Overhead traveling cranes with approximately 10 and 5 metric ton hook capacities for source handling and shield cask movement
- Gamma Irradiation Facility operations offices and experimenter offices and labs

(Boldt *et al*., 1995; Miller, 1998)

4.5 Hazards and Hazard Controls

In the new Gamma Irradiation Facility, high-intensity radioactive sources for the dry and wet irradiation facilities are stored in a large, deep pool of water. The primary hazard is from large quantities of radioactive material in the form of sealed sources. Although the source term is large, the form, usage, and storage conditions for this material are such that the facility presents only a low contamination hazard. Based on DOE Order 6430.1A criteria, the facility is designed to limit worker radiation exposure to less than 1 rem per year. Because of the excellent radiation shielding provided by the Gamma Irradiation Facility pool, little dose is attributable to sources that are stored in the pool, and almost the entire expected dose arises while sources are raised into the cells.

The primary containment or confinement boundary for radioactive material at the new Gamma Irradiation Facility is the source cladding. All sources are sealed in cladding, and no handling of unencapsulated sources is proposed. Also, the radioactive material is in a solid form; no gaseous or liquid sources are permitted in the new Gamma Irradiation Facility. Therefore, the cladding provides a sufficient barrier to prevent the dispersal of the radioactive material. To protect the cladding integrity, strict administrative controls are placed on source handling and movement, cladding environmental conditions (such as water purity), and experiment energy sources.

The Gamma Irradiation Facility pool primarily serves as a radiation shield for sources. The pool does not serve as an active cooling system nor confinement boundary. Up to 2.4 MCi of Co-60 as multiple sealed sources (pins) are stored in an 5.5-m deep water pool. If the Co-60 inventory is reduced, the pool may also contain other radioactive sources based on the total thermal power. The source limit is for the overall pool and does not imply any proportioning between the dry or wet irradiation facilities. For the dry irradiation portion of the facility, the sources are raised out of the pool and into shielded cells for exposure of the test units. All activities for the wet irradiations, including source movement and exposure of test material, occur under water.

While sources are raised in the cells, radiation shielding is provided by the 1.8-m thick cell walls composed of commercial-grade concrete. The irradiation cell represents the primary radiation shield when the sources are raised. Access control ensures that an inadvertent radiation exposure of operations personnel does not occur in a cell, where dose rates can attain 10 krads per minute.

Chemical hazards within the Gamma Irradiation Facility are minimal. Flammables or toxic chemicals in greater-than-laboratory quantities are not normally stored at the facility. Laboratory quantities of some flammable or toxic chemicals will be stored for experiments to be performed in the wet irradiation facilities and the steam subsystem.

Test units introduced into the Gamma Irradiation Facility may contain additional hazardous materials, such as chemicals, explosives, radioactive substances, electrical systems, and thermal energy sources. However, these materials are typically contained within weapons, military hardware, nuclear reactor components, or systems associated with the space program. Such units are engineered to resist extreme environments. Catastrophic failure resulting in the breach of the radioactive source cladding is extremely unlikely.

(Boldt *et al*., 1995; Miller, 1998)

4.6 Accident Analysis Summary

The new Gamma Irradiation Facility incorporates the sources and test capabilities of two existing SNL irradiation facilities—the current Gamma Irradiation Facility in Tech Area V (in operation since 1962) and the LICA facilities in Tech Area I (in operation since 1982). Experience gained during the 42 total years of safe operation of these two facilities and conformance to industry standards serve as the foundation for determining the new Gamma Irradiation Facility design and planned operation.

4.6.1 In-Cell Irradiation Capabilities

The desired gamma irradiation capabilities for the new Gamma Irradiation Facility are based on the capabilities in the existing Gamma Irradiation Facility and LICA facilities and new capabilities desired for future experiments. The existing Gamma Irradiation Facility routinely irradiates experiments in dry cells with Co-60 sources that are in the range of 50 to 100 kCi. In order to cover this range of experimentation and to allow for the decay of the Co-60 source, a design value of 250 kCi for each of the smaller north and south cells is established. The large east cell provides for experimentation on larger test units, and therefore the design value is established at 500 kCi to account for the longer distances possible between the source and test unit. The dose rate follows basically a linear relationship with the source strength and a $1/r^2$ relationship with distance from the source.

At 2 m from a 250-kCi Co-60 source, the direct dose rate (the dose rate that a test unit would receive directly from the source in a cell) is 80,000 rads per hour. However, due to reflection off of the cell walls, the actual dose received is higher. For the same size source, the reflected dose rate in a cell is approximately 10,000 rads per hour and is relatively independent of location. The total dose rate is therefore 90,000 rads per hour for a test unit at 2 m from the source. The north cell (high-fidelity cell) contains lead-lined walls to reduce the reflected component. At 2 m from the 500-kCi Co-60 source in the large east cell, the total dose rate is approximately 180,000 rads.

Two other dose predictions, which are of concern in assessing accident consequences, are the dose rates at 10 m and 50 m. The assumed distance from the pool area to the outside of the Gamma Irradiation Facility building is 10 m, and 50 m is the assumed distance to the site boundary. With only air shielding (no building walls), the dose rate at 10 m from Co-60 sources of 250 kCi and 10 kCi are 3,200 rads per hour and 130 rads per hour, respectively. At 50 m from the same sources, the dose rates are 120 rads hour and 4.7 rads per hour, respectively.

4.6.2 Source Inventory

The radioactive sources used in the Gamma Irradiation Facility are all sealed sources. The Gamma Irradiation Facility sources can be various radioactive nuclides. Most, if not all, of the radioactive material will be Co-60, which is in the form of a nonsoluble metal. The type and intensity of the radioactive material may vary.

Radioactive gamma-emitting sources generate heat as a result of the attenuation of the long-range, energetic photons. For the Gamma Irradiation Facility, this heat is deposited as a volumetric heat source in the pool water. It does not present a localized cooling concern. There may be some internal attenuation within the radioactive source material; however, due to the long range of gammas, this power source is not sufficiently large to require water cooling of the pins. In the dry irradiation cells, sources are routinely brought out of the water for extended periods with only slight increase in temperature.

4.7 Reportable Events

The new Gamma Irradiation Facility is a planned facility under construction and is not yet operational.

4.8 Scenarios for Impact Analysis

In all of the scenarios for impact analysis in this section, base year values are for FY1996 unless otherwise noted.

4.8.1 Activity Scenario for Test Activities: Tests

4.8.1.1 Alternatives for Test Activities: Tests

Table 13-32 shows the alternatives for tests at the new Gamma Irradiation Facility.

Table 13-32. Alternatives for Test Activities: Tests

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 hours	0 hours	13,000 hours	13,000 hours	24,000 hours

4.8.1.2 Assumptions and Actions for the “Reduced” Values

The “reduced” alternative for testing in the new Gamma Irradiation Facility assumes that the facility is not irradiating test packages. The impact of the “reduced” scenario relative to the baseline is a slightly reduced level of staffing.

4.8.1.3 Assumptions and Rationale for the “No Action” Values

The “no action” alternative for testing in the new Gamma Irradiation Facility assumes that the facility is irradiating test packages in one of the available test cells for 13,000 test hours per year (approximately 26 weeks continuous irradiation in each of three cells). The key consumable resource in the new Gamma Irradiation Facility is the radioisotope sources that provide the gamma radiation necessary to conduct the tests. The radioactivity of these radioisotope sources diminishes over time, regardless of whether or not tests are conducted. Therefore, the number of test hours assumed in the “no action,” “reduced,” and “expanded” alternatives has no impact on the depletion of the radioisotope sources. This facility would be constructed after the “no action” baseline time frame; hence, for the “no action” alternative, this facility is assumed to be operational only for the FY2003 and FY2008 timeframes.

4.8.1.4 Assumptions and Actions for the "Expanded" Values

The "expanded" alternative for testing in the new Gamma Irradiation Facility assumes that the facility is irradiating test packages in one of the two available test cells for 24,000 test hours per year (approximately 330 days of continuous irradiation in three cells). The impact of the "expanded" scenario relative to the baseline is an increased level of staffing.

4.8.2 Material Inventories

4.8.2.1 Nuclear Material Inventory Scenarios

The new Gamma Irradiation Facility has no nuclear material inventories.

4.8.2.2 Radioactive Material Inventory Scenarios

The new Gamma Irradiation Facility has no radioactive material inventories.

4.8.2.3 Sealed Source Inventory Scenario for Co-60

4.8.2.3.1 Alternatives for Co-60 Sealed Source Inventory

Table 13-33 shows the alternatives for the Co-60 sealed source inventory at the new Gamma Irradiation Facility.

Table 13-33. Alternatives for Co-60 Sealed Source Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
150,000 Ci	0 Ci	1,150,000 Ci	1,150,000 Ci	2,000,000 Ci

4.8.2.3.2 Operations That Require Co-60

Co-60 sources are the primary radioactive sources that comprise the new Gamma Irradiation Facility irradiation capability. The facility is under construction; hence, the "no action" base year value is not applicable. The new Gamma Irradiation Facility will be constructed prior to FY2003; hence, the "no action" FY2003 and FY2008 values assume that the Co-60 sources from the existing Gamma Irradiation Facility will be transferred to the new Gamma Irradiation Facility and an additional 1,000,000 Ci of sources will be procured for the new facility.

4.8.2.3.3 Basis for Projecting the "Reduced" and "Expanded" Values

The "reduced" alternative assumes that no additional Co-60 sources are procured; hence, only those sources that exist in the current Gamma Irradiation Facility would be utilized. The "expanded" alternative assumes that an additional 850,000 Ci of Co-60 will be procured to increase test capability.

4.8.2.4 Spent Fuel Inventory Scenarios

The new Gamma Irradiation Facility has no spent fuel inventories.

4.8.2.5 Chemical Inventory Scenarios

The new Gamma Irradiation Facility has no inventories of chemicals of concern.

4.8.2.6 Explosives Inventory Scenario for Bare UNO 1.1

4.8.2.6.1 Alternatives for Bare UNO 1.1 Explosives Inventory

Table 13-34 shows the alternatives for bare UNO 1.1 explosives inventory at the new Gamma Irradiation Facility.

Table 13-34. Alternatives for Bare UNO 1.1 Explosives Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 g	0 g	500 g	500 g	500 g

4.8.2.6.2 Operations That Require Bare UNO 1.1

Occasionally, test items containing explosives will be present in the new Gamma Irradiation Facility. The expected administrative limits will allow up to 500 g of TNT-equivalent explosives; hence, the "no action" FY2003 and FY2008 values assume that this amount is present in the facility.

4.8.2.6.3 Basis for Projecting the "Reduced" and "Expanded" Values

The "reduced" alternative assumes the "no action" base year value. Occasionally, test items containing explosives will be present in the new Gamma Irradiation Facility. The expected administrative limits will allow up to 500 g of TNT-equivalent explosives; hence, the "expanded" alternative assumes that this amount is present in the facility. Experiments that contain explosives are either "bench safe" or contained in certified containers.

4.8.2.7 Other Hazardous Material Inventory Scenarios

The new Gamma Irradiation Facility has no inventories of hazardous materials that do not fall into the categories of nuclear or radioactive material, sealed sources, spent fuel, explosives, or chemicals.

4.8.3 Material Consumption

4.8.3.1 Nuclear Material Consumption Scenarios

Nuclear material is not consumed at the new Gamma Irradiation Facility.

4.8.3.2 Radioactive Material Consumption Scenario for Co-60

4.8.3.2.1 Alternatives for Co-60 Consumption

Table 13-35 shows the alternatives for Co-60 consumption at the new Gamma Irradiation Facility.

Table 13-35. Alternatives for Co-60 Consumption

Reduced Alternative		No Action Alternative						Expanded Alternative	
		Base Year		FY2003		FY2008			
0 pkgs	0 Ci	0 pkgs	0 Ci	0 pkgs	142,000 Ci	0 pkgs	142,000 Ci	0 pkgs	246,000 Ci

4.8.3.2.2 Operations That Require Co-60

The "no action" FY2003 and FY2008 alternatives assume that 142,000 Ci of Co-60 is procured each year to replenish the material that naturally decays to maintain a Co-60 inventory of 1,150,000 Ci.

4.8.3.2.3 Basis for Projecting the "Reduced" and "Expanded" Values

The "reduced" alternative assumes that no Co-60 is procured to replenish the material that naturally decays. The "expanded" alternative assumes that 246,000 Ci of Co-60 is procured each year to replenish the material that naturally decays to maintain a Co-60 inventory of 2,000,000 Ci.

4.8.3.3 Chemical Consumption Scenarios

Information initially provided for this section resides in the Facility Information Manager database and will be made available to the analysts responsible for preparing the sitewide environmental impact statement.

4.8.3.4 Explosives Consumption Scenarios

Explosives are not consumed at the new Gamma Irradiation Facility.

4.8.4 Waste

4.8.4.1 Low-Level Radioactive Waste Scenario

4.8.4.1.1 Alternatives for Low-Level Radioactive Waste at the New Gamma Irradiation Facility

Table 13-36 shows the alternatives for low-level radioactive waste for the new Gamma Irradiation Facility.

Table 13-36. Alternatives for Low-Level Radioactive Waste

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
56 ft^3	0 ft^3	92 ft^3	92 ft^3	126 ft^3

4.8.4.1.2 Operations That Generate Low-Level Radioactive Waste

Low-level waste in the form of resins and personal protective equipment is generated during operation of the new Gamma Irradiation Facility. The resins are required to maintain Gamma Irradiation Facility pool purity and may be potentially contaminated. Under the “no action” alternative for FY2003 and FY2008, the facility is kept operational, but no testing (irradiation) is performed. Waste volume includes 24 ft^3 of resins and 68 ft^3 (nine drums per year) of personal protective equipment. The facility is not yet constructed; hence, there is no waste identified in the in the “no action” base year.

4.8.4.1.3 General Nature of Waste

The Gamma Irradiation Facility resins are potentially contaminated with radionuclides introduced to the pool water. Activity levels may be less than detectable or very low. There is generally no detectable contamination associated with the personal protective equipment.

4.8.4.1.4 Waste Reduction Measures

Use of the resins for water purification results in water recycling and reduced use.

4.8.4.1.5 Basis for Projecting the “Reduced” and “Expanded” Values

Under the “reduced” alternative, the facility is kept operational but no testing (irradiation) is performed. Waste volume includes 12 ft^3 of resins and 44 ft^3 (6 drums per year) of personal protective equipment.

The operations associated with this “expanded” alternative are described in “4.8.1 Activity Scenario for test Activities: Tests.” Waste volume includes 36 ft^3 of resins and 90 ft^3 (12 drums) of personal protective equipment.

4.8.4.2 Transuranic Waste Scenario

Transuranic waste is not produced at the new Gamma Irradiation Facility.

4.8.4.3 Mixed Waste

4.8.4.3.1 Low-Level Mixed Waste Scenario

Low-level mixed waste is not produced at the new Gamma Irradiation Facility.

4.8.4.3.2 Transuranic Mixed Waste Scenario

Transuranic mixed waste is not produced at the new Gamma Irradiation Facility.

4.8.4.4 Hazardous Waste Scenario

4.8.4.4.1 Alternatives for Hazardous Waste at the New Gamma Irradiation Facility

Table 13-37 shows the alternatives for hazardous waste at the new Gamma Irradiation Facility.

Table 13-37. Alternatives for Hazardous Waste

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
7 ft^3	0 ft^3	14 ft^3	14 ft^3	14 ft^3

4.8.4.4.2 Operations That Generate Hazardous Waste

Hazardous waste is generated during routine facility maintenance at the Gamma Irradiation Facility.

4.8.4.4.3 General Nature of Waste

Hazardous waste generated at the Gamma Irradiation Facility includes batteries and hazardous bulbs or lamps (sodium vapor or metal halide). Under the “no action” alternative for FY2003 and FY2008, the facility is kept operational, but no testing (irradiation) is performed. Waste volume assumes that 14 ft^3 (two drums per year) of hazardous waste is generated. The facility is not yet constructed; hence, there is no waste identified in the in the “no action” base year.

4.8.4.4.4 Waste Reduction Measures

Nonhazardous materials are used whenever possible.

4.8.4.4.5 Basis for Projecting the “Reduced” and “Expanded” Values

For the “reduced” alternative, the Gamma Irradiation Facility is operational, but no testing (irradiation) is performed. Approximately one drum (7 ft^3) per year of hazardous waste is generated when, for example, bulbs are changed.

The operations associated with the “expanded” alternative are described in “4.8.1 Activity Scenario for Test Activities: Tests.” Approximately two drums of hazardous waste are generated each year.

4.8.5 Emissions

4.8.5.1 Radioactive Air Emissions Scenarios

Radioactive air emissions are not produced at the new Gamma Irradiation Facility.

4.8.5.2 Chemical Air Emissions

Information on an extensive list of chemicals was obtained from the SNL/NM Chemical Inventory System (CIS). For the air emissions analysis, the entire annual inventory of these chemicals was assumed to have been released over a year of operations for each specific facility (i.e., the annual inventory was divided by facility operating hours). The emissions from this release were then subjected, on a chemical-by-chemical basis, to a progressive series of screening steps for potential exceedances of both regulatory and human health thresholds. For those chemicals found to exceed this screening, process knowledge was used to derive emission factors. The emission factors for these chemicals were then modeled using the U.S. Environmental Protection Agency's *Industrial Source Complex Air Quality Dispersion Model, Version 3*. The results of this modeling are discussed as part of the analysis in support of the SNL/NM site-wide environmental impact statement.

4.8.5.3 Open Burning Scenarios

The new Gamma Irradiation Facility does not have outdoor burning operations.

4.8.5.4 Process Wastewater Effluent Scenario

The new Gamma Irradiation Facility does not generate process wastewater.

4.8.6 Resource Consumption

4.8.6.1 Process Water Consumption Scenario

4.8.6.1.1 Alternatives for Process Water Consumption at the New Gamma Irradiation Facility

Table 13-38 shows the alternatives for process water consumption at the new Gamma Irradiation Facility.

Table 13-38. Alternatives for Process Water Consumption

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 gal	0 gal	166,000 gal	166,000 gal	255,000 gal

4.8.6.1.2 Operations That Consume Process Water

Under the “no action” baseline, the facility has not yet been constructed. The “no action” alternatives in FY2003 and FY 2008 assume that the evaporation rate of water in the facility pool is 166,000 gal per year to cool the radioactive sources.

4.8.6.1.3 Consumption Reduction Measures

This section is not applicable.

4.8.6.1.4 Basis for Projecting the “Reduced” and “Expanded” Values

The “reduced” alternative assumes that no tests are conducted; however, there is no planned reduction in the number of radioactive sources. Therefore water use would not decrease in the “reduced” alternative.

The “expanded” alternative assumes that additional sources would be acquired; hence water use would increase to approximately 255,000 gal per year.

4.8.6.2 Process Electricity Consumption Scenario

The new Gamma Irradiation Facility does not consume process electricity.

4.8.6.3 Boiler Energy Consumption Scenario

The new Gamma Irradiation Facility does not consume energy for boilers.

4.8.6.4 Facility Personnel Scenario

4.8.6.4.1 Alternatives for Facility Staffing at the New Gamma Irradiation Facility

Table 13-39 shows the alternatives for facility staffing at the new Gamma Irradiation Facility.

Table 13-39. Alternatives for Facility Staffing

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
2 FTEs	0 FTEs	3 FTEs	3 FTEs	4 FTEs

4.8.6.4.2 Operations That Require Facility Personnel

There are no personnel requirements for the "no action" base year alternative because the new Gamma Irradiation Facility is under construction. Under the "no action" FY2003 and FY2008 alternatives, approximately three FTEs will be required to operate the facility and conduct scheduled tests.

4.8.6.4.3 Staffing Reduction Measures

This section is not applicable.

4.8.6.4.4 Basis for Projecting the "Reduced" and "Expanded" Values

Under the "reduced" alternative, there will be no test irradiations; however, two FTEs are necessary to maintain the facility. Under the "expanded" alternative, one additional FTE would be required relative to the "no action" alternatives to conduct additional tests.

4.8.6.5 Expenditures Scenario

4.8.6.5.1 Alternatives for Expenditures at the New Gamma Irradiation Facility

Table 13-40 shows the alternatives for expenditures at the new Gamma Irradiation Facility.

Table 13-40. Alternatives for Expenditures

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
$0	$0	$6 million	$500,000	$1 million

4.8.6.5.2 Operations That Require Expenditures

For Tech Area V facilities, SNL/NM has included only cost expenditures for projected major capital improvements. No labor costs are included in these projections. The new Gamma Irradiation Facility will be completed in the timeframe between the "no action" base year and FY2003 at a cost of approximately $5 million, with an additional expenditure of $1 million for radioactive sources (one million Ci at $1 per Ci) that will be procured in addition to those sources transferred from the existing Gamma Irradiation Facility. An additional one-time purchase of additional sources will be conducted in the FY2008 timeframe to make up for the loss in source activity that occurs over time. Alternatively, this $500,000 one-time procurement could be assumed to be a $100,000-per-year procurement between FY2003 and FY2008.

4.8.6.5.3 Expenditure Reduction Measures

This section is not applicable.

4.8.6.5.4 Basis for Projecting the "Reduced" and "Expanded" Values

The "reduced" alternative assumes that there would be no difference relative to the "no action" scenarios. The "expanded" alternative assumes that an additional one million Ci of radioactive sources will be procured at a cost of $1 per Ci.

5.0 ANNULAR CORE RESEARCH REACTOR FACILITY (DP) SOURCE INFORMATION

5.1 Purpose and Need

The primary purpose of the Annular Core Research Reactor Facility in the DOE Office of Defense Programs (DP) configuration is to provide neutron and sustained gamma pulsed environments for the evaluation of a variety of experiments, including those for DP testing of systems components electronics and reactor safety research.

The Annular Core Research Reactor DP configuration discussed in this section is the DP pulse reactor configuration that has been in use at SNL since 1978 for defense radiation effects and other advanced nuclear technology experiment programs. The ownership of the Annular Core Research Reactor was transferred to DOE Office of Nuclear Energy, Science, and Technology for application to radioisotope production. Two options exist for providing an Annular Core Research Reactor neutron effects test capability for DP if required in the future. The current Annular Core Research Reactor configuration for Mo-99 production could be reconfigured to allow pulse testing for a "window" of time in the Mo-99 operation, or the DP configuration can be reconstituted using the UO_2BeO fuel in a new tank in another location in Tech Area V. Reconfiguration of the Annular Core Research Reactor to do DP tests is identified in the Mo-99 record of decision as a possibility under national emergency situations. Reconstitution, as used here, refers to the construction of a new reactor that is of the same design as the existing Annular Core Research Reactor and uses the existing UO_2BeO fuel.

The scenarios presented in this section are limited to DP tests that would be conducted in the existing Annular Core Research Reactor in a national emergency and tests that could be conducted in a new "reconstituted" Annular Core Research Reactor Facility. These scenarios are based on the following assumptions:

- The “reduced” alternative assumes that there are no DP tests conducted, neither in a reconfigured nor a reconstituted Annular Core Research Reactor Facility.

- The “no action” alternative assumes that a single DP test is required at some point in the future to respond to a national emergency. This test will be conducted in the existing Annular Core Research Reactor Facility, which would have to be temporarily reconfigured to restore DP testing capability. During this time, medical isotope production would be interrupted. Following this DP test, the Annular Core Research Reactor configuration would return to that required for isotope production.

- The “expanded” alternative assumes that there will be an ongoing need for DP testing in the Annular Core Research Reactor Facility. To meet this need, an additional Annular Core Research Reactor Facility would be reconstituted using the same fundamental design as the existing Annular Core Research Reactor Facility. The specially designed UO_2BeO fuel from the existing Annular Core Research Reactor would be utilized for the reconstituted Annular Core Research Reactor to support DP test requirements. New fuel of a more standard design would be purchased for the original Annular Core Research Reactor to support ongoing isotope production activities.

Except for these scenarios, the existing Annular Core Research Reactor Facility will be utilized for the production of medical and other related isotopes. This use of the Annular Core Research Reactor Facility is described in “6.0 ANNULAR CORE RESEARCH REACTOR FACILITY (MO-99) SOURCE INFORMATION.”

5.2 Description

Important facility design features of the Annular Core Research Reactor include a small pool-type reactor under 6.2 m of water, cranes for remote handling of irradiated experiment packages, and a high-efficiency particulate air (HEPA) filtered, ventilated highbay.

The Annular Core Research Reactor in the DP configuration is a water-moderated and reflected low-power research reactor that uses enriched UO_2BeO cylindrical fuel elements arranged in a close-packed hexagonal lattice around a central experiment cavity. The reactor has several features for conducting experiments, including a dry cavity in the central core region and a radiography tube, and it is capable of producing a high yield of high-energy neutrons in the central dry cavity over a very short period of time. The reactor is located in a deep, water-filled tank. The DP configuration Annular Core Research Reactor could be either in the current Building 6588 tank (“no action” alternative, FY2008) or relocated to another Tech Area V location (“expanded” alternative).

The highbay is constructed of concrete block walls reinforced by vertical steel columns that support a sheet metal roof, and it is a confinement structure rather than a containment structure. Because Annular Core Research Reactor Facility fission product inventories are low and because the site is isolated from any population center (by approximately 10,000 m), a containment or other structural integrity feature is not required. Similarly, because of the inherent low core energy of the reactor, an elaborate confinement structure with a filter-equipped ventilation system or a post-operation core heat removal system is not required. In addition, the Annular Core Research Reactor need not be operable during or following a disastrous event such as an earthquake. The Annular Core Research Reactor Facility can tolerate a loss of all utilities because curtailment or cessation of operation is standard procedure under such circumstances. All emergency equipment is battery powered and is for monitoring only. No emergency equipment is required for heat rejection or ventilation and is not required by safety analysis.

The current highbay ventilation system consists of three distinct systems—a supply system, a highbay exhaust system, and an experiment cavity purge system. The highbay exhaust has a HEPA filter, and the experiment exhaust has both charcoal and HEPA filters. The normal core assembly consists of 200 to 250 fuel elements, six fuel-followed control rods, two fuel-followed safety rods, and three void-followed transient rods. The outer row of fuel is surrounded by nickel "reflector" elements. A loading tube that extends vertically upward from the center of the core provides access to the central irradiation cavity. Approximately midway to the water surface, the tube branches, with a straight section continuing vertically upward, and a branching section that parallels the straight section to the surface with an offset of 1.6 m. The entire tube structure is air-filled, ballasted for negative buoyancy, and supported by a permanent mounting platform that extends over the reactor tank. Neutron streaming up the straight branch of the loading tube is prevented by a shield plug, which is in place during reactor operation except for special experiments.

The Annular Core Research Reactor fuel elements are designed to operate at maximum temperatures not to exceed 1,800°C. Neither the maximum fuel temperature during pulsing nor the maximum fuel temperature during steady-state operation approaches the design limit temperature of 1,800°C.

Three major external experiment facilities are available for use with the Annular Core Research Reactor. These are the Fuel Ringed External Cavity, versions I and II (FREC-I and FREC-II), and the Advanced Laser External Cavity (ALEC). Any of these three units can be inserted or removed from the reactor tank as required.

Two storage facilities for radioactive and fissionable materials support Annular Core Research Reactor operations. These facilities are below grade and are located in the highbay. One facility consists of two large vaults side by side, and the second facility consists of five steel-lined holes in line with the reactor north-south axis. In addition to these vaults, the storage/transfer pool (STP) shared by the Annular Core Research Reactor and Gamma Irradiation Facility can store large experiments and has fuel holsters for storing extra fuel elements. Fuel elements and other materials that are stored in the STP to support operation of the Annular Core Research Reactor are addressed in this section. Materials stored in the STP to support the Gamma Irradiation Facility are addressed in "5.3 Program Activities," and "5.4 Operations and Capabilities."

5.3 Program Activities

Table 13-41 shows the program activities at the Annular Core Research Reactor Facility (DP).

Table 13-41. Program Activities at the Annular Core Research Reactor Facility (DP)

Program Name	Activities at the Annular Core Research Reactor Facility (DP)	Category of Program	Related Section of the *SNL Institutional Plan*
Defense Programs Radiation Sciences	The following activities apply to a DP test in the existing Annular Core Research Reactor in a national emergency under the "no action" alternative or a number of DP tests in a new, reconstituted Annular Core Research Reactor Facility in the "expanded" alternative: • Neutron effects on fissile components • Radiation effects on electronics • Neutron radiography • Radiation-hardened microelectronics • Defense materials irradiation • Advanced nuclear systems studies	Work for Non-DOE Entities (Work for Others)	None
Nuclear Regulatory Commission	The following activities apply to tests in a new, reconstituted Annular Core Research Reactor Facility in the "expanded" alternative: • Reactor safety studies • Advanced reactor fuel development • Neutron radiography • Radiation-hardened microelectronics • Materials irradiation	Work for Non-DOE Entities (Work for Others)	Section 6.2.2

5.4 Operations and Capabilities

The reactor is operated by means of the reactor instrumentation and control system (ICS) in two basic modes:

- Short duration, steady-state power at 2 MW or less
- Fast transients (pulses)

The ICS is used by the reactor operator to determine reactor power, fuel temperature, and reactor startup rate. The system also includes the rod positioning components that permit the operator to make fine adjustments to the reactivity in steady-state modes and to make near-step reactivity insertions in the pulse modes.

The control rod system has sufficient reactivity worth to enable the reactor to operate at prescribed power levels when experiments of large negative worth are in place in the central irradiation cavity. The transient rod system is capable of producing pulses of high peak power when in pneumatic drive.

The diagnostic instrumentation system (DIS) is primarily used to perform post-pulse analysis of prompt excursions. Pulsing the reactor increases the power on periods, which can vary from approximately 7 to 100 milliseconds. The DIS contains components that are capable of monitoring and saving pulse information for later analysis.

The balance-of-plant system provides the display and control of systems that are classified as nonsafety or nonreactor systems but that are necessary for a functioning reactor. These systems include the radiation monitoring system, reactor pool cleanup system, bulk water system, cavity purge system, highbay exhaust system, and nitrogen gas system.

A plant protect system (PPS) limits or prevents damage to the fuel by shutting down the reactor in the event that preestablished limits are exceeded during reactor operation. All PPS signal-conditioning electronics, switching functions, and direct current power supplies are contained in three modules or drawers—two protect drawers and one PPS magnet power supply drawer. The only PPS components external to these drawers are the sensors, the field wiring, two manual scram switches, and the actuation devices (control rod, safety rod, and transient rod scram magnets and the transient rod pneumatic control valves). The PPS provides a minimum of eight scram channels in steady-state modes and ten scram channels in the pulse modes. The system logic is such that tripping any one of the protective action channels will produce the required system-level protective function of dropping (gravity insertion) all withdrawn control, safety, and transient rods into the reactor.

5.5 Hazards and Hazard Controls

Operation of the Annular Core Research Reactor Facility involves the possibility of an accidental release of radioactive fission products to the environment. Such a release constitutes primarily a worker hazard as the potential hazard to the offsite public is negligible. Several potential accidents have been analyzed for which releases could occur. The total fission product inventory in the Annular Core Research Reactor core has been calculated using the ORIGEN code (see Bennett, 1979) based on the postulated reactor operating history. The total core inventory will be approximately 5×10^7 Ci based on a period of steady-state power operation followed by a reactor pulse.

The only other significant hazard associated with Annular Core Research Reactor Facility operations involves experiment containment packages that may contain high-energy sources, high pressures, or explosives. Although experiment inventory may vary depending on the nature of the experiment, experiment materials must be enclosed within a container that has demonstrated satisfactory mechanical integrity (leak-tight integrity and rupture strength) to prevent the uncontrolled release of the materials.

The following are hazard controls at the Annular Core Research Reactor Facility:

- Administrative controls:
  - **Technical Safety Requirements -** The primary operation-governing documents that are reviewed and approved by DOE and that set forth the operational limits and administrative controls deemed necessary for the safe operation of the facility.
  - **Criticality Safety** - A process for the review of procedures, supporting analyses, and criticality safety control parameters to ensure proper handling, storage, and use of fissile materials.
  - **Conduct of Operations -** The operation of the Annular Core Research Reactor Facility is governed by formalized work practices, such as development and maintenance of procedures, operator training and certification, and an independent review and appraisal system.
  - **Radiation Protection Organization (RPO)** - A Sandia-wide radiation protection organization maintains a work force associated with the operation of the Annular Core Research Reactor Facility. The RPO assists Annular Core Research Reactor Facility

personnel in the proper use and application of radiation protection measures, procedures, and equipment.

- Design features:

    - The reactor core is located approximately 6.2 m below the surface of the water, which provides adequate cooling for the core and shielding from radiation.

    - Air flows are controlled to ensure that the highbay is maintained at a pressure differential that is negative with respect to all other adjoining spaces and the outside environment. The experiment cavity purge system maintains a pressure differential that ensures air flow from the highbay through experiment facilities and to preclude the accumulation of radioactive gases in the experiment facilities connected to the purge system manifold.

    - All radioactive and fissionable material storage vaults are equipped with locked covers and are assigned storage limits based on criticality safety evaluations.

    - The ICS includes operational interlocks that prevent the operator from performing a reactor operation in an unapproved sequence.

    - Although the prompt negative temperature coefficient of reactivity inherent in the UO_2BeO fuel will automatically return the reactor to a sub-prompt-critical condition following a pulse, the transient rod system returns all transient rods to their full-down position shortly after a pulse, even in the absence of electrical power. Fuel-followed safety rods extend the available range and rate of reactivity variance of the Annular Core Research Reactor core.

    - Because electromechanical systems cannot provide a large measure of protection for rapid power excursions, reactor safety is ensured by limiting the reactivity that can be rapidly inserted and by determining the functional relations between pulse parameters (for example, peak power, yield, and fuel temperature) and the reactivity inserted.

    - The PPS shuts down the reactor in the event that preestablished limits are exceeded during reactor operation.

5.6 Accident Analysis Summary

See Sandia National Laboratories (1996).

5.7 Reportable Events

Table 13-42 lists the occurrence reports for the Annular Core Research Reactor over the past five years.

Table 13-42. Occurrence Reports for the Annular Core Research Reactor

Report Number	Title	Category	Description of Occurrence
ALO-KO-SNL-6000REACT-1993-0001	Improper Discharge of Make-Up Water	2E	The thermal expansion tank overflowed.
ALO-KO-SNL-9000-1996-0009	Actuation of Plant Protection System (PPS) and Deficiencies in Notifications and Log Keeping Deemed to be Worthy of Reporting	10C	A reactor scrammed due to operator inattention, and the scram was not reported as required.
ALO-KO-SNL-9000-1997-0001	Suspension of Operations for Safety Review and Determination of Technical Specifications and Determination of Technical Specification Violations & Items Deemed Worthy of Reporting	1C and 1F	Operations were suspended after a management review of operations at the Tech Area V reactors.

5.8 Scenarios for Impact Analysis

In all of the scenarios for impact analysis in this section, base year values are for FY1996 unless otherwise noted.

5.8.1 Activity Scenario for Test Activities: Irradiation Tests

5.8.1.1 Alternatives for Test Activities: Irradiation Tests

Table 13-43 shows the alternatives for irradiation tests at the Annular Core Research Reactor Facility (DP).

Table 13-43. Alternatives for Test Activities: Irradiation Tests

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 tests	0 tests	0 tests	1 tests	2 to 3 tests

5.8.1.2 Assumptions and Actions for the “Reduced” Values

No DP test activities are planned under the “reduced” scenario. The “reduced” alternative assumes that there are no DP tests conducted, neither in a reconfigured or a new, reconstituted Annular Core Research Reactor Facility.

5.8.1.3 Assumptions and Rationale for the “No Action” Values

The “no action” alternative assumes that a single DP test in the existing Annular Core Research Reactor Facility is required at some point in the future to respond to a national emergency. This test will be conducted in the existing Annular Core Research Reactor Facility, which would have to be temporarily reconfigured to restore DP testing capability. During this time, medical isotope production would be interrupted. Following this DP test, the Annular Core Research Reactor configuration would return to that required for isotope production.

The reconfiguration activities to restore the Annular Core Research Reactor to the DP test configuration would mainly consist of replacing the central cavity; enabling the pulse mode of operation; reconfiguring the core fuel; reinstalling the appropriate fuel-ringed external cavity (if required); and executing the necessary battery of tests, documentation, and reviews to certify that the reconfigured reactor is operational. Following the test, these changes would be reversed to restore the reactor for isotope production. Each reconfiguration (isotope production to DP or DP to isotope production) would likely take from several weeks to a few months to complete. If a DP test is needed after a new isotope production core (fuel elements with no pulse test capability) has been installed, the total reconfiguration time would be increased to allow for a complete core refueling to switch back to the UO_2BeO fuel.

5.8.1.4 Assumptions and Actions for the “Expanded” Values

The “expanded” alternative assumes that there will be an ongoing need for DP testing in an Annular Core Research Reactor Facility. To meet this need, an additional Annular Core Research Reactor Facility would be reconstituted using the same fundamental design as the existing Annular Core Research Reactor Facility. The specially designed UO_2BeO fuel from the existing Annular Core Research Reactor would be utilized for the reconstituted Annular Core Research Reactor to support DP test requirements. New fuel of a more standard design would be purchased for the original Annular Core Research Reactor to support ongoing isotope production activities. The “expanded” alternative for DP testing in the Annular Core Research Reactor assumes that approximately two or more test campaigns (consisting of several individual tests) would be conducted each year. A test campaign would consist of a test setup period of a few days to two weeks and a test duration (time in reactor) of one day to two weeks. These tests typically use the Annular Core Research Reactor in its pulsed mode or steady-state operations that do not typically exceed a few days in duration. Hence, a minimal amount of resources such as uranium fuel and water are expended for these tests.

Approximately two major fissile component tests and approximately six materials irradiation and electronics effects tests would be performed each year. These tests involve a setup, calibration, and conduct sequence that could require from one to two days to several weeks, depending on the conditions of the test.

Transfer of the UO_2BeO fuel for the DP reactor would be negotiated to occur at the time that the DOE Office of Nuclear Energy, Science, and Technology procures replacement fuel for the Mo-99 program.

5.8.2 Material Inventories

5.8.2.1 Nuclear Material Inventory Scenarios

5.8.2.1.1 Nuclear Material Inventory Scenario for Enriched Uranium

Alternatives for Enriched Uranium Nuclear Material Inventory - Table 13-44 shows the alternatives for enriched uranium inventory for the Annular Core Research Reactor Facility (DP).

Table 13-44. Alternatives for Enriched Uranium Nuclear Material Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
12 kg	12 kg	37 kg	37 kg	85 kg

Operations That Require Enriched Uranium - The existing Annular Core Research Reactor fuel is of a specialized design that enables the generation of an intense burst of very short duration, which is often referred to as “pulsed” operation. This specialized fuel is commonly called UO_2BeO or BeO fuel because it consists of uranium oxide (UO_2) and beryllium oxide (BeO). A typical test often consists of one or only a few pulses. Hence, these fuel elements have an unlimited life from the standpoint of fuel (uranium) “burnup” when the Annular Core

Research Reactor is operated in a pulsed mode for occasional testing. This UO_2BeO fuel is also suitable for steady-state operation such as that needed for isotope production. However, there is no readily available procurement source to replace this specialized fuel. Because the DOE Office of Defense Programs wants to retain the Annular Core Research Reactor pulsed test capability that requires the UO_2BeO fuel, the amount of fuel use or "burnup" that is allowed on the UO_2BeO fuel for isotope production will be limited such that the pulse capability is retained. This restriction will allow for up to a few years of operation for isotope production before the fuel must be taken out of service. At that time, a new set of fuel elements that are of a more commercially available design will be procured and placed in the reactor core.
The "no action" base year value assumes that the 247 UO_2BeO fuel elements (25 kg total) are being used for isotope production; hence, this fuel is accounted for in "6.0 ANNULAR CORE RESEARCH REACTOR FACILITY (MO-99) SOURCE INFORMATION," for this timeframe.
The 200 elements from the former Annular Core Pulse Reactor reactor configuration (12 kg total) that are used to fuel the fuel-ringed external cavities for DP testing are accounted for in this document under all scenarios.

The "no action" alternative assumes that the UO_2BeO fuel would be used for isotope production until the FY2003 time frame, when new fuel elements would be purchased for isotope production (see "6.0 ANNULAR CORE RESEARCH REACTOR [MO-99] SOURCE INFORMATION") and the UO_2BeO fuel elements would be reserved for DP testing. Hence, values for the FY2003 and FY2008 timeframes assume that the 247 (25 kg) BeO elements and the 200 Annular Core Pulse Reactor elements (12 kg) are reserved for DP testing (total of 37 kg).

***Basis for Projecting the "Reduced" and "Expanded" Values* -** The "reduced" alternative follows the same assumption as the "no action" baseline.

The current established facility criticality limits allow up to 85 kg (administrative limit) of U-235 in the highbay vaults; hence, it is assumed for the "expanded" alternative that these amounts may be present in the facility.

5.8.2.1.2 Nuclear Material Inventory Scenario for Plutonium-239

***Alternatives for Plutonium-239 Nuclear Material Inventory* -** Table 13-45 shows the alternatives for the Pu-239 inventory at the Annular Core Research Reactor Facility (DP).

Table 13-45. Alternatives for Plutonium-239 Nuclear Material Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
148 g	148 g	148 g	148 g	8,800 g

Operations That Require Plutonium-239 **-** During the “no action” base year, 148 g of Pu-239 were in Annular Core Research Reactor Facility inventory. It is assumed for the “no action” years (from the present through FY2008) that this amount will be present in the facility.

Basis for Projecting the “Reduced” and “Expanded” Values **-** The “reduced” alternative follows the same assumption as the “no action” baseline.

The current established facility criticality limits allow up to 8.8 kg of Pu-239 in the highbay vaults; hence, “expanded” alternative assumes that these amounts may be present in the facility.

5.8.2.2 Radioactive Material Inventory Scenario for Co-60

5.8.2.2.1 Alternatives for Co-60 Radioactive Material Inventory

Table 13-46 shows the alternatives for the Co-60 inventory at the Annular Core Research Reactor Facility (DP).

Table 13-46. Alternatives for Co-60 Radioactive Material Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
33.6 Ci	33.6 Ci	19 Ci	10 Ci	33.6 Ci

5.8.2.2.2 Operations That Require Co-60

The Co-60 inventories are activation products present in 55 nickel reflector elements from the Annular Core Research Reactor core that are currently in highbay storage holes. The values shown for FY2003 and FY2008 are calculated values based on natural decay of the current inventory of Co-60 (half life of 5.27 years) assuming that the reflector elements are not reinserted into the Annular Core Research Reactor.

5.8.2.2.3 Basis for Projecting the “Reduced” and “Expanded” Values

The values for the “reduced” and “expanded” alternatives are the same as that of the “no action” alternative base year.

5.8.2.3 Sealed Source Inventory Scenarios

The Annular Core Research Reactor Facility (DP) has no sealed source inventories.

5.8.2.4 Spent Fuel Inventory Scenarios

The Annular Core Research Reactor Facility (DP) has no spent fuel inventories.

5.8.2.5 Chemical Inventory Scenarios

The Annular Core Research Reactor Facility (DP) has no inventories of chemicals of concern.

5.8.2.6 Explosives Inventory Scenario for Bare UNO 1.2

5.8.2.6.1 Alternatives for Bare UNO 1.2 Explosives Inventory

Table 13-47 shows the alternatives for bare UNO 1.2 explosives at the Annular Core Research Reactor Facility (DP).

Table 13-47. Alternatives for Bare UNO 1.2 Explosives Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 g	0 g	500 g	500 g	500 g

5.8.2.6.2 Operations That Require Bare UNO 1.2

Occasionally, test items containing explosives are present in the Annular Core Research Reactor Facility. Current administrative limits allow up to 500 g of TNT equivalent. Hence, the values for the “no action” FY2003 and FY2008 timeframes assume that this amount is present in the facility to allow for activities such as neutron radiography of weapons components that may contain small amounts of explosives.

5.8.2.6.3 Basis for Projecting the “Reduced” and “Expanded” Values

The “reduced” alternative assumes no explosives are present in the facility. The “expanded” alternative assumes that an amount of explosives, equal to the 500-g administrative limits, are present in the facility.

5.8.2.7 Other Hazardous Material Inventory Scenarios

The Annular Core Research Reactor Facility (DP) has no inventories of hazardous materials that do not fall into the categories of nuclear or radioactive material, sealed sources, spent fuel, explosives, or chemicals.

5.8.3 Material Consumption

5.8.3.1 Nuclear Material Consumption Scenario for Enriched Uranium

5.8.3.1.1 Alternatives for Enriched Uranium Consumption

Table 13-48 shows the alternatives for enriched uranium consumption at the Annular Core Research Reactor Facility (DP).

Table 13-48. Alternatives for Enriched Uranium Consumption

Reduced Alternative		No Action Alternative						Expanded Alternative	
		Base Year		FY2003		FY2008			
0 pkgs	0 g	0 pkgs	0 g	0 pkgs	0 g	0 pkgs	0 g	0 pkgs	2 g

5.8.3.1.2 Operations That Require Enriched Uranium

Operation of the Annular Core Research Reactor results in consumption of the U-235 contained within the fuel elements.

In accordance with the defined activity scenarios, the Annular Core Research Reactor is used for only one test in the “no action” alternative in FY2008. Insignificant amounts of uranium (<1 g) would be consumed in this test.

5.8.3.1.3 Basis for Projecting the “Reduced” and “Expanded” Values

For the “reduced” alternative, no uranium-235 (U-235) is consumed. The expanded alternative assumes that less than 2 g of U-235 in the fuel is consumed annually by the operation of the new reconstituted reactor.

5.8.3.2 Radioactive Material Consumption Scenarios

Radioactive material is not consumed at the Annular Core Research Reactor Facility (DP).

5.8.3.3 Chemical Consumption Scenarios

Information initially provided for this section resides in the Facility Information Manager database and will be made available to the analysts responsible for preparing the sitewide environmental impact statement.

5.8.3.4 Explosives Consumption Scenarios

Explosives are not consumed at the Annular Core Research Reactor Facility (DP).

5.8.4 Waste

5.8.4.1 Low-Level Radioactive Waste Scenario

5.8.4.1.1 Alternatives for Low-Level Radioactive Waste at the Annular Core Research Reactor Facility (DP)

Table 13-49 shows the alternatives for low-level radioactive waste for the Annular Core Research Reactor Facility (DP).

Table 13-49. Alternatives for Low-Level Radioactive Waste

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 ft^3	0 ft^3	0 ft^3	35 ft^3	170 ft^3

5.8.4.1.2 Operations That Generate Low-Level Radioactive Waste

Low-level waste generated during operation of the Annular Core Research Reactor for DP purposes includes resins and personal protective equipment. The “no action” FY2008 value is based on the assumption that a single test will generate five drums (35 ft^3) of low-level waste. Resins in the all of the “no action” periods of time are accounted for in “6.0 ANNULAR CORE RESEARCH REACTOR FACILITY (MO-99) SOURCE INFORMATION.”

5.8.4.1.3 General Nature of Waste

Primary isotopes associated with the resins include tritium (H-3), lead-210 (Pb-210), and thallium-208 (Tl-208). Both alpha and beta activity has been measured in the resins. Additional radionuclides, such as Cs-137 and Co-60, may be present in trace quantities due to contamination introduced during cask transfers. Detectable contamination is not usually present on the Annular Core Research Reactor personal protective equipment.

5.8.4.1.4 Waste Reduction Measures

The circulation of the pool water through resin beds results in the recycling of water.

5.8.4.1.5 Basis for Projecting the "Reduced" and "Expanded" Values

Under the "reduced" scenario, no activity would take place at the facility. The "expanded" scenario is based on facility operations of eight hours per day, five days per week. The waste volume includes 18 ft^3 of resins and 150 ft^3 of personal protective equipment per year.

5.8.4.2 Transuranic Waste Scenario

5.8.4.2.1 Alternatives for Transuranic Waste at the Annular Core Research Reactor Facility (DP)

Table 13-50 shows the alternatives for transuranic waste at the Annular Core Research Reactor Facility (DP).

Table 13-50. Alternatives for Transuranic Waste

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 ft^3	0 ft^3	0 ft^3	0 ft^3	5 ft^3

5.8.4.2.2 Operations That Generate Transuranic Waste

Annular Core Research Reactor activities that generate transuranic waste could include Los Alamos National Laboratory and Lawrence Livermore National Laboratory plutonium weapon tests performed at the Annular Core Research Reactor Facility.

5.8.4.2.3 General Nature of Waste

Transuranic waste could include personal protective equipment, decontamination materials, and plutonium samples.

5.8.4.2.4 Waste Reduction Measures

No waste reduction measures are applicable.

5.8.4.2.5 Basis for Projecting the "Reduced" and "Expanded" Values

The "reduced" alternative assumes no DP tests. The "expanded" alternative assumes two to three DP weapons test activities.

5.8.4.3 Mixed Waste

5.8.4.3.1 Low-Level Mixed Waste Scenario

Alternatives for Low-Level Mixed Waste at the Annular Core Research Reactor Facility (DP) - Table 13-51 shows the alternatives for low-level mixed waste at the Annular Core Research Reactor Facility (DP).

Table 13-51. Alternatives for Low-Level Mixed Waste

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 ft^3	0 ft^3	0 ft^3	0 ft^3	5 ft^3

Operations That Generate Low-Level Mixed Waste - Low-level mixed waste is potentially generated at the Annular Core Research Reactor when materials such as cadmium are activated or oil is contaminated. Planning activities have minimized the generation of mixed waste to the point where mixed wastes are not typically generated.

General Nature of Waste - The potential hazardous components are metals such as lead or cadmium and oils. Radionuclide content would vary.

Waste Reduction Measures - Nonhazardous materials are used when possible.

Basis for Projecting the "Reduced" and "Expanded" Values - No mixed wastes are generated in the "reduced" scenario. For the "expanded" scenario, test activities result in the generation of about 5 ft^3 of mixed waste.

5.8.4.3.2 Transuranic Mixed Waste Scenario

Alternatives for Transuranic Mixed Waste at the Annular Core Research Reactor Facility (DP) - Table 13-52 shows the alternatives for transuranic mixed waste at the Annular Core Research Reactor Facility (DP).

Table 13-52. Alternatives for Transuranic Mixed Waste

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 ft^3	0 ft^3	0 ft^3	0 ft^3	5 ft^3

Operations That Generate Transuranic Mixed Waste **-** Annular Core Research Reactor Facility activities that could generate transuranic mixed waste include Los Alamos National Laboratory and Lawrence Livermore National Laboratory plutonium weapon tests that could be performed at the Annular Core Research Reactor.

General Nature of Waste **-** Waste could include personal protective equipment, decontamination materials, and plutonium samples.

Waste Reduction Measures **-** No waste reduction measures are required.

Basis for Projecting the "Reduced" and "Expanded" Values **-** The "reduced" alternative assumes no DP tests. The "expanded" alternative assumes increased DP test activities.

5.8.4.4 Hazardous Waste Scenario

5.8.4.4.1 Alternatives for Hazardous Waste at the Annular Core Research Reactor Facility (DP)

Table 13-53 shows the alternatives for hazardous waste at the Annular Core Research Reactor Facility (DP).

Table 13-53. Alternatives for Hazardous Waste

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 ft^3	0 ft^3	0 ft^3	2 ft^3	14 ft^3

5.8.4.4.2 Operations That Generate Hazardous Waste

Hazardous waste is generated at the Annular Core Research Reactor during routine maintenance activities. A single DP test in the "no action" FY2008 timeframe would produce little or no hazardous waste.

5.8.4.4.3 General Nature of Waste

Wastes include batteries and hazardous lamps or bulbs (sodium vapor and metal halide).

5.8.4.4.4 Waste Reduction Measures

Nonhazardous materials are used whenever possible.

5.8.4.4.5 Basis for Projecting the "Reduced" and "Expanded" Values

The "reduced" alternative value is zero because no DP tests will be conducted in this scenario**.** The "expanded" alternative value is based on previous experience.

5.8.5 Emissions

5.8.5.1 Radioactive Air Emission Scenario for Ar-41

5.8.5.1.1 Alternatives for Ar-41 Emissions at the Annular Core Research Reactor Facility (DP)

Table 13-54 shows the alternatives for the argon-41 (Ar-41) emissions at the Annular Core Research Reactor Facility (DP).

Table 13-54. Alternatives for Ar-41 Emissions

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 Ci	2.6 Ci	2.6 Ci	2.6 Ci	7.8 Ci

5.8.5.1.2 Operations That Generate Ar-41 Air Emissions

The irradiation of components in the central cavity causes the activation of the argon in the air.

5.8.5.1.3 General Nature of Emissions

The emissions are gaseous emissions from activated air.

5.8.5.1.4 Emission Reduction Measures

No emission reduction measures exist.

5.8.5.1.5 Basis for Projecting the "Reduced" and "Expanded" Values

The "reduced" and "no action" values are based on no operations. The base year value is based on the 1994 and 1995 emissions of Ar-41. The expanded value is estimated assuming an increase in the operation of the reactor.

5.8.5.2 Chemical Air Emissions

Information on an extensive list of chemicals was obtained from the SNL/NM Chemical Inventory System (CIS). For the air emissions analysis, the entire annual inventory of these chemicals was assumed to have been released over a year of operations for each specific facility (i.e., the annual inventory was divided by facility operating hours). The emissions from this release were then subjected, on a chemical-by-chemical basis, to a progressive series of screening steps for potential exceedances of both regulatory and human health thresholds. For those chemicals found to exceed this screening, process knowledge was used to derive emission factors. The emission factors for these chemicals were then modeled using the U.S. Environmental Protection Agency's *Industrial Source Complex Air Quality Dispersion Model, Version 3*. The results of this modeling are discussed as part of the analysis in support of the SNL/NM site-wide environmental impact statement.

5.8.5.3 Open Burning Scenarios

The Annular Core Research Reactor Facility (DP) does not have outdoor burning operations.

5.8.5.4 Process Wastewater Effluent Scenario

5.8.5.4.1 Alternatives for Process Wastewater at the Annular Core Research Reactor Facility (DP)

Table 13-55 shows the alternatives for process wastewater at the Annular Core Research Reactor Facility (DP).

Table 13-55. Alternatives for Process Wastewater

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 gal	0 gal	0 gal	10,000 gal	50,000 gal

5.8.5.4.2 Operations That Generate Process Wastewater

During steady-state operations, a portion the water in the secondary cooling system is continually expelled and replenished (bled and fed) with fresh water to maintain water chemistry within acceptable limits. Under the defined scenarios, small volumes of process wastewater would be generated. This amount would be less than 50,000 gal per year for the "expanded" alternative and 10,000 gal for the "no action" alternative in FY2008. All other times and alternatives are assumed to have no significant process wastewater effluents.

5.8.5.4.3 General Nature of Effluents

The effluents are bled from the secondary cooling system.

5.8.5.4.4 Effluent Reduction Measures

No wastewater reduction measures are available.

5.8.5.4.5 Basis for Projecting the “Reduced” and “Expanded” Values

See “5.8.5.4.2 Operations That Generate Process Wastewater.”

5.8.6 Resource Consumption

5.8.6.1 Process Water Consumption Scenario

5.8.6.1.1 Alternatives for Process Water Consumption at the Annular Core Research Reactor Facility (DP)

Table 13-56 shows the alternatives for process water consumption for the Annular Core Research Reactor Facility (DP).

Table 13-56. Alternatives for Process Water Consumption

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 gal	0 gal	0 gal	10,000 gal	100,000 gal

5.8.6.1.2 Operations That Consume Process Water

Under the defined scenarios, small volumes of process water would be consumed. This amount would be less than 100,000 gal per year for the “expanded” alternative and 10,000 gal for the ”no action” alternative in FY2008. All other times and alternatives are assumed to have no significant process water consumption.

5.8.6.1.3 Consumption Reduction Measures

No consumption reduction measures are available.

5.8.6.1.4 Bases for Projecting the "Reduced" and "Expanded" Values

See "5.8.6.1.2 Operations That Consume Process Water."

5.8.6.2 Process Electricity Consumption Scenario

The Annular Core Research Reactor Facility (DP) does not consume process electricity.

5.8.6.3 Boiler Energy Consumption Scenario

The Annular Core Research Reactor Facility (DP) does not consume energy for boilers.

5.8.6.4 Facility Personnel Scenario

5.8.6.4.1 Alternatives for Facility Staffing at the Annular Core Research Reactor Facility (DP)

Table 13-57 shows the alternatives for facility staffing for the Annular Core Research Reactor Facility (DP).

Table 13-57. Alternatives for Facility Staffing

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
1 FTE	1 FTE	1 FTE	1 FTE	8 FTEs

5.8.6.4.2 Operations That Require Facility Personnel

Under the Annular Core Research Reactor Facility (DP) "reduced" and "no action" alternatives, only minimal personnel are needed to maintain readiness and monitor DP fuel and equipment if required in a future test campaign. In the "expanded" alternative, personnel are required to either reconfigure and prepare for DP testing or to assist in reconstitution and to operate the reconstituted Annular Core Research Reactor in the DP configuration.

5.8.6.4.3 Staffing Reduction Measures

Staffing reduction is not feasible to meet the DP testing scenarios described.

5.8.6.4.4 Basis for Projecting the "Reduced" and "Expanded" Values

The "reduced" and "no action" alternatives assume that no tests are conducted and no supplemental staff are required in addition to those that are in place to operate the Annular Core Research Reactor for medical isotope production.

The "expanded" alternative assumes that a new Annular Core Research Reactor-like facility is constructed to conduct the necessary DP tests. This new facility would require additional staff to construct, operate, and maintain the new facility and to conduct the DP test activities.

5.8.6.5 Expenditures Scenario

5.8.6.5.1 Alternatives for Expenditures at the Annular Core Research Reactor Facility (DP)

Table 13-58 shows the alternatives for expenditures at the Annular Core Research Reactor Facility (DP).

Table 13-58. Alternatives for Expenditures

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
$200,000	$200,000	$200,000	$5 million	$12 million

5.8.6.5.2 Operations That Require Expenditures

For Tech Area V facilities, SNL/NM has included only cost expenditures for projected major capital improvements. No labor costs are included in these estimates. Although there will be no DP tests in the "no action" base year, "no action" FY2003, and "reduced" alternatives, maintaining readiness to perform tests under national emergency conditions will require expenditure of resources for preserving and maintaining pulse testing hardware, software, and safety basis documentation.

The "no action" alternative assumes that a single "national emergency" test is conducted in the existing Annular Core Research Reactor. This test will require some equipment procurement and will incur a liability for replacement cost for isotopes not produced. The total expenditure for these items is estimated to be $5 million.

5.8.6.5.3 Expenditure Reduction Measures

This section is not applicable.

5.8.6.5.4 Basis for Projecting the "Reduced" and "Expanded" Values

Under the "reduced" alternative, no DP tests would be conducted, but limited expenditures will be required to preserve pulse testing options under national emergency conditions. The "expanded" alternative assumes that a new facility is constructed at an estimated cost of $10 million and that the operational cost thereafter is approximately $1 million per year.

6.0 ANNULAR CORE RESEARCH REACTOR FACILITY (MO-99) SOURCE INFORMATION

6.1 Purpose and Need

The primary purpose for the Annular Core Research Reactor Facility (Mo-99) is the production of isotopes such as molybdenum-99 (Mo-99), whose daughter, technetium-99 (Tc-99m), is used in nuclear medicine applications. The potential exists for expanding the range of isotopes produced to cover the broad field of medical isotopes and various research isotopes. The long-term, steady-state operation of the reactor for isotope production allows the associated use of the reactor for neutron irradiation, radiography experiments, and other activities that are suitable for concurrent use of the Annular Core Research Reactor while it is in operation for the production of isotopes.

If a national emergency situation requires a nuclear weapons component or system test, the production of isotopes could be interrupted so that the Annular Core Research Reactor could be reconfigured to allow for this testing. Reconfiguration of the Annular Core Research Reactor to perform these DP tests is identified in the Medical Isotopes Production Program record of decision as a possibility under national emergency situations (see U.S. Department of Energy, 1996). This DP use of the existing Annular Core Research Reactor in a national emergency is described in the "no action" alternative in "5.0 ANNULAR CORE RESEARCH REACTOR FACILITY (DP) SOURCE INFORMATION." The "no action" alternative in "5.0 ANNULAR CORE RESEARCH REACTOR FACILITY (DP) SOURCE INFORMATION," assumes that a single DP test is required at some point in the future to respond to a national emergency. This test will be conducted in the existing Annular Core Research Reactor facility, which would have to be temporarily reconfigured to restore DP testing capability. During this time, medical isotope production would be interrupted. Following this DP test, the Annular Core Research Reactor configuration would return to that required for isotope production.

Except for the national emergency scenario, the existing Annular Core Research Reactor Facility will be utilized for the production of medical and other related isotopes.

(Miller, 1998)

6.2 Description

The Annular Core Research Reactor Facility is located within Tech Area V in Building 6588. This building is part of a larger complex that includes two other major structures, Buildings 6580 and 6581. Building 6588 comprises the reactor room, lowbay, control room, building utilities, several small laboratories, and support staff offices.

The working space within Building 6588, which houses the reactor, is generally referred to as the reactor room or highbay. The highbay is constructed of concrete block walls reinforced by vertical steel columns that support a sheet metal roof and acts as a confinement structure rather than a containment structure. The highbay ventilation system consists of three distinct systems—a supply system, a highbay exhaust system, and an experiment cavity purge system. The highbay exhaust may be filtered by HEPA filters, and the cavity purge system exhaust is filtered by charcoal and HEPA filters.

The reactor control room is located to the northwest of the reactor room. The control room houses the reactor control console. Remote-controlled, closed-circuit television cameras provide the capability for continuous and complete visual observation of the reactor room and roof area from the control room.

The reactor core is located in an open pool of water 3 m in diameter and 8.6 m in depth, with the top of the core approximately 7 m below the top of the tank. The pool water provides radiation shielding and natural convection cooling for the core. The reactor core currently consists of cylindrical stainless-steel-clad UO_2BeO fuel elements arranged in a close-packed hexagonal lattice with an approximately 23-cm central water-filled irradiation region. The central region is used to locate and irradiate isotope production targets.

The existing Annular Core Research Reactor fuel elements are of a specialized design that enables the generation an intense burst of very short duration, which is often referred to as "pulsed" operation. This specialized fuel is commonly called UO_2BeO or BeO fuel because it consists of uranium oxide (UO_2) and beryllium oxide (BeO). There is no readily available procurement source that can replace this specialized fuel. Because DOE Office of Defense Programs wants to retain the Annular Core Research Reactor pulsed test capability that requires the UO_2BeO fuel, the amount of fuel use, or "burnup," that is allowed on the UO_2BeO fuel for isotope production will be limited such that the pulse capability is retained. This restriction will allow for up to a few years of operation for isotope production before the fuel must be taken out of service. At that time, a new set of fuel elements that are of a more commercially available design will be procured and placed in the reactor core. A single DP test may be required at some point in the future to respond to a national emergency. This test would be conducted in the existing Annular Core Research Reactor Facility, which would have to be temporarily reconfigured to restore DP testing capability. During this time, medical isotope production would be interrupted. Following this DP test, the Annular Core Research Reactor configuration would return to that required for isotope production.

The reconfiguration activities to restore the Annular Core Research Reactor to the DP test configuration would mainly consist of replacing the central cavity; enabling the pulse mode of operation; reconfiguring the core fuel; reinstalling the appropriate fuel-ringed external cavity (if required); and executing the necessary battery of tests, documentation, and reviews to certify that the reconfigured reactor is operational. Following the test, these changes would be reversed to restore the reactor for isotope production. If a DP test is needed after a new isotope production core (fuel elements with no pulse test capability) has been installed, a complete core refueling would be required to switch back to the UO_2BeO fuel.

The reactor shares the highbay space with the Gamma Irradiation Facility. The Gamma Irradiation Facility consists of two shielded concrete cells containing Co-60 sources used to irradiate objects within the cells. Between the reactor pool and the Gamma Irradiation Facility is a storage/transfer pool (STP). Reactor fuel elements, isotope production targets, and other experiments may be stored in either the reactor pool or the STP. Small storage racks for temporary storage of reactor fuel elements are installed around the periphery of the reactor pool tank and reactor pool tank bottom. Holsters on the side of the reactor pool tank may be used to temporarily store reactor fuel elements or isotope production targets. In the STP, three 90-element storage racks and seven 28-element racks are available for storage of reactor fuel elements.

A cooling system for the pool water is used to remove core-generated heat from the reactor pool water. The pool water cooling system consists of a primary coolant loop, a secondary coolant loop, and a cleanup loop. These systems consist of piping, valves, pumps, ion-exchange resin beds, heat exchangers, and a cooling tower. Contaminants are removed from the reactor pool water through the cleanup loop, which extracts pool water and passes it through the resin beds.

A neutron radiography unit (NRU) is available for installation in the reactor pool. The NRU consists of a heavy-water-moderated cavity that can be positioned near the side of the reactor core, a collimator that allows a thermal neutron beam to run vertically to the top of the reactor pool, a radiography platform to place objects for neutron exposure, and a blast shield that may be utilized in the radiography of explosive materials or devices. Single experiments of explosives would be separately packaged and tested within the reactor and transferred out of the reactor. Any amount of explosives within the reactor would be limited to the 500-g administrative limit.

(Sandia National Laboratories, 1996; Miller, 1998)

6.3 Program Activities

Table 13-59 shows the program activities at the Annular Core Research Reactor Facility (Mo-99).

Table 13-59. Program Activities at the Annular Core Research Reactor Facility (Mo-99)

Program Name	**Activities at the Annular Core Research Reactor Facility (Mo-99)**	**Category of Program**	**Related Section of the *SNL Institutional Plan***
Office of Nuclear Energy, Isotope Production and Distribution	• Irradiation of Mo-99 isotope production targets. • Irradiation of isotope production targets or materials for other radionuclides.	Programs for the Department of Energy	Section 6.1.7.2
Office of Nonproliferation and National Security	Experimental validation of low-enrichment fission isotope production methods.	Programs for the Department of Energy	Section 6.1.3
Assistant Secretary for Defense Programs	• Steady-state irradiation of experiment packages. (Steady-state activities that are compatible and capable of being conducted concurrently with isotope production.) • Transient testing of DP components in a national emergency. (See “5.0 ANNULAR CORE RESEARCH REACTOR FACILITY [DP] SOURCE INFORMATION.”)	Programs for the Department of Energy	Section 6.1.1
All Other Reimbursables	Steady-state irradiation of experiment packages for other organizations such as the following: • DoD • Army • Navy • Air Force • National Aeronautics and Space Administration • Nuclear Regulatory Commission (These activities are compatible and capable of being conducted concurrently with isotope production.)	Work for Non-DOE Entities (Work for Others)	Section 6.2.8

6.4 Operations and Capabilities

The reactor is operated safely by restricting steady-state power operations within the limits of the fuel element and isotope production target design and material limits, which include fuel melting, clad overheating due to a boiling transition, and internal pressure due to fission gas generation.

A reactor (plant) protection system (PPS) prevents damage to the fuel element by automatically shutting down the reactor in the event that the preestablished limits are exceeded during reactor operation. The system logic is such that tripping any one of the protective action channels will result in the insertion (by gravity) of all withdrawn reactivity regulating rods into the reactor, bringing the reactor to a subcritical state.

The reactor is operated by means of the reactor instrumentation and control system (ICS). The ICS is used by the reactor operator to monitor and control reactor power and reactivity regulating rod position.

A balance-of-plant system provides for the display and control of the other systems that are necessary for a functioning reactor. These systems include the pool water cooling system, radiation monitoring system, pool water cleanup system, and the highbay exhaust system.

(Sandia National Laboratories, 1996; Miller, 1998)

6.5 Hazards and Hazard Controls

The existing safety analysis report for the Annular Core Research Reactor (see Sandia National Laboratories, 1996), augmented by the unreviewed safety question documentation, continues to provide the authorization basis for preparation of the production of Mo-99. A new safety analysis report would be prepared prior to routine production of Mo-99.

The primary hazards associated with the operation of the Annular Core Research Reactor include radioactive materials and fissile materials. As such, measures must be taken to ensure the protection of the worker, the public, and the environment from the uncontrolled release of fission products, unnecessary exposure to radioactive materials, and the occurrence of criticality events. Measures in place at the Annular Core Research Reactor for the control of these hazards include the following:

- Administrative controls:

  - **Technical Safety Requirements -** Included in a primary operation-governing document reviewed and approved by the DOE that sets forth the operational limits and administrative controls deemed necessary for the safe operation of the facility.

  - **Criticality Safety** - A process for the review of procedures, supporting analyses, and criticality safety control parameters to ensure proper handling, storage, and use of fissile materials.

  - **Conduct of Operations -** The operation of the Annular Core Research Reactor is governed by formalized work practices such as development and maintenance of procedures, operator training and certification, and an independent review and appraisal system.

  - **Radiation Protection Organization (RPO) -** An SNL-wide radiation protection organization maintains a work force associated with the operation of the Annular Core Research Reactor. The RPO assists Annular Core Research Reactor personnel in the proper use and application of radiation protection measures, procedures, and equipment.

- Design features:

  - **The PPS -** A system that monitors certain reactor process parameters and that is capable of automatically shutting down the reactor in the event that any of these parameters exceeds limiting values prescribed in the technical safety requirements.

  - **Reactor Fuel Element Design -** The cladding of the individual fuel elements serve as a containment for fission products generated during reactor operation. Operation within the parameters set forth in the technical safety requirements and the proper functioning of the PPS ensure the integrity of this primary barrier.

  - **Reactor Pool Design -** The reactor core is located several meters below the surface of water in the reactor pool tank. This water provides cooling for the core, shielding from radiation, and mitigation of fission product release from elements or targets.

- **Reactor Highbay Ventilation System -** The highbay is maintained at a pressure that is negative with respect to all other adjoining spaces and the outside environment. The cavity purge system precludes the accumulation of radioactive gases in the experiment facilities connected to the purge system manifold.

(Sandia National Laboratories, 1996; Miller, 1998)

6.6 Accident Analysis Summary

The existing safety analysis report for the Annular Core Research Reactor (see Sandia National Laboratories, 1996), augmented by the unreviewed safety question documentation, continues to provide the authorization basis for preparation of the production of Mo-99. A new safety analysis report would be prepared prior to routine production of Mo-99.

6.6.1 Selection of Accidents Analyzed in Safety Documents

The operational accidents addressed in the Annular Core Research Reactor safety analysis report fall into three primary categories. The first category is that of design basis accidents (DBA), which are postulated to define the functional capabilities and operational reactor trip setpoints of the reactor protection system. These include the following:

- Loss of electrical power
- Uncontrolled reactivity regulating rod bank withdrawal
- Loss of coolant
- Loss of heat sink

The other category is that of evaluation basis accidents (EBA), which are postulated to evaluate the degree of hazard mitigation afforded by site location and facility ventilation and filtration systems. These include the following:

- Leaking fuel element
- Dropped fuel element(s) during loading, unloading, and transfers
- Leaking isotope production target
- Fission product release from an irradiated target during outdoor transfer

The final category is that of a beyond design-basis accident (BDBA), which is postulated to provide a semi-quantitative view of the residual risk associated with the operation of the facility. The BDBA essentially consists of the release of 100 percent of noble gas activity and 10 percent of halogen activity with no filtration. The BDBA is clearly an incredible event that assumes the total failure of all protection systems and operator actions.

6.6.2 Analysis Methods and Assumptions

The accident analysis for the Annular Core Research Reactor uses a deterministic approach; specific accidents are analyzed for potential worst-case consequences, without regard for their likelihood of occurrence. This is a suitable approach because the Annular Core Research Reactor is a hazard category 2 nuclear facility and does not have the potential to significantly affect the health and safety of the offsite public.

The source terms for the EBAs analyzed is based upon the saturated noble gas and halogen activity for a fuel element operated at 30 kW and a Mo-99 isotope production target operated for up to 21 days at 20 kW. These fundamental source terms are scaled based upon the number of elements and targets assumed to be involved in the accident scenario.

6.6.3 Summary of Accident Analysis Results

Results from the DBA analyses prescribe the functional requirements and operational reactor trip setpoints for the PPS. The PPS setpoints are prescribed in such a way that no damage to the fuel elements or targets occurs during any postulated DBA, and thus no fission products are released. No requirements for emergency electrical power or backup residual heat removal are identified.

The exclusion area radius, defined as the distance from the reactor site over which SNL can exercise administrative control, is 3,000 m (1.9 mi) for the Annular Core Research Reactor. Neither the calculated doses from the postulated EBAs nor the BDBA exceed the offsite (outside the exclusion area boundary) dose evaluation guideline of 25 rem (whole body). None of these events requires the disruption, interruption, or restriction of normal public or private activity. The nearest population center distance (metropolitan Albuquerque) is no closer than 10,000 m (6.2 mi).

(Sandia National Laboratories, 1996; Miller, 1998)

6.7 Reportable Events

See “5.7 Reportable Events.”

6.8 Scenarios for Impact Analysis

In all of the scenarios for impact analysis in this section, base year values are for fiscal year (FY) 1996 unless otherwise noted.

6.8.1 Activity Scenario for Test Activities: Irradiation of Production Targets

6.8.1.1 Alternatives for Test Activities: Irradiation of Production Targets

Table 13-60 shows the alternatives for irradiation of production targets at the Annular Core Research Reactor Facility (Mo-99).

Table 13-60. Alternatives for Test Activities: Irradiation of Production Targets

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
40 targets	8 targets	375 targets	375 targets	1,300 targets

6.8.1.2 Assumptions and Actions for the "Reduced" Values

Under the "reduced" alternative, the Annular Core Research Reactor would irradiate the minimum number of targets required to maintain the facility, staff, processes, and material inventories needed to restart production activities on short notice. This would consist of the irradiation of approximately 40 targets per year only for the "reduced" alternative. This alternative would require operation of the Annular Core Research Reactor for approximately eight hours per day for 24 weeks and would require the operation of the reactor for a single operational shift for two weeks each month (approximately 1,000 hours of operation per year) at a maximum power level of 4 MW (approximately 4,000 MW-hours per year).

6.8.1.3 Assumptions and Rationale for the "No Action" Values

The base year number of eight tests includes the chemical extraction experiments, which were performed to provide realistic information about the potential environmental effects of the Mo-99 separation process and to test and evaluate the actual process for separating the Mo-99 from fission products. Under the "no action" alternative, the Annular Core Research Reactor would operate for 52 weeks to irradiate targets to produce approximately 30 percent of the U.S. demand (on average, not necessarily a "fixed" amount each week) for Mo-99 and other isotopes such as iodine-125 (I-125), I-131, and xenon-133 (Xe-133). The 2003 and 2008 estimates assume that the SNL/NM medical isotope production program operates primarily as a backup to Nordion, Inc., the current supplier for the U.S. market, at the nominal 30 percent of U.S. demand level. This would require the irradiation of about seven highly enriched uranium targets per week (375 per year). It is assumed that the Annular Core Research Reactor will operate at the same power regardless of what fraction of U.S. medical isotope demand is being produced. Irradiation time will vary rather than operating power. To satisfy 30 percent of U.S. demand, which is the production level expected for FY2003 and FY2008, the reactor will be operated for 16 hours per day, five days per week (4,160 hours per year) at a maximum power level of 4 MW (approximately 16,640 MW-hours per year). The production needs may require varying scenarios that would range from periods of shutdown to periods of operation at 100 percent of the U.S. demand level (approximately 25 targets per week). However, it is anticipated that the annual total would not exceed approximately 1,300 targets irradiated in a particular year (100 percent production level). The irradiation schedule could require reactor operations that vary from as little as a single worker shift (typically an 8-hour shift) for only a few days per week to 24 hours per day, seven days per week operation. DOE has evaluated this program and has issued a record of decision that addresses operations and production levels to meet the entire U.S. demand continuously at this facility (U.S. Department of Energy, 1996).

A single DP test may be required at some point in the future to respond to a national emergency. This test would be conducted in the existing Annular Core Research Reactor facility, which would have to be temporarily reconfigured to restore DP testing capability. During this time, medical isotope production would be interrupted. Following this DP test, the Annular Core Research Reactor configuration would return to that required for isotope production. This and other DP use of the Annular Core Research Reactor is described in "5.0 ANNULAR CORE RESEARCH REACTOR FACILITY (DP) SOURCE INFORMATION."

The baseline year estimates reflect the series of tests and experiments that were conducted in calendar year 1996.

6.8.1.4 Assumptions and Actions for the "Expanded" Values

Under the "expanded" alternative, the Annular Core Research Reactor would be operated for 24 hours per day, seven days per week at a maximum power level of 4 MW (approximately 35,000 MW-hours per year) to meet the entire U.S. demand for Mo-99 and other isotopes such as I-125, I-131, and Xe-133. This would require the radiation of about 25 highly enriched uranium targets per week (1,300 per year). DOE has evaluated this program and has issued a record of decision that addresses production levels to meet the entire U.S. demand continuously at this facility (U.S. Department of Energy, 1996).

6.8.2 Material Inventories

6.8.2.1 Nuclear Material Inventory Scenario for Enriched Uranium

6.8.2.1.1 Alternatives for Enriched Uranium Nuclear Material Inventory

Table 13-61 shows the alternatives for enriched uranium inventory for the Annular Core Research Reactor Facility (Mo-99).

Table 13-61. Alternatives for Enriched Uranium Nuclear Material Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
18.3 kg	25.8 kg	56.7 kg	56.7 kg	56.7 kg

6.8.2.1.2 Operations That Require Enriched Uranium

The value for the "no action" base year assumes that the 247 UO_2BeO fuel elements (25 kg total) are used for isotope production. This value also assumes an inventory of 30 targets, each which contains an estimated 25 g of U-235 (total of 0.8 kg).

The FY2003 and FY2008 timeframes assume that the 247 UO_2BeO elements are reserved for DP testing and that 180 new fuel elements (estimated to have 280 g of U-235 per element) are procured for isotope production. In addition, there is expected to be an inventory of 250 targets, each of which contains an estimated 25 g of U-235 (total of 6.3 kg).

6.8.2.1.3 Basis for Projecting the "Reduced" and "Expanded" Values

The "reduced" alternative assumes that the Annular Core Research Reactor core has been reconfigured to use 170 UO_2BeO fuel elements and that there is an inventory of 50 targets that contain 25 g of U-235 each (total of 1.3 kg).

The "expanded" alternative assumes the new 180 fuel elements core (estimated to have 280 g of U-235 per element) is used for isotope production. In addition, there is expected to be an inventory of 250 targets, each of which contains an estimated 25 g of U-235 (total of 6.3 kg). Target consumption is addressed in "7.0 HOT CELL FACILITY SOURCE INFORMATION." Consumption could increase; however, the inventory would be maintained within the administrative limits.

6.8.2.2 Radioactive Material Inventory Scenarios

The Annular Core Research Reactor Facility (Mo-99) has no radioactive material inventories.

6.8.2.3 Sealed Source Inventory Scenarios

The Annular Core Research Reactor Facility (Mo-99) has no sealed source inventories.

6.8.2.4 Spent Fuel Inventory Scenario for Spent Fuel From Fuel Elements

6.8.2.4.1 Alternatives for Spent Fuel From Fuel Elements Spent Fuel Inventory

Table 13-62 shows the alternatives for the inventory of spent fuel from fuel elements at the Annular Core Research Reactor Facility (Mo-99).

Table 13-62. Alternatives for Spent Fuel From the Fuel Elements Spent Fuel Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
42 kg	0 kg	0 kg	189 kg	399 kg

6.8.2.4.2 Operations That Require Spent Fuel From Fuel Elements

Values for the years between FY2003 and FY2008 conservatively assume that 27 fuel elements (estimated at approximately 7 kg per element) are replaced each year (48 percent of expanded alternative based on estimated 16,640 MW-hours per year relative to spent fuel estimates for the “expanded” alternative scenario at 35,000 MW-hours per year).

6.8.2.4.3 Basis for Projecting the “Reduced” and “Expanded” Values

The “reduced” alternative assumes that approximately six fuel elements (estimated at approximately 7 kg per element) are replaced each year (11 percent of “expanded” alternative based on estimated 4,000 MW-hours relative to spent fuel estimates for the “expanded” alternative scenario at 35,000 MW-hours per year).

The value for the “expanded” alternative conservatively assumes that 57 fuel elements (estimated at approximately 7 kg per element) are replaced each year for operation at 4 MW for 8,736 hours per year (35,000 MW-hours per year).

6.8.2.5 Chemical Inventory Scenarios

The Annular Core Research Reactor Facility (Mo-99) has no inventories of chemicals of concern.

6.8.2.6 Explosives Inventory Scenario for Bare UNO 1.2

6.8.2.6.1 Alternatives for Bare UNO 1.2 Explosives Inventory

Table 13-63 shows the alternatives for bare UNO 1.2 explosives inventory at the Annular Core Research Reactor Facility (Mo-99).

Table 13-63. Alternatives for Bare UNO 1.2 Explosives Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 g	0 g	500 g	500 g	500 g

6.8.2.6.2 Operations That Require Bare UNO 1.2

Occasionally, test items containing explosives are present in the Annular Core Research Reactor Facility. Current administrative limits allow up to 500 g of TNT-equivalent explosives. Hence, the values for the “no action” FY2003 and FY2008 timeframes assume that this amount is present in the facility to allow for potential concurrent activities, such as neutron radiography of weapons components that may contain small amounts of explosives.

6.8.2.6.3 Basis for Projecting the “Reduced” and “Expanded” Values

The “reduced” alternative assumes no explosives are present in the facility. The “expanded” alternative assumes that an amount of explosives equal to the 500 g administrative limit is present in the facility.

6.8.2.7 Other Hazardous Material Inventory Scenarios

The Annular Core Research Reactor Facility (Mo-99) has no inventories of hazardous materials that do not fall into the categories of nuclear or radioactive material, sealed sources, spent fuel, explosives, or chemicals.

6.8.3 Material Consumption

6.8.3.1 Nuclear Material Consumption Scenario for Enriched Uranium

6.8.3.1.1 Alternatives for Enriched Uranium Consumption

Table 13-64 shows the alternatives for enriched uranium consumption at the Annular Core Research Reactor Facility (Mo-99).

Table 13-64. Alternatives for Enriched Uranium Consumption

Reduced Alternative		No Action Alternative						Expanded Alternative	
		Base Year		FY2003		FY2008			
0 pkgs	0 kg	0 pkgs	0 kg	0 pkgs	0.38 kg	0 pkgs	10.6 kg	0 pkgs	16 kg

6.8.3.1.2 Operations That Require Enriched Uranium

Operation of the Annular Core Research Reactor results in consumption of the U-235 contained within the fuel elements. During the “no action” base year, insignificant amounts of material were consumed. Up until FY2003, it is assumed that operation of the reactor using the existing UO_2BeO fuel will result in a consumption of approximately 10 percent of the fuel in 38 of the fuel elements each year.

For the years between FY2003 and FY2008, it is assumed that 38 new fuel elements (approximately 280 g per element) are replaced each year and that any U-235 that was not consumed by the operation of the reactor is to be eventually discarded as spent fuel and not recovered. Hence, 100 percent of the U-235 that was originally present in each element is considered to be consumed. The values listed are annual values.

6.8.3.1.3 Basis for Projecting the “Reduced” and “Expanded” Values

For the “reduced” alternative, minimal U-235 is consumed. The “expanded” alternative assumes that 57 fuel elements are replaced each year and that any U-235 that was not consumed by the operation of the reactor is to be eventually discarded as spent fuel and not recovered. Hence, 100 percent of the U-235 that was originally present in each element is considered to be consumed. The values listed are annual values.

6.8.3.2 Radioactive Material Consumption Scenarios

Radioactive material is not consumed at the Annular Core Research Reactor Facility (Mo-99).

6.8.3.3 Chemical Consumption Scenarios

Information initially provided for this section resides in the Facility Information Manager database and will be made available to the analysts responsible for preparing the sitewide environmental impact statement.

6.8.3.4 Explosives Consumption Scenarios

Explosives are not consumed at the Annular Core Research Reactor Facility (Mo-99).

6.8.4 Waste

6.8.4.1 Low-Level Radioactive Waste Scenario

6.8.4.1.1 Alternatives for Low-Level Radioactive Waste at the Annular Core Research Reactor Facility (Mo-99)

Table 13-65 shows the alternatives for radioactive waste at the Annular Core Research Reactor Facility (Mo-99).

Table 13-65. Alternatives for Low-Level Radioactive Waste

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
56 ft^3	56 ft^3	370 ft^3	370 ft^3	1,090 ft^3

6.8.4.1.2 Operations That Generate Low-Level Radioactive Waste

During operation of the Annular Core Research Reactor for isotope production, low-level waste is generated in the form of resins used for water purification and personal protective equipment. The low-level radioactive waste discussed here is the waste associated with reactor operations only and does not include isotope production. Low-level waste estimates are based on process knowledge and past experience.

6.8.4.1.3 General Nature of Waste

Primary isotopes associated with the Annular Core Research Reactor resins include H-3, Pb-210, and Tl-208. Both alpha and beta activity can be measured in the resins. Other radionuclides, such as Cs-137 and Co-60, may be present in trace quantities due to contamination introduced during cask transfers. Detectable contamination is not usually present on the Annular Core Research Reactor personal protective equipment.

6.8.4.1.4 Waste Reduction Measures

The circulation of the pool water through resin beds results in the recycling of water.

6.8.4.1.5 Basis for Projecting the “Reduced” and “Expanded” Values

The value for the “reduced” alternative is based on the generation of 12 ft^3 of resins and 44 ft^3 (0.5 drum per month) of personal protective equipment during operation of the Annular Core Research Reactor to produce 40 irradiated targets.

The value for the "expanded" alternative is based on the generation of 90 ft^3 of resins and 1,000 ft^3 (3 drums per week) of personal protective equipment during operation of the Annular Core Research Reactor to produce 1,300 irradiated targets.

The values for FY2003 and FY2008 are based on the generation of 40 ft^3 of resins and 330 ft^3 (45 drums) of personal protective equipment per year during the processing of 375 targets (30 percent of the U.S. demand).

6.8.4.2 Transuranic Waste Scenario

Transuranic waste is not produced at the Annular Core Research Reactor Facility (Mo-99).

6.8.4.3 Mixed Waste

6.8.4.3.1 Low-Level Mixed Waste Scenario

Low-level mixed waste is not produced at the Annular Core Research Reactor Facility (Mo-99).

6.8.4.3.2 Transuranic Mixed Waste Scenario

Transuranic mixed waste is not produced at the Annular Core Research Reactor Facility (Mo-99).

6.8.4.4 Hazardous Waste Scenario

6.8.4.4.1 Alternatives for Hazardous Waste at the Annular Core Research Reactor Facility (Mo-99)

Table 13-66 shows the alternatives for hazardous waste at the Annular Core Research Reactor Facility (Mo-99).

Table 13-66. Alternatives for Hazardous Waste

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
7 ft^3	7 ft^3	14 ft^3	14 ft^3	30 ft^3

6.8.4.4.2 Operations That Generate Hazardous Waste

Hazardous waste is generated during routine maintenance activities and from batteries and metal halide of sodium vapor lamps. These waste generation estimates are based on historical experience.

6.8.4.4.3 General Nature of Waste

Hazardous waste may include batteries and hazardous bulbs.

6.8.4.4.4 Waste Reduction Measures

Nonhazardous materials are used whenever possible.

6.8.4.4.5 Basis for Projecting the “Reduced” and “Expanded” Values

For the “reduced” alternative, limited production to keep the facility operational would result in the generation of about one drum per year of hazardous waste. For the “expanded” alternative, a production level of 100 percent of the U.S. demand would result in the generation of about 30 ft^3 (four drums) of hazardous waste per year.

6.8.5 Emissions

6.8.5.1 Radioactive Air Emissions Scenarios

6.8.5.1.1 Radioactive Air Emission Scenario for H-3

Alternatives for H-3 Emissions at the Annular Core Research Reactor Facility (Mo-99) **-** Table 13-67 shows the alternatives for H-3 emissions at the Annular Core Research Reactor Facility (Mo-99).

Table 13-67. Alternatives for H-3 Emissions

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0.24 Ci	0 Ci	1.1 Ci	1.1 Ci	2.2 Ci

Operations That Generate H-3 Air Emissions **-** Irradiation of targets for Mo-99 production generates H-3 air emissions. The FY2003 and FY2008 values are based on the “expanded” alternative value, reduced by the ratio of the number of hours that the reactor is assumed to be operating in the “expanded” alternative (8,760 hours for 24 hours per day, seven days per week operation) to the number of hours that the reactor is assumed to be operating in the “no action” alternative for FY2003 and FY2008 (4,160 hours for two 8-hour shifts, five days per week operation).

General Nature of Emissions **-** The emissions are gaseous.

Emission Reduction Measures **-** No emission reduction measures exist.

Basis for Projecting the "Reduced" and "Expanded" Values **-** The "reduced" alternative value is based on the "expanded" alternative value, reduced by the ratio of the number of hours that the reactor is assumed to be operating in the expanded alternative (8,760 hours for 24 hours per day, seven days per week of operation) to the number of hours that the reactor is assumed to be operating in the "reduced alternative" (960 hours for an 8-hour shift, ten days per month of operation).

The "expanded" alternative is based on 100 percent of the current U.S. market (approximately 1,300 targets per year). The value is consistent with that presented in U.S. Department of Energy (1996).

6.8.5.1.2 Radioactive Air Emission Scenario for Ar-41

Alternatives for Ar-41 Emissions at the Annular Core Research Reactor Facility (Mo-99) **-** Table 13-68 shows the alternatives for Ar-41 emissions at the Annular Core Research Reactor Facility (Mo-99).

Table 13-68. Alternatives for Ar-41 Emissions

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0.24 Ci	35.4 Ci	1.1 Ci	1.1 Ci	2.2 Ci

Operations That Generate Ar-41 Air Emissions **-** The "no action" base year emissions of Ar-41 were the result of isotope production experiments in the Annular Core Research Reactor DP configuration with the central experiment cavity in place. The experiment cavity allowed air to become irradiated to produce Ar-41.

In the isotope production configuration that is now in place, the central cavity is removed and Ar-41 emission is reduced significantly.

The FY2003 and FY2008 values are based on the "expanded" alternative value, reduced by the ratio of the number of hours that the reactor is assumed to be operating in the "expanded" alternative (8,760 hours for 24 hours per day, seven days per week of operation) to the number of hours that the reactor is assumed to be operating in the "no action" alternative for FY2003 and FY2008 (4,160 hours for two 8-hour shifts, five days per week of operation).

General Nature of Emissions **-** The nature of emission is gaseous emission of activated air.

Emission Reduction Measures **-** No emission reduction measures exist.

Basis for Projecting the "Reduced" and "Expanded" Values **-** The "reduced" alternative value is based on the "expanded" alternative value, reduced by the ratio of the number of hours that the reactor is assumed to be operating in the "expanded" alternative (8,760 hours for 24 hours per day, seven days per week of operation) to the number of hours that the reactor is assumed to be operating in the "reduced" alternative (960 hours for an 8-hour shift, ten days per month of operation).

The "expanded" alternative is based on 100 percent of current U.S. market (approximately 1,300 targets per year). The value is consistent with that presented in U.S. Department of Energy (1996).

6.8.5.2 Chemical Air Emissions

Information on an extensive list of chemicals was obtained from the SNL/NM Chemical Inventory System (CIS). For the air emissions analysis, the entire annual inventory of these chemicals was assumed to have been released over a year of operations for each specific facility (i.e., the annual inventory was divided by facility operating hours). The emissions from this release were then subjected, on a chemical-by-chemical basis, to a progressive series of screening steps for potential exceedances of both regulatory and human health thresholds. For those chemicals found to exceed this screening, process knowledge was used to derive emission factors. The emission factors for these chemicals were then modeled using the U.S. Environmental Protection Agency's *Industrial Source Complex Air Quality Dispersion Model, Version 3*. The results of this modeling are discussed as part of the analysis in support of the SNL/NM site-wide environmental impact statement.

6.8.5.3 Open Burning Scenarios

The Annular Core Research Reactor Facility (Mo-99) does not have outdoor burning operations.

6.8.5.4 Process Wastewater Effluent Scenario

6.8.5.4.1 Alternatives for Process Wastewater at the Annular Core Research Reactor Facility (Mo-99)

Table 13-69 shows the alternatives for process wastewater at the Annular Core Research Reactor Facility (Mo-99).

Table 13-69. Alternatives for Process Wastewater

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
240,000 gal	125,000 gal	1,000,000 gal	1,000,000 gal	2,190,000 gal

6.8.5.4.2 Operations That Generate Process Wastewater

During steady-state operations, a portion the water in the secondary cooling system is continually expelled and replenished (bled and fed) with fresh water to maintain water chemistry within acceptable limits. Approximately 6,000 gal of water per day (250 gal per hour) would be expelled for each day of full-power operation (2,190,000 gal per year for the expanded alternative), evaporated from a cooling tower to cool the Annular Core Research Reactor pool water during times of extended or continuous operations. During the “no action” base year, the reactor was operated for less than 500 hours.

The FY2003 and FY2008 values are based on the “expanded” alternative value, reduced by the ratio of the number of hours that the reactor is assumed to be operating in the “expanded” alternative (8,760 hours for 24 hours per day, seven days per week of operation) to the number of hours that the reactor is assumed to be operating in the “no action” alternative for FY2003 and FY2008 (4,160 hours for two 8-hour shifts, five days per week of operation).

6.8.5.4.3 General Nature of Effluents

The process water effluent is water expelled from the secondary cooling system.

6.8.5.4.4 Effluent Reduction Measures

No wastewater reduction measures are available.

6.8.5.4.5 Basis for Projecting the “Reduced” and “Expanded” Values

The “expanded” alternative value is based on 250 gal per hour for 8,760 hours of operation per year.

The “reduced” alternative value is based on the “expanded“alternative value, reduced by the ratio of the number of hours that the reactor is assumed to be operating in the “expanded” alternative (8,760 hours for 24 hours per day, seven days per week of operation) to the number of hours that the reactor is assumed to be operating in the “reduced” alternative (960 hours for an 8-hour shift, ten days per month of operation).

6.8.6 Resource Consumption

6.8.6.1 Process Water Consumption Scenario

6.8.6.1.1 Alternatives for Process Water Consumption at the Annular Core Research Reactor Facility (Mo-99)

Table 13-70 shows the alternatives for process water consumption at the Annular Core Research Reactor Facility (Mo-99).

Table 13-70. Alternatives for Process Water Consumption

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
1,200,000 gal	600,000 gal	5,000,000 gal	5,000,000 gal	11,000,000 gal

6.8.6.1.2 Operations That Consume Process Water

Water is evaporated from a cooling tower to cool the Annular Core Research Reactor pool water during times of extended or continuous operations. Approximately 1,200 gal of water is evaporated per hour of operation of the reactor at production power levels (< 4 MW). During the “no action” base year, the reactor was operated for less than 500 hours.

Values for the “no action” years FY2003 and FY2008 assume that the Annular Core Research Reactor will operate at the same power regardless of what fraction of U.S. medical isotope demand is met. Irradiation time is assumed to be varied while operating power remains constant. At the 30 percent of U.S. demand production level projected for FY2003 and FY2008, it is assumed that the reactor will be operated for 16 hours per day, five days per week (4,160 hours per year) at a maximum power level of 4 MW. This would result in a water consumption rate of approximately 5,000,000 gal per year.

6.8.6.1.3 Consumption Reduction Measures

No consumption reduction measures are available without changing standard operations.

6.8.6.1.4 Basis for Projecting the “Reduced” and “Expanded” Values

The “reduced” alternative assumes that approximately one target would be irradiated and processed each week. However, it is not likely that the reactor would be operated each week. A more likely scenario would involve the operation of the reactor for a single operational shift for two weeks each month (1,000 hours of operation per year) at a maximum power level of 4 MW. Hence, water consumption for the “reduced” alternative is estimated to be 1,200,000 gal per year.

Under the “expanded” alternative, the reactor would be operated for 24 hours per day, seven days per week at a maximum power level of 4 MW to meet the entire U.S. demand for medical isotopes. This would result in the consumption of 11,000,000 gal of water per year.

6.8.6.2 Process Electricity Consumption Scenario

The Annular Core Research Reactor Facility (Mo-99) does not consume process electricity.

6.8.6.3 Boiler Energy Consumption Scenario

The Annular Core Research Reactor Facility (Mo-99) does not consume energy for boilers.

6.8.6.4 Facility Personnel Scenario

6.8.6.4.1 Alternatives for Facility Staffing at the Annular Core Research Reactor Facility (Mo-99)

Table 13-71 shows the alternatives for facility staffing at the Annular Core Research Reactor Facility (Mo-99)

Table 13-71. Alternatives for Facility Staffing

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
7 FTEs	9 FTEs	14 FTEs	14 FTEs	22 FTEs

6.8.6.4.2 Operations That Require Facility Personnel

Under the “no action” base year, the Annular Core Research Reactor was staffed by approximately eight FTEs. Under the production level projected for the FY2003 and FY2008 timeframes, it is expected that an additional four FTEs will be required to staff a second shift of reactor personnel.

6.8.6.4.3 Staffing Reduction Measures

This section is not applicable.

6.8.6.4.4 Basis for Projecting the "Reduced" and "Expanded" Values

The "reduced" alternative assumes that the staffing level will be the same as the "no action" base year levels. The "expanded" alternative would require a significant number of additional staff to operate the Annular Core Research Reactor 24 hours per day, seven days per week.

6.8.6.5 Expenditures Scenario

6.8.6.5.1 Alternatives for Expenditures at the Annular Core Research Reactor Facility (Mo-99)

Table 13-72 shows the alternatives for expenditures at the Annular Core Research Reactor Facility (Mo-99).

Table 13-72. Alternatives for Expenditures

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
$0	$200,000	$4.5 million	$4 million	$0

6.8.6.5.2 Operations That Require Expenditures

For Tech Area V facilities, SNL/NM has included only cost expenditures for projected major capital improvements. No labor costs are included in these projections. For the "no action" base year timeframe, the Annular Core Research Reactor was being modified for isotope production. Most of the costs of this modification was staff (FTE) costs; however, approximately $200,000 was spent on procurements. Between FY1999 and FY2003, a one-time expenditure of approximately $500,000 will be necessary to further upgrade the reactor systems for isotope production. These modifications will enable the 100 percent production level described for the "expanded" alternative. While 100 percent production is addressed in the "expanded" alternative, the modification (development of the production capacity) is planned in the "no action" alternative. Also, in the FY2003 time frame, approximately $4 million will be spent to procure fuel elements to replace the existing fuel. The existing fuel will be placed in storage to support DP tests. Another set of replacement fuel is accounted for in FY2008, though it is expected that the fuel purchased in the FY2003 timeframe will last for more than five years.

6.8.6.5.3 Expenditure Reduction Measures

This section is not applicable.

6.8.6.5.4 Bases for Projecting the “Reduced” and “Expanded” Values

The production level for the “reduced” alternative does not allow a reduction in expenditures. The production capacity for the “expanded” alternative is developed in the “no action” alternative; therefore, no large additional expenditures are necessary for the “expanded” alternative.

7.0 HOT CELL FACILITY SOURCE INFORMATION

7.1 Purpose and Need

The Hot Cell Facility is primarily an isotope production facility that supports the DOE Isotope Production and Distribution Program. Among other activities, the DOE Isotope Production and Distribution Program has responsibility for ensuring that the U.S. health care community has access to a reliable supply of molybdenum-99 (Mo-99). In just a few days after its production, Mo-99 decays to form metastable technetium-99 (Tc-99m), the most widely used medical radioisotope in the U.S. Currently under modification for enhanced production capability, the Hot Cell Facility will provide the only domestic capability to produce a continuous supply of Mo-99 and related medical isotopes.

The only other supplier in North America, Nordion International of Ottawa, Canada, depends on a nearly 40-year-old reactor, owned by Atomic Energy of Canada Ltd., for its supply of Mo-99.

A history of labor strikes and unplanned outages or shutdowns of the aging Canadian reactor have jeopardized the U.S. supply of the short-lived Mo-99 in the past. The Hot Cell Facility, together with the Annular Core Research Reactor and the Gamma Irradiation Facility, is the best option to provide a reliable additional source of Mo-99 in the U.S. Without isotope production in the Hot Cell Facility, the U.S. would be vulnerable to further interruptions in the Mo-99 supply from Canada. Furthermore, if the Canadian source were to become unavailable, the supply of Mo-99 available to the U.S. would be substantially reduced or eliminated. A shortage of Mo-99 would limit the use of medical isotopes for diagnoses of thousands of medical patients in the U.S. each day.

In addition to its primary mission as an isotope production facility, the Hot Cell Facility has the capability to provide some limited support for tests, experiments, and the handling of radiological materials. These experiments and chemical and material science analysis activities with radioactive and other hazardous materials would support requirements of DOE Office of Defense Programs, the Nuclear Regulatory Commission, and other agencies. Other facilities associated with the Hot Cell Facility are solely used for these experiments, while the Hot Cell Facility itself will be used primarily and almost solely for isotope production.

(Miller, 1998; Restrepo and Saloio, 1995)

7.2 Description

The Hot Cell Facility primary operating areas are located in Building 6580 and Building 6581 in Technical Area V. The facility includes the following:

- Mechanical equipment room
- Central facility housed in the basement of Building 6580
- Hydraulic system housed in Building 6581
- Liquid nitrogen holding tank

Generally, the term "Hot Cell Facility" is used to designate that portion of the facility in the basement of Building 6580**.** The Hot Cell Facility is a concrete shielded location that contains four distinct areas:

- Hot Cell Laboratory for remote, shielded handling of hazardous material
- Quality Control Laboratory for analysis of isotope products
- Radioactive waste storage operations area (Rooms 109 and 108)
- Product packaging and shipping area

The Hot Cell Laboratory contains eleven steel confinement boxes (SCBs) and one steel transfer box (STB) in a shielded area referred to as Ventilation Zone 2A. Remote manipulators are used to accomplish tasks inside the SCBs and STB with observation through high-density, shield-glass windows in the side of the shielded support area. The isotope extraction, separation, purification, initial isotope product packaging, and radioactive waste packaging processes for isotope production are accomplished in the SCBs. The eleven SCBs comprise Ventilation Zone 1, internal to Ventilation Zone 2A. Irradiated isotope production targets, chemical processing material kits, waste solidification and packaging material kits, and small production process equipment enter the SCBs through the STB from basement Room 111 of Building 6580.

The STB is part of Ventilation Zone 2A and forms an interface with Ventilation Zone 2, which comprises multiple rooms in the basement of Building 6580. Radioactive, irradiated isotope production targets are transferred in a shielded cask on a forklift from the Annular Core Research Reactor in an adjacent building. Targets enter the shielded area via the STB. The targets are transported into the Hot Cell Facility in shielded casks by forklift. The forklift enters the basement of Building 6580 through a truck ramp and then passes through a set of airlock doors to enter Ventilation Zone 2. Large equipment and materials such as radioactive waste barrels enter Ventilation Zone 2A through an airlock from Room 112 of Ventilation Zone 2 in the Building 6580 basement.

The Isotope product in initial packaging containers and the quality control product extract vials exit in shielded containers from the Ventilation Zone 1 packaging SCBs directly to Room 111 of Ventilation Zone 2. The isotope product containers are taken to the product packaging and shipping area in Room 113A of Ventilation Zone 2 to complete packaging for shipment to radiopharmaceutical companies. The quality control product extract is taken to the Quality Control Laboratory in Room 113 of Ventilation Zone 2 for analysis of the isotope products. The Quality Control Laboratory contains a shielded glove box (SGB) where the isotope product extract is diluted and divided to make lower activity samples for quality control analysis in ventilation hoods, which are also in Room 113.

The radioactive waste storage area is in basement Room 109 of Building 6580. Room 109 is part of Ventilation Zone 2A and separated from the Hot Cell Laboratory shielded support area by a massive shielding door. Radioactive process liquid is neutralized and solidified in the SCBs and transferred to a waste SCB for packaging into a waste barrel with other solid radioactive waste. The waste barrels are stored temporarily in a pit in the floor until enough barrels are accumulated for storage in the Room 109 waste storage area.

While radioactive waste storage is in Room 109, other radioactive material may exist at other locations in the Hot Cell Facility. Proper security and radiological safety and criticality safety requirements must be met in all areas. Chemical processing for isotope extraction, separation, and purification occurs only in the SCBs, which have chemical material kits with measured volumes of chemicals in marked containers that are prepared in a separate location. Chemical processes for quality control analysis may use small amounts of prepared chemicals that are measured in the SGB or ventilation hoods for use as needed.

Ventilation Zone 3 in the basement of Building 6580 includes all areas that are not a part of Ventilation Zone 1, Ventilation Zone 2A, or Ventilation Zone 2.

The major mechanical system supporting the SCBs, STB, Ventilation Zone 2A, and the rest of the Hot Cell Facility is the ventilation system. This system provides a safe operating environment within the facility by ensuring that proper differential air pressures are maintained so that leakage is from zones of lesser contamination (Ventilation Zone 3) to zones of higher contamination (Ventilation Zone 1).

A minimum of three stages of nuclear-grade HEPA filters treat exhaust gases from Ventilation Zone 1 and Ventilation Zone 2A to remove particulate contaminants from the exhaust air prior to release to the atmosphere through the exhaust stack. In addition, charcoal filters in the

SCBs and Ventilation Zone 1 exhaust are designed to trap iodine vapors to control radioactive contamination in the SCBs and ventilation ducts. The exhaust systems are equipped with test ports and are periodically checked for operating efficiency. Motor control circuits provide sequential control to prevent overpressurization of any part of the ventilation system.

Several facilities associated with the Hot Cell Facility for the purpose of this analysis include the shielded work area in Building 6595, Building 6596, Building 6597, Building 6597 highbay and midbay storage areas, and the Tech Area V storage facilities such as the monorail storage holes, the storage area South of Building 6588, and the dense-pack storage holes.

The shielded work area in Building 6597 consists of a closed, shielded area with remote manipulators for work on radioactive material. Observation of work is through high-density shield windows. Entry to the shielded work area is by a shielded opening in the top. A local ventilation system provides a negative pressure in the shielded work area with respect to the inhabited areas of the building with filtration of the exhaust provided by HEPA filters. Work to date in this facility has been limited to the handling and repackaging of radioactive material.

The monorail storage holes are outside and adjacent to Building 6580 (the Hot Cell Facility). The monorail storage holes consist of three nominally 24-in. diameter holes 20 or 30 ft deep and ten nominally 10-in. diameter holes 20 ft deep. All holes have stainless-steel casings with concrete bottoms sealed with epoxy paint. The tops are raised slightly above grade to shed water and have a weather cover. The tops of the holes also have shield plugs for shielding of radioactive material in storage. All holes provide dry storage of radioactive material except one nominally 24-in. diameter hole that has been fitted with a 20-in. diameter stainless-steel tube liner for wet storage of radioactive material. A monorail crane system is used to access the material in the holes and allow its transfer to suitable shielding casks.

The dense-pack storage holes are located in the Sandia Pulsed Reactor fenced area and are outside storage. The dense-pack storage hole construction is similar to the monorail storage holes with the exception of mild steel instead of stainless steel for the hole casing. All holes are dry storage and 20 ft deep. Twelve holes are 10-in. diameter, four holes are 16-in. diameter, and three holes are 24-in. diameter. No dedicated crane system is associated with the dense-pack storage holes.

The north wing of Building 6596 is used for storage of radioactive material and activated material. Building 6597 highbay and midbay storage areas, Building 6595, and the storage area South of Building 6588 support activities in the Hot Cell Facility and other Tech Area V facilities and operations. These supporting activities may include material staging, storage, and assembly and waste storage.

(Miller, 1998; Restrepo and Saloio, 1995)

7.3 Program Activities

Table 13-73 shows the program activities at the Hot Cell Facility.

Table 13-73. Program Activities at the Hot Cell Facility

Program Name	Activities at the Hot Cell Facility	Category of Program	Related Section of the *SNL Institutional Plan*
Experimental Activities	The Hot Cell Facility consists of the Hot Cell Laboratory, the Glove Box Laboratory, and the Analytical Laboratory. The Hot Cell Facility allows safe handling of irradiated and nonirradiated nuclear and other radioactive materials. Experiments can be assembled and tested or disassembled for examination; samples can be prepared; and microscopic, radiological, and chemical analyses can be performed. The Hot Cell Facility is being modified to support the production of radiopharmaceuticals with reconfiguration of the Glove Box Laboratory. An auxiliary hot cell was recently developed for handling experimental materials.	Programs for the Department of Energy	Section 6.1.1.1
Other Programs of DOE Defense Programs, Nuclear Regulatory Commission, and other agencies	Limited experiments and chemical and material science analysis activities with radioactive and other hazardous material.	Programs for the Department of Energy	None

7.4 Operations and Capabilities

The primary mission and designed capability of the modified Hot Cell Facility is isotope production. The modified Hot Cell Facility was designed to produce up to 100 percent of the current U.S. demand for Mo-99. That production level would require the processing of five irradiated isotope production targets per day for five days per week. A planned annual two-week suspension of production for Hot Cell Facility production maintenance would be accommodated by support agreements with the Canadian Mo-99 producer.

Operations and capabilities of the Hot Cell Facility support efficient isotope production. Experiments and chemical and material science analysis activities with radioactive and other hazardous materials can be accommodated but would impact isotope production in some way.

If isotope production is low during a period, it may be possible to accommodate some limited experiments.

Isotope production operations and associated capabilities of the Hot Cell Facility are as follows:

- **Expedited Entry of Materials to the Isotope Production Process in the Hot Cell Laboratory -** Irradiated isotope production target receipt and transfer to the processing SCBs is done from Hot Cell Facility Room 111 through the STB by passing the entire shielded cask and target assembly into the STB through a shielded entrance. Then, the irradiated target is passed through an under-SCB-transfer conveyer system to the processing SCBs. Chemical processing material kits, waste solidification and packaging material kits, and small production process equipment also enter the production process operation through the STB.

- **Isotope Extraction and Separation Processing in the Hot Cell Laboratory -** Four large extraction SCBs, comprising four separate production lines, are dedicated to the extraction and separation process. The fission product isotopes and uranium oxide are extracted from within the irradiated production target through a heated acid dissolution process. Fission product noble gases, halogens, and any other volatile isotopes are captured through a cold trap process using equipment in the extraction SCBs or a separate waste SCB. Mo-99 isotope or other isotope products are separated from the other fission products in the dissolution solution by a chemical precipitation process.

- **Isotope Product Purification Processing in the Hot Cell Laboratory -** Four additional SCBs, comprising four separate purification production lines, are dedicated to the purification of the separated isotope products by a filter column and impurity precipitation process. Charcoal filtering for the ventilation system in each SCB is designed to prevent cross-contamination of SCBs in the Hot Cell Laboratory to ensure high product quality.

- **Isotope Product Packaging and Quality Sample Extraction in the Hot Cell Laboratory -** Two additional packaging SCBs are used for isotope product packaging and quality sample extraction. Each packaging SCB serves two purification SCBs to comprise a packaging production line. A small sample is extracted from the isotope product for quality control analysis. The vial containing the product extract sample is placed into its shielding pig and removed from the shielded packaging SCB through its dedicated product exit system. Each packaging SCB has its own product exit system to remove material directly from Ventilation Zone 1 to Ventilation Zone 2 in Room 111. After a radiation survey of surface contamination by swipe sampling, the product in its outer sealed container is placed in its shielded container and removed from the packaging SCB through the product exit system.

- **Isotope Product Quality Control Analysis in the Quality Control Laboratory -** The isotope product extract sample is analyzed in the Quality Control Laboratory to provide product purity and quantity information for the customer. A shielded glove box (SGB) is used to precisely measure and dilute samples of the product extract so it may be divided to reduce the activity of analysis samples in the ventilation hoods. The diluted and divided samples used in the ventilation hood reduce the dose to production personnel. Quality control analysis samples are produced in the ventilation hoods using small quantities of prepared chemicals. The quality sample activity on the resulting counting planchets is analyzed in a separate building.

- **Isotope Product Final Packaging in the Product Packaging and Shipping Area -** The isotope product in its shielded container is taken to the product packaging and shipping area in Room 113A. The isotope product in its shielded container is assembled into its outer package and prepared for shipment in this dedicated area. Returned package inspection for reuse is also conducted in this area.

- **Radioactive Waste Neutralization and Solidification in the Hot Cell Laboratory -** After the isotope product from the irradiated isotope production target leaves the extraction SCB, the remaining fission product and uranium solution is neutralized and solidified as concrete in a stainless-steel container. The process requires rotating the stainless-steel container on an electric rotation device to mix the cement and liquid combination. After the cement sets to a solid, the stainless steel container can be transferred to the waste SCB.

- **Solid Radioactive Waste Packaging in the Hot Cell Laboratory -** The final SCB, the waste SCB, receives the solid radioactive process waste from all SCBs. That waste consists of fission products and uranium in stainless-steel waste containers, used process equipment, and the empty target shells. The process is designed to minimize this waste and package all the waste in 55-gal barrels. Filled waste barrels are sealed and stored temporarily in a pit in the floor of the shielded support area of the Hot Cell Laboratory until enough are accumulated for storage in the Room 109 waste storage area. In addition, the nobles, halogens, and other volatile fission products that were captured by a cold trap process in the extraction SCBs are vented after a minimum decay time, which is determined by environmental release requirements.

- **Radioactive Waste Barrel Storage in the Hot Cell Facility Radioactive Waste Storage Area -** Radioactive waste barrels are transferred to the Room 109 radioactive waste storage area in groups to minimize the number of times the massive door to the waste storage area is opened. Because of the large inventory of accumulated waste activity in Room 109 and in the waste barrel group, the waste storage operation is done remotely in an extension of the shielded support area of the Hot Cell Laboratory with observation through high-density shield glass windows. Removal of the accumulated radioactive waste barrels for transport to an approved waste disposal site is planned after a future Hot Cell Facility modification makes a safe exit route for the waste barrels to shielded transport casks located outside of Building 6580.

- **Maintenance and Repair of Hot Cell Facility Equipment On Site -** Maintenance and repair of process equipment is available in the Hot Cell Facility itself. A full machine shop in Room 100 and Room 101 of Building 6580 is available to aid in rebuilding of dedicated equipment, such as remote manipulators, in a timely manner. A shop area in Room 112 provides space for repair and normal maintenance activities. The SCBs and the shielded support area of the Hot Cell Laboratory are designed for quick removal of components that may fail in use to ensure a continuing production capability between annual two-week suspensions of production for Hot Cell Facility production maintenance.

The multiple production line configuration of the Hot Cell Laboratory SCBs allows flexible process flow planning that can be tailored to equipment availability. Thus, minor breakdowns or spill cleanup can be accommodated by simply using another SCB or processing more targets in a given SCB. The same multiple production line configuration will facilitate production of other radioisotopes in addition to the initial production of Mo-99.

Several facilities associated with the Hot Cell Facility for the purpose of this analysis include Building 6595; the shielded work area in Building 6597; Building 6597 highbay and midbay storage areas; and the Tech Area V storage facilities such as the monorail storage holes, the storage area South of Building 6588, and the dense-pack storage holes. Capabilities vary for these facilities, but their missions include the handling and storage of radiological material.

The shielded work area in Building 6597 has the capability for remote handling of radiological material. The shield walls, high-density shield glass, and remote manipulators provide the remote handling capability for operations in this facility. The HEPA-filtered area exhaust forces a net flow into the area from the surrounding building.

Tech Area V storage facilities such as the monorail storage holes and dense-pack storage holes provide a shielded storage capability for many sealed packages of radiological material. Storage and movement operations for the radiological material require material-type or group-specific plans. Specific shield case and safety requirements are specified in these plans.

(Miller, 1998; Restrepo and Saloio, 1995)

7.5 Hazards and Hazard Controls

Because the Hot Cell Facility conducts primarily repetitive production activities, the specific hazards can be readily identified as corresponding to the activities, materials, facilities, and equipment of the production process for medical isotopes. Specific hazards have been analyzed by operation, process step, and location. Production of additional isotopes will have similar hazards that can also be characterized readily. In addition to normal industrial hazards, the specific hazards identified with the Mo-99 separation and purification operations are radiation, chemical, cryogenic, pressure, and vacuum hazards.

The hazards for many of these experiments must be characterized when and if the experiments are permitted in the Hot Cell Facility.

The most severe hazard to Hot Cell Facility isotope production workers is the direct radiation resulting from work in the SCBs and from waste storage activities. In addition, a scattered radiation hazard exists during waste storage operations. These operations involve the greatest quantity of radioactive material for the longest periods of time. Similarly, the most severe hazard to collocated occupational workers and members of the public is the potential inhalation or ingestion of radioactive material released from operations in the Hot Cell Facility.

Chemicals used in the Mo-99 isotope production process are well known. The procedure used to separate Mo-99 from uranium dioxide and to purify it involves acidic and basic chemicals in the Hot Cell Facility SCBs. The chemicals listed below are used in various concentrations and quantities for the particular process step. Material safety data sheets for these chemicals have been examined, and no carcinogens or other particularly hazardous materials were found. Milliliter to tens of milliliter amounts of the listed process chemicals are loaded into hypodermic syringes at a separate facility before the separation process begins. The process chemicals are injected through rubber membranes into the process-sealed glassware in the SCB at the proper isotope separation and purification step. Total volume of chemicals used is less than 400 ml per target. That amounts to less than 2 l per day or less than 10 l (approximately 2.5 gallons) per week at the production level for 100 percent of the U.S. demand for Mo-99. These process chemical solutions are shipped as isotope product or used in the radioactive waste neutralization and solidification process each day. The chemicals in syringes are transported to the SCBs in kits of materials and equipment. Process glassware and hardware are evacuated for radioactive material containment. The chemical hazard from acid and base corrosive chemicals is mitigated by remote handling in the SCBs and by the sealed process hardware and glassware. Any spills are contained in a spill tray and cleaned up with an acid spill kit in the SCB. The process chemicals used are listed below.

- Sulfuric acid (H_2SO_4)
- Nitric acid (HNO_3)
- Iodine carrier (NaI solution)
- Silver nitrate in nitric acid ($AgNO_3$ in HNO_3)

- Hydrochloric acid (HCl)
- Potassium permanganate ($KMnO_4$)
- Ruthenium carrier (Ru in H_2SO_4 and HNO_3)
- Sodium hydroxide (NaOH)
- Molybdenum carrier (Mo in neutralized NaOH)
- Rhodium carrier (Rh in HNO_3)
- Benzoin-alpha-oxime for molybdenum precipitation (Benzoin-alpha-oxime in NaOH)

In addition, liquid nitrogen in small quantities is used to cool equipment for isotope extraction and separation in a cold-trap process. Dissolution of uranium dioxide for separation requires heat and resulting pressure in the sealed target. Process glassware and hardware are evacuated for radioactive material containment. The liquid nitrogen cryogenic hazard is mitigated by installed plumbing that restricts the liquid nitrogen to the SCB. Similarly, the pressure and vacuum hazards to the worker are mitigated by the heavy wall and window construction of the SCBs. The isotope production target design has been qualified as a pressure vessel for the pressures that it experiences in uranium oxide dissolution.

Chemicals used in the quality control analyses in the SGB and ventilation hoods of the Quality Control Laboratory involve small (less than a liter) quantities of some acidic and basic chemicals. The chemicals are mixed in a separate facility. Material safety data sheets for these chemicals have been examined, and no carcinogens or other particularly hazardous materials were found. Operations in the SGB for preparation of various Mo-99 product dilution samples would require a small bulk supply of sodium hydroxide (0.1N NaOH). Quality control analysis sample preparation operations require small bulk supplies of the following chemicals:

- Concentrated nitric acid (HNO_3)
- Chloroform ($CHCl_3$)
- Water (H_2O)
- 50 percent ammonium thiocyanate in water (NH_4SCN)
- Potassium iodide carrier solution (KI carrier)
- Equilibrated ethyl acetate solution (ethyl acetate)
- Concentrated hydrochloric acid (HCl)
- 20 percent sodium nitrite in water ($NaNO_2$)
- Sulfuric acid 1 + 9 with water (H_2SO_4)
- 10 percent stannous chloride in 10 percent hydrochloric acid ($SnCl_2$)
- Ferric sulfate solution, 10 mg iron/ml in 1 percent sulfuric acid ($Fe_2[SO_4]_3$)
- Fission product carrier solution (Rh, Ru, and Mo in acid)

Workers who perform quality control analysis use basic safe chemical handling procedures as spelled out in Sandia National Laboratories (1999).

Safety during Hot Cell Facility operations is maintained as follows:

- The Hot Cell Laboratory shielded support area and SCBs combined shielding provide protection against direct radiation to mitigate the dose to workers so that exposure is as low as reasonably achievable (ALARA). A combination of added shielding and administrative controls to restrict entry provide protection against scattered radiation near the entrance to the Ventilation Zone 2A airlock in Room 112 during waste handling operations.

- The air pressure differentials between the various ventilation zones in the Hot Cell Facility and between the inside and outside of the SGB as well as the air flow through the ventilation hoods control contamination during facility operations. The SCBs, Ventilation Zone 2A, and the SGB are all isolated from and operated at a negative pressure relative to the areas occupied by workers to ensure that any leakage from the area where workers are located goes from areas of lesser contamination to areas of greater contamination. Because the SCBs, Ventilation Zone 2A, and the SGB will always contain radioactive material (from contamination), the ventilation system will operate essentially continuously within limits specified in the technical safety requirements. The atmospheres from the SCBs, Ventilation Zone 2A, the SGB, and ventilation hoods are exhausted through multiple HEPA filters to the Tech Area V stack. In addition, charcoal filters in the SCBs and Ventilation Zone 1 exhaust are designed to trap iodine vapors to control radioactive contamination in the SCBs and ventilation ducts. Also, workers handle materials by remote manipulators or with gloved hands in the SCBs, Ventilation Zone 2A, and the SGB. Appropriate gloves and other personnel protective equipment are used when working in the ventilation hoods with the low activity product dilution samples. These measures ensure that workers do not breathe or have skin contact with hazardous and radioactive materials being used in the SCBs, Ventilation Zone 2A, the SGB, or the ventilation hoods.

- Operations in the SCBs involve only premeasured quantities of acidic or basic chemicals in syringes or a closed container for use with process glassware and hardware. Prepared as kits for one target in a separate facility, the syringes and other equipment are introduced to the Hot Cell Facility and SCBs only as needed. Quality control analysis operations involve only small quantities (less than a liter) of chemicals that are prepared in a separate facility.

- All use of chemicals must be in accordance with Sandia National Laboratories (1999).

- The Radiological and Criticality Safety Committee (RCSC) and line management review and approve new processes, projects, or one-of-a-kind experiments and the types and quantities of materials to be used before those new processes, projects, or experiments can proceed.

- Facility management sets appropriate administrative limits as needed on quantities of hazardous, radioactive, and fissile materials to ensure that operations can be safely conducted. The RCSC reviews exceptions to these administrative limits, and line management approves them. All exceptions go through an unreviewed safety question determination.

- Radiation monitoring systems warn of unsafe radiation conditions and verify by measurement that a safe radiation environment is maintained within the Hot Cell Facility. Continuous air monitoring systems and remote area monitoring systems in the vicinity of the SGB and ventilation hoods warn workers if gamma dose rates or airborne contamination rates exceed set levels. Remote area monitoring systems in the vicinity of the Ventilation Zone 2A airlock entrance in Room 112 warn workers if scattered gamma dose rates exceed set levels. Area radiological control technicians (RCT) monitor these systems and verify that safe conditions exist.

- Because startup and shutdown do not have clear-cut meanings for the Hot Cell Facility, personnel monitor system status before operations begin by confirming operation of the ventilation system, the standby diesel generator (and electrical components), the fire protection system, the oxygen sensor system, and other systems on a regular schedule as described in the facility technical safety requirements. If the required systems are not operational, no production operations or experiments are conducted.

- The direct exposure shielding for the Hot Cell Laboratory shielded support area and SCBs is sufficient to support the isotope production up to 100 percent of the current U.S. demand for Mo-99 within the worker design and modification requirements of 10 CFR 835.1002 (an average of 0.5 mrem per hour or as low as reasonably achievable below that). Thus, the shielding is sufficient to accommodate the processing of five irradiated isotope production targets per day for five days per week with two targets in a single extraction SCB. The total fission product activity of an irradiated production target is expected to be up to 20,000 Ci. Most of this target activity remains in the residual process liquid after the Mo-99 and possibly other isotope products are extracted. After neutralization and solidification, the waste container for one target is transferred to the waste SCB and additional targets may be processed in that extraction SCB. The waste SCB and associated waste barrel shielding is sufficient to package the barrel with twelve targets for temporary storage in the pit in the floor of the Hot Cell Laboratory shielded support area. Worker direct-exposure shielding opposite to waste storage area in Room 109 is sufficient for transfer of four waste barrels of decayed target waste to the open door of Room 109. The accumulated 160 waste barrels of decayed waste in the Room 109 waste storage area, when full, should have up to 1,500,000 Ci activity. Worker doses are kept as low as reasonably achievable and at levels to ensure that workers do not receive doses in excess of limits given in DOE 5480.11.

- Proper security, radiological safety, and criticality safety requirements must be met in all storage areas. Criticality safety in all areas of the Hot Cell Facility is maintained by established load limits.

- Buildings 6580 and 6581 are provided with automatic fire protection sprinkler systems throughout, except the Ventilation Zone 1 SCBs and Ventilation Zone 2A, where water sprinklers would create a hazard. Ventilation Zone 2A is equipped with manual and automatic nitrogen-inerting fire suppression systems. The Ventilation Zone 1 SCBs do not have fire suppression systems of any kind but they do have inherent fire dampers between the SCBs and the rest of the Hot Cell Facility due to their heavy, steel-wall construction. In addition, the low ventilation flow rate through the SCBs and the relatively small box size will limit the oxygen available to sustain an SCB fire.

Hazards associated with handling or storage of radiological materials in the facilities associated with the Hot Cell Facility cannot be fully characterized because the material and the handling and storage operations vary. The hazards for handling and storage of radiological materials are characterized when such operations are planned.

The basic hazards of radiological material handling and storage include the direct exposure to radiation. In addition, some release of radioactive material could occur if the sealed packaging of the material were breached by an accident. These hazards include direct radiation exposure and immersion, inhalation, and ingestion radiation dose. The detailed techniques used to mitigate these hazards for a particular storage or handling operation are undefined, but certain common mitigation techniques will probably be examined for the particular operation. These mitigation techniques include shielding from transfer casks and shielded work areas during specific operations. Operating procedures for the radioactive material handling and storage must be designed to prevent accidents that could breach the radioactive material package or preclude or mitigate radioactive releases.

(Miller, 1998; Restrepo and Saloio, 1995)

7.6 Accident Analysis Summary

The Hot Cell Facility is currently in transition to isotope production capability and has been essentially decontaminated, and equipment has been removed in preparation for the modifications necessary to produce Mo-99 at levels near 100 percent of the U.S. demand. The modified Hot Cell Facility will be configured essentially as described in this document.

Because the Hot Cell Facility will primarily conduct repetitive production activities, the specific hazards can be readily identified as corresponding to the activities, materials, facilities, and equipment of the production process for Mo-99.

Hot Cell Facility technical safety requirements or operating procedures will restrict operations to limit the hazard within safe bounds in accordance with production requirements. To provide consequence information and mitigation effectiveness for development of operational safety requirements and identification of safety-class structures, systems, and components, any accident analysis must develop the bounding accidents in a realistic analysis.

The bounding accidents defined to date are representative of a number of similar accidents of lesser risk and are described as follows.

- Cask breach, target released and damaged or breached during transfer from Annular Core Research Reactor to Hot Cell Facility outside (large direct high-dose field and airborne inhalation dose):
    - Causes include:
        - Forklift rolls or runaways (inattention, mechanical failure, or load shift).
        - Fork hydraulic failure with elevated load (maintenance, aging, or procedures).
        - Fork rams fixed object (inattention, brake failure).
        - Another vehicle strikes load (inattention, procedure violation).
    - Prevention features in the facility design include bolts on the lid and target cladding.
    - Administrative prevention features include:
        - Target transfer procedure.
        - Target cask loading procedure to ensure the lid is properly installed.
        - Forklift maintenance.
        - Trained forklift operators.
    - Frequency is $10^{-4} > F \geq 10^{-6}$.

- Mitigative features include:
  - Emergency operating procedures.
  - Access control.
  - Majority of workers located a significant distance from cask route.
  - Distance to site boundary and area fence.
- Unmitigated consequences include direct exposure and airborne release doses.

- Release of volatiles in an extraction SCB (in-process targets and stored Cold Finger [CF] 1s and CF2s) from multiple breach of targets and CFs (Note: Also applies to all extraction SCBs simultaneously with frequency < 10^{-6}):
  - Causes include:
    - Operator error or inadvertent opening.
    - Failure of fittings or mechanical fatigue.
    - Fire in the SCB that breaches targets and CFs and releases volatiles.
    - External forces applied to the SCB (natural phenomena or external events).
  - Prevention features in the facility design include:
    - Mechanical properties of targets and CFs.
    - Well-designed fittings and holding fixtures.
    - Structural integrity of the SCB.
  - Administrative prevention features include:
    - Operating procedures.
    - Training.
    - Minimization of ignition sources.

- Frequency is $10^{-4} > F \geq 10^{-6}$.
- Mitigative features in the facility design include:
  - Ventilation flow.
  - Stack height.
  - Shielding.
  - Distance to site boundary.
- Administrative mitigative features include EOPs and minimization of combustible material.
- Unmitigated consequences include the release of entire volatile extraction SCB in-process inventory (noble gases, halogens, and some matrix material) into SCB (several targets and charged CFs).

- Overpressure in extraction SCB and nitrogen release during processing:
  - Causes include:
    - Regulator connection failure.
    - Operator error.
    - Uncontrolled release from process LN2.
    - Line break (spontaneous or external forces).
  - Prevention features in the facility design include the LN2 regulator system .
  - Administrative prevention features include operating procedures and training.
  - Frequency is $1 > F \geq 10^{-2}$.
  - Mitigative features in the facility design include:
    - Ventilation flow.
    - SCB blowout panels.
    - Shielding.
    - Sealed penetration.
    - Stack height.
    - Distance to site boundary.

- Administrative mitigative features include EOPs.

- Unmitigated consequences include release of loose contamination into Ventilation Zone 2A and up ventilation systems (Ventilation Zone 1 and Ventilation Zone 2A) and possible release through manipulator boots.

- Mo-99 product spill in Ventilation Zone 2 (DU shield, 2R, and plastic bottle breach):

  - Causes include operator error and mechanical failure of package handling equipment.

  - Prevention features in the facility design include the plastic bottle in the metal 2R and DU shield for double containment and shielding.

  - Administrative prevention features include:

    - Operations procedures.

    - Maintenance of handling equipment.

  - Frequency is $10^{-4} > F \geq 10^{-6}$.

  - Mitigative features in the facility design include ventilation flow in zones to stack.

  - Administrative mitigative features include access control.

  - Unmitigated consequences include direct exposure and airborne release doses.

- Explosion and fire in Room 113 SGB (product extract sample):

  - Causes include an improper chemical mixture in SGB.

  - Administrative mitigative features include access control.

  - Prevention features in the facility design include contents-labeling of chemicals and glassware.

  - Frequency is $10^{-4} > F \geq 10^{-6}$.

  - Administrative prevention features include operations procedures.

  - Unmitigated consequences include airborne dose.

  - Mitigative features in the facility design include ventilation flow that limits the inhalation hazard and limited combustibles.

- Release of volatiles stored in the cold trap in an SCB (maximum radionuclide inventory in the cold trap) from a breach of confinement barriers and warming of the cold trap:
  - Causes include:
    - Major mishandling event during waste box operations.
    - Major fire that breaches confinement barriers and releases volatiles.
    - External forces applied to the SCB (natural phenomena or external event).
  - Prevention features in the facility design include:
    - Mechanical properties of the cold trap and other barriers.
    - Well-designed fittings and holding fixtures.
    - Structural integrity of SCBs.
  - Administrative prevention features include:
    - Operating procedures.
    - Training.
    - Minimization of ignition sources.
  - Frequency is $10^{-4} > F \geq 10^{-6}$.
  - Mitigative features in the facility design include:
    - Ventilation flow.
    - Stack height.
    - Shielding.
    - Distance to the site boundary.
  - Administrative mitigative features include EOPs and minimization of combustible material.

- Unmitigated consequences include the release of the entire volatile cold trap inventory (volatiles from multiple targets) into the Ventilation Zone 1 ventilation system.

- Accidental exposure to scattered radiation from the Ventilation Zone 2A waste inventory with the elevator up or in transit to Room 109 waste storage area:

  - Causes include a failed elevator (hydraulic) and inadvertent entry to the Ventilation Zone 2A airlock entry area in Room 112.
  - Prevention features in the facility design include the backup cage and motor and the Ventilation Zone 2A airlock, which eliminates line of sight to the source and reduces escape of scattered radiation.
  - Administrative prevention features include the Hot Cell Facility operating procedure.
  - Administrative mitigative features include access control.
  - Mitigative features in the facility design include the Ventilation Zone 2A shield walls and the distance from the source to workers.
  - Unmitigated consequences include radiation scattered out of Ventilation Zone 2A airlock, which causes a local high dose rate at the airlock entrance.
  - Frequency is $1 > F \geq 10^{-2}$.

- Exposure of fresh waste drum inventory to workers in Room 112 through Ventilation Zone 2A airlock doors while storing waste in row 5 of 109:

  - Causes include the fall of a waste drum from a cart toward airlock door (inattention, mechanical failure, or load shift).
  - Prevention features in the facility design include floor rails to guide the waste cart, and mounting rings on the cart and rack for the upper drum level that holds drums on cart.
  - Administrative prevention features include the Hot Cell Facility operating procedure.
  - Frequency is $1 > F \geq 10^{-2}$.
  - Mitigative features in the facility design include the Ventilation Zone 2A shield walls and the distance through Ventilation Zone 2A airlock.
  - Administrative mitigative features include access control.

- Unmitigated consequences include direct exposure to a high dose rate at the Ventilation Zone 2A airlock entry.

- Explosion in the elevator pit with waste drums in the pit:
  - Causes include LEL for H_2 exceeded.
  - Frequency is $10^{-4} > F \geq 10^{-6}$.
  - No prevention features exist in the facility design.
  - No administrative prevention features exist.
  - No mitigative features in the facility design currently exist.
  - No administrative mitigative features currently exist.
  - Unmitigated consequences include the potential for facility damage and worker injury or fatality.
  -

- Explosion in Room 109 followed by a fire (no doors open):
  - Causes include H_2 ignition.
  - Prevention features in the facility design include the ventilation and size of the room, and insufficient H_2 accumulation.
  - No administrative prevention features exist.
  - Frequency is $10^{-4} > F \geq 10^{-6}$.
  - Mitigative features in the facility design include:
    - Low volatility of material.
    - Metallic containers.
    - Door and wall thickness to shield.
  - Administrative mitigative features include access and inventory control and EOPs.

- Unmitigated consequences include the potential for facility damage and worker injury and airborne release.

- Exposure of inventory (both doors to Room 108 open as a worker enters Room 108):

    - Causes include a problem with the seals and human error.
    - No administrative prevention features exist.
    - Administrative mitigative measures include access control.
    - Frequency is $1 > F \geq 10^{-2}$.
    - No prevention features in the facility design exist.
    - No mitigative features exist in the facility design.
    - Unmitigated consequences include high radiation dose.

The accident analysis would include the categories of operational accidents (for example, fires, explosions, exposure, and spills), natural phenomena (for example, earthquakes), and external events (for example, a plane crash). The bounding accidents described above should also be described more completely for the analysis.

Radioisotope inventories used in the analysis would be those resulting from the isotope production process. Irradiated isotope fission production targets are the source of all radioactive material in the Hot Cell Facility. The fission products comprise the largest category of radioactive material and the largest radiological hazard. Fission products can be divided into subgroups that define their release and transport characteristics in the event of a release from confinement in process hardware. The subgroups used are noble gases, halogens, and other fission products.

Radioisotope inventories from the production targets that were used in the modified Hot Cell Facility design are the standard production U-235 loading, target fission power, and irradiation time. The accident analysis would also examine the effect on accident radiation dose resulting from certain limited variations from the standard target irradiation parameters.

7.7 Reportable Events

Table 13-74 lists the occurrence reports for the Hot Cell Facility over the past five years.

Table 13-74. Occurrence Reports for the Hot Cell Facility

Report Number	Title	Category	Description of Occurrence
ALO-KO-SNL-6000REACT-1993-0002	Personnel Contamination in Hot Cell Facility	4B	A plastic bag and vial failed during a transfer of irradiated fuel samples.
ALO-KO-SNL-6000REACT-1993-0004	Radioactive Material Contamination Discovered Outside of a Controlled Area	1D	A contaminated drain screen was found beneath a floor drain gate.
ALO-KO-SNL-6000REACT-1993-0003	Failure to Follow Procedures for Special Nuclear Material (SNM) Load Limit	1A	A storage cabinet with a 700-g limit was found to contain 717 g of U-235.
ALO-KO-SNL-6000REACT-1994-0001	A Previously Unrecognized Radiological Area Was Identified	10C	Two maintenance workers received measurable radiation exposure while working above a steel containment box.
ALO-KO-SNL-6000REACT-1995-0001	Violation of Technical Safety Requirements - Fire Protection System Inspection	1C	A six-month fire protection system inspection was found delinquent.
ALO-KO-SNL-6000REACT-1995-0004	Inadequate USQD Procedure Design Discovered During Unsatisfactory Factory Inspections	1G	A higher than expected drop across a charcoal absorber revealed an unidentified change in a system component.
ALO-KO-SNL-6000REACT-1995-0006	Inadequate Procedure and Failure to Require Radiological Protection Pre-Job Survey	1F	Three people were contaminated, two of them internally, below threshold reporting levels due to inadequate survey procedures.
ALO-KO-SNL-9000-1996-0002	Unauthorized Entry into a Radiological Controlled Area	3C, 10B and 10C	A steel confinement box was entered prior to completing the confined space requirements.
ALO-KO-SNL-9000-1996-0004	Violation of Procedures for Access Control and Hot Cell Facility Access Instruction	1F	An individual failed to recognize and adhere to radiological postings.
ALO-KO-SNL - 9000-1996-0005	Non-PPE Clothing Contamination at Hot Cell Facility Frisk Out Station	4B	A worker’s shirt was contaminated by a radioactive particle.
ALO-KO-SNL - 9000-1996-0007	Radiation Worker Received a Discrete Particle on Personal Clothing Resulting in Personnel Contamination	4B	An electrician’s clothing was contaminated while he was working on a switch box that had been surveyed and declared noncontaminated.
ALO-KO-SNL-9000-1996-0008	Radiation Worker Received Skin Contamination	4B	A worker was contaminated by highly water-soluble contaminates, through his PPE, while working under thermal stress.
ALO-KO-SNL-9000-1997-0002	Unsatisfactory Surveillance Resulting From Equipment Service Needs, Maintenance and Modification Activities	1G	Several redundant systems failed revealing inadequate surveillance procedures.

Table 13-74. Occurrence Reports for the Hot Cell Facility (Continued)

Report Number	Title	Category	Description of Occurrence
ALO-KO-SNL-9000-1997-0005	Ozone Exposure Obtained During Plasma Torch Cutting Operation	3A	Ozone levels developed over the threshold limit value during a welding operation.
ALO-KO-SNL-NMFAC-1997-0008	Safety Concern Due to Subcontractor Personnel Working at Heights Without Proper Fall Protection	3C	Subcontractors were working at a 12-ft height without fall protection.

7.8 Scenarios for Impact Analysis

In all of the scenarios for impact analysis in this section, base year values are for FY1996 unless otherwise noted.

7.8.1 Activity Scenario for Development or Production of Devices, Processes, and Systems: Processing of Production Targets

7.8.1.1 Alternatives for Development or Production of Devices, Processes, and Systems: Processing of Production Targets

Table 13-75 shows the alternatives for processing of production targets at the Hot Cell Facility.

Table 13-75. Alternatives for Development or Production of Devices, Processes, and Systems: Processing of Production Targets

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
40 targets	8 targets	375 targets	375 targets	1,300 targets

7.8.1.2 Assumptions and Actions for the "Reduced" Values

Under the "reduced" alternative, the Hot Cell Facility would process the minimum number of targets required to maintain the facility, staff, processes, and material inventories needed to restart production activities on short notice. It is estimated that this would consist of the processing of approximately one target per week over 40 weeks or 40 targets per year. A 40-week operational year takes into account SNL/NM shutdown periods and individual personal leave schedules. This 40-week operational year applies only to the "reduced" alternative. All other alternatives assume a 52-week operational year.

The facilities associated with the Hot Cell Facility would be staffed, and their operational procedures would be kept up to date. Occasional activities would be performed to support those programs that require the capabilities of these facilities.

7.8.1.3 Assumptions and Rationale for the “No Action” Values

Under the “no action” alternative, the Hot Cell Facility would process approximately 30 percent of the U.S. demand for Mo-99 and other isotopes such as I-125, I-131, and Xe-133. This would require the processing of about seven irradiated highly enriched uranium targets per week (375 per year). The production needs may require varying scenarios that would range from periods of shutdown to periods of operation at 100 percent of the U.S. demand level (approximately 25 targets per week). However, it is anticipated that the annual total would not exceed approximately 1,300 targets processed in a particular year. The DOE has evaluated this program and has issued a record of decision that addresses production levels to meet the entire U.S. demand continuously at this facility (see U.S. Department of Energy, 1996).

The facilities associated with the Hot Cell Facility would be in use continuously for activities that fall within their operating parameters.

The base year estimate reflects the series of tests and experiments that were conducted in CY96. The FY2003 and FY2008 estimates assume that the SNL/NM medical isotope production program operates primarily as a backup (supplying 30 percent of the U.S. demand) to Nordion, Inc., the current supplier for the U.S. market.

7.8.1.4 Assumptions and Actions for the “Expanded” Values

Under the “expanded” alternative, the Hot Cell Facility would continuously process 100 percent of the U.S. demand for Mo-99 and other isotopes such as I-125, I-131, and Xe-133. This would require the processing of about 25 irradiated highly enriched uranium targets per week (1,300 per year). The DOE has evaluated this program and has issued a record of decision that addresses production levels to meet the entire U.S. demand continuously at this facility (see U.S. Department of Energy, 1996).

The shielded work area in Building 6597 would be in use continuously for activities that fall within its operating parameters.

7.8.2 Material Inventories

7.8.2.1 Nuclear Material Inventory Scenario for Enriched Uranium

7.8.2.1.1 Alternatives for Enriched Uranium Nuclear Material Inventory

Table 13-76 shows the alternatives for the enriched uranium inventory at the Hot Cell Facility.

Table 13-76. Alternatives for Enriched Uranium Nuclear Material Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
25 g	25 g	25 g	25 g	125 g

7.8.2.1.2 Operations That Require Enriched Uranium

The “no action” alternative assumes that one 25-g target is in process on a given day. After processing to remove the desired isotopes, the remaining U-235 is accounted for as waste rather than nuclear material.

7.8.2.1.3 Basis for Projecting the “Reduced” and “Expanded” Values

Under the “reduced” alternative, the “no action” assumptions are applied. The “expanded” alternative assumes that five targets are in process on a given day.

7.8.2.2 Radioactive Material Inventory Scenario for Mixed Fission Products

7.8.2.2.1 Alternatives for Mixed Fission Products Radioactive Material Inventory

Table 13-77 shows the alternatives for the inventory of mixed fission products at the Hot Cell Facility.

Table 13-77. Alternatives for Mixed Fission Products Radioactive Material Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
10,800 Ci	3,000 Ci	10,800 Ci	10,800 Ci	54,100 Ci

7.8.2.2.2 Operations That Require Mixed Fission Products

Mixed fission products are byproducts generated when the U-235 in the targets is fissioned to produce the desired isotopes.

The “no action” baseline value is based on experimental activities conducted in 1996 during prototype testing of the production process at SNL/NM. The “no action” FY2003 and FY2008 values are based on a single target being in process on a given day. After the desired isotopes are extracted from the target, the remaining mixed fission products are packaged as waste. These accumulated waste materials are accounted for as low-level waste rather than radioactive material inventory.

7.8.2.2.3 Basis for Projecting the “Reduced” and “Expanded” Values

The “reduced” alternative applies the same assumptions as the “no action” FY2003 and FY2008 values. The “expanded” alternative values are based on five targets in process on a given day. After the desired isotopes are extracted from the target, the remaining mixed fission products are packaged as waste. As discussed earlier, these accumulated waste materials are accounted for as low-level waste rather than radioactive material inventory.

7.8.2.3 Sealed Source Inventory Scenarios

The Hot Cell Facility has no sealed source inventories.

7.8.2.4 Spent Fuel Inventory Scenarios

The Hot Cell Facility has no spent fuel inventories.

7.8.2.5 Chemical Inventory Scenarios

7.8.2.5.1 Alternatives for Chemical Inventories

Table 13-78 shows the alternatives for chemical inventories at the Hot Cell Facility.

Table 13-78. Alternatives for Chemical Inventories

Chemical	Reduced Alternative	No Action Alternative			Expanded Alternative
		Base Year	FY2003	FY2008	
Chloroform	1 l	4 l	2 l	2 l	6 l
Ethyl acetate	1 l	4 l	2 l	2 l	6 l
Hydrochloric acid	0.5 l	0.5 l	1 l	1 l	3 l
Hydrogen peroxide 30%	0.5 l	0.5 l	1.5 l	1.5 l	4 l
Nitric acid	1 l	0.5 l	3 l	3 l	8 l
Sodium hydroxide, dry solid, flake, bead	6 kg	11.3 kg	12 kg	12 kg	15 kg
Sulfuric acid	1.5 l	0.5 l	5 l	5 l	15 l

7.8.2.5.2 Operations That Require Chemical Inventories

The programs and operations that utilize these chemicals are described in detail in “7.2 Description,” “7.3 Program Activities,” and 7.4 Operations and Capabilities.”

7.8.2.5.3 Basis for Projecting the Values in the “No Action” Columns

Baseline values for the chemicals listed in this table were obtained from the SNL Chemical Information System. The values for the no action alternatives were derived from process knowledge based on the assumptions described in “7.8.1 Activity Scenario for Development or Production of Devices, Processes, and Systems: Processing of Production Targets.”

7.8.2.5.4 Basis for Projecting the Values in the “Reduced” Column

The values for the “reduced” alternative was derived from process knowledge based on the assumptions described in “7.8.1 Activity Scenario for Development or Production of Devices, Processes, and Systems: Processing of Production Targets.”

7.8.2.5.5 Basis for Projecting the Values in the “Expanded” Column

The values for the “expanded” alternative was derived from process knowledge based on the assumptions described in “7.8.1 Activity Scenario for Development or Production of Devices, Processes, and Systems: Processing of Production Targets.”

7.8.2.6 Explosives Inventory Scenarios

The Hot Cell Facility has no explosives inventories.

7.8.2.7 Other Hazardous Material Inventory Scenarios

The Hot Cell Facility has no inventories of hazardous materials that do not fall into the categories of nuclear or radioactive material, sealed sources, spent fuel, explosives, or chemicals.

7.8.3 Material Consumption

7.8.3.1 Nuclear Material Consumption Scenario for Enriched Uranium

7.8.3.1.1 Alternatives for Enriched Uranium Consumption

Table 13-79 shows the alternatives for enriched uranium consumption at the Hot Cell Facility.

Table 13-79. Alternatives for Enriched Uranium Consumption

Reduced Alternative		No Action Alternative						Expanded Alternative	
		Base Year		FY2003		FY2008			
0 pkgs	1.0 kg	0 pkgs	0.2 kg	0 pkgs	9.4 kg	0 pkgs	9.4 kg	0 pkgs	32.5 kg

7.8.3.1.2 Operations That Require Enriched Uranium

Under the “no action” base year, 0.2 kg of 93 percent enriched uranium was utilized for production experiments and is now considered to be waste. The “no action” FY2003 and FY2008 values assume that 375 targets, each containing approximately 25 g of U-235, are consumed each year and declared as waste.

7.8.3.1.3 Basis for Projecting the “Reduced” and “Expanded” Values

The “reduced” alternative assumes that 40 targets, each containing approximately 25 g of U-235, are consumed each year and declared as waste. The “expanded” alternative assumes that 1,300 targets, each containing approximately 25 g of U-235, are consumed each year and declared as waste.

7.8.3.2 Radioactive Material Consumption Scenarios

Radioactive material is not consumed at the Hot Cell Facility.

7.8.3.3 Chemical Consumption Scenarios

Information initially provided for this section resides in the Facility Information Manager database and will be made available to the analysts responsible for preparing the sitewide environmental impact statement.

7.8.3.4 Explosives Consumption Scenarios

Explosives are not consumed at the Hot Cell Facility.

7.8.4 Waste

7.8.4.1 Low-Level Radioactive Waste Scenario

7.8.4.1.1 Alternatives for Low-Level Radioactive Waste at the Hot Cell Facility

Table 13-80 shows the alternatives for low-level radioactive waste at the Hot Cell Facility.

Table 13-80. Alternatives for Low-Level Radioactive Waste

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
270 ft^3	100 ft^3	2,200 ft^3	2,200 ft^3	5,000 ft^3

7.8.4.1.2 Operations That Generate Low-Level Radioactive Waste

Low-level radioactive waste is generated in the Hot Cell Facility during the processing of irradiated U-235 targets to remove desired isotopes such as Mo-99. Additional activities that generated low-level waste include quality control activities for product material and routine maintenance and decontamination activities.

7.8.4.1.3 General Nature of Waste

Low-level waste generated in the Hot Cell Facility includes glassware, plastic, and metal-containing materials (steel, copper, aluminum), concrete-stabilized liquids, personal protective equipment, and filters (HEPA filters and microfilters). The radionuclide inventory source includes the fission and activation products generated during a short irradiation period. While shorter-lived isotopes dominate the initial inventory, after a decay period the dominant isotopes are cesium (Cs-137), ruthenium-106 (Ru-106), strontium-90 (Sr-90), iron-55 (Fe-55), and uranium-234 (U-234).

7.8.4.1.4 Waste Reduction Measures

Where practical, launderable personal protective equipment is used.

7.8.4.1.5 Basis for Projecting the "Reduced" and "Expanded" Values

The waste volumes provided for the "reduced" alternative are based on the processing of four targets per year, or about one per operational week for the 40-week operational year. Assuming five targets per drum, the volume of process waste equals 60 ft^3. Additional waste volume (for example, personal protective equipment) equals 200 ft^3. Total predicted waste volume is 260 ft^3.

For the "expanded" alternative, waste volumes are based on the storage of 160 drums of process waste in Room 109 (100 percent capacity), or a total of 1,180 ft^3 of process waste.

Additional waste volume (for example, personal protective equipment) is 3,800 ft^3. Total predicted volume under this scenario is 5,000 ft^3.

For the base year (FY1996), volumes given are based on the processing (during testing) of eight targets. Volume of process waste is 25 ft^3. The volume of additional waste is 75 ft^3, for a total of 100 ft^3. This amount does not include any legacy decontamination waste.

For FY2003 and FY2008, the volumes given are based on the processing of 375 targets (30 percent of production capacity). The volume of process waste is 550 ft^3 (five targets per drum). Volume of additional waste (for example, personal protective equipment) is 1,650 ft^3. The total predicted volume is 2,200 ft^3.

7.8.4.2 Transuranic Waste Scenario

Transuranic waste is not produced at the Hot Cell Facility.

7.8.4.3 Mixed Waste

7.8.4.3.1 Low-Level Mixed Waste Scenario

Alternatives for Low-Level Mixed Waste at the Hot Cell Facility - Table 13-81 shows the alternatives for low-level mixed waste for the Hot Cell Facility.

Table 13-81. Alternatives for Low-Level Mixed Waste

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
5 ft^3	7 ft^3	17 ft^3	17 ft^3	40 ft^3

Operations That Generate Low-Level Mixed Waste - Low-level mixed waste is generated in the Hot Cell Facility during quality control assessment of product material and during routine maintenance activities (replacement of metal halide or sodium vapor bulbs).

General Nature of Waste - It is anticipated that the radionuclide inventory associated with the low-level mixed waste that will be generated will include the following main isotopes:

- Molybdenum-99 (Mo-99)
- Technetium-99 (Tc-99)
- Cesium-137 (Cs-137)
- Zirconium (Zr-95)
- Ruthenium-106 (Ru-106)

Other fission products will be present to lesser degrees.

Waste Reduction Measures - Nonhazardous solvents and other materials are used in routine decontamination activities whenever possible.

Basis for Projecting the "Reduced" and "Expanded" Values - The "reduced" scenario is based on the processing of 40 targets per year or about 1 per operational week. The predicted volume of low-level mixed waste is 5 ft^3.

The "expanded" scenario is based on the generation of a total 40 ft^3 (30 ft^3 of quality control waste and 10 ft^3 from maintenance).

The FY2003 and FY2008 scenarios are based on the generation of 7 ft^3 of mixed waste from quality control activities and 10 ft^3 from routine maintenance activities.

7.8.4.3.2 Transuranic Mixed Waste Scenario

Transuranic mixed waste is not produced at the Hot Cell Facility.

7.8.4.4 Hazardous Waste Scenario

7.8.4.4.1 Alternatives for Hazardous Waste at the Hot Cell Facility

Table 13-82 shows the alternatives for hazardous waste at the Hot Cell Facility.

Table 13-82. Alternatives for Hazardous Waste

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
7 ft^3	7 ft^3	14 ft^3	14 ft^3	22 ft^3

7.8.4.4.2 Operations That Generate Hazardous Waste

Routine maintenance activities occasionally result in the generation of hazardous waste, such as metal-containing oils, metal halide bulbs, sodium vapor lamps, batteries, or off-spec chemicals.

7.8.4.4.3 General Nature of Waste

See “7.8.4.4.2 Operations That Generate Hazardous Waste.”

7.8.4.4.4 Waste Reduction Measures

Whenever possible, nonhazardous materials are used.

7.8.4.4.5 Basis for Projecting the “Reduced” and “Expanded” Values

For the “reduced” alternative, routine maintenance activities associated with the processing of 40 targets per year result in the generation of 7 ft^3 (one drum) of hazardous waste. For the “expanded“ alternative, routine maintenance activities associated with the processing of 1,300 targets per year (100 percent of U.S. demand) result in the generation of 22 ft^3 of hazardous waste (three drums).

7.8.5 Emissions

7.8.5.1 Radioactive Air Emissions Scenarios

7.8.5.1.1 Radioactive Air Emission Scenario for I-131

Alternatives for I-131 Emissions at the Hot Cell Facility - Table 13-83 shows the alternatives for I-131 emissions at the Hot Cell Facility.

Table 13-83. Alternatives for I-131 Emissions

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0.117 Ci	0.00196 Ci	1.17 Ci	1.17 Ci	3.9 Ci

***Operations That Generate I-131 Air Emissions* -** The predominant Hot Cell Facility radiological air emissions result from the chemical separation of Mo-99 from irradiated fission targets.

The base year value represents FY96 actual values from the Hot Cell Facility stack monitoring system.

The “no action” FY2003 and FY2008 estimate for nobles was extracted from U.S. Department of Energy (1996) and multiplied by 0.3 (30 percent). The environmental impact statement estimate was not developed by SNL, and the document does not provide sufficient information to define the basis used to determine the estimate. However, the estimate is similar to the result obtained by calculation using ORIGEN2, assuming that 30 percent of the U.S. demand is met and that:

- 375 targets are processed per year.
- Each target is irradiated continuously with a target power of 21 kW for seven days.
- 10 percent of the noble gases in the target six hours after irradiation are released.

The “no action” 2003 and 2008 estimate for halogens was extracted from U.S. Department of Energy (1996) and multiplied by 0.3 (30 percent). The environmental impact statement estimate was not developed by SNL, and the document does not provide sufficient information to define the basis used to determine the estimate. However, the estimate is similar to the result obtained by calculation using ORIGEN2, assuming that 30 percent of the U.S. demand is met and that:

- 375 targets are processed per year.
- Each target is irradiated continuously with a target power of 21 kW for seven days.
- 10 percent of the halogens in the target six hours after irradiation are released.

- Three sets of charcoal filters are in place to capture the halogens.

- Each charcoal filter is conservatively assumed to be only 90 percent effective in halogen capture.

General Nature of Emissions **-** Emissions are primarily gaseous nobles and halogens. Although there are particulates emitted from the process, they will not be detectable due to the reduction measures.

Emission Reduction Measures **-** There are prefilters, HEPA filters, and charcoal banks in the ventilation system.

Basis for Projecting the "Reduced" and "Expanded" Values **-** The "reduced" estimate for nobles was extracted from U.S. Department of Energy (1996) and multiplied by 0.03 (3 percent, or approximately 40 targets per year). The environmental impact statement estimate was not developed by SNL, and the document does not provide sufficient information to define the basis used to determine the estimate. However, the estimate is similar to the result obtained by calculation using ORIGEN2, assuming that production capability is maintained and that:

- 40 targets are processed per year.

- Each target is irradiated continuously with a target power of 21 kW for seven days.

- 10 percent of the noble gases in the target six hours after irradiation are released.

The "reduced" estimate for halogens was extracted from U.S. Department of Energy (1996) and multiplied by 0.03 (3 percent, or approximately 40 targets per year). The environmental impact statement estimate was not developed by SNL, and the document does not provide sufficient information to define the basis used to determine the estimate. However, the estimate is similar to the result obtained by calculation using ORIGEN2, assuming that production capability is maintained and that:

- 40 targets are processed per year.

- Each target is irradiated continuously with a target power of 21 kW for seven days.

- 10 percent of the halogens in the target six hours after irradiation are released.

- Three sets of charcoal filters are in place to capture the halogens.
- Each charcoal filter is conservatively assumed to be only 90 percent effective in halogen capture.

The “expanded” estimate for nobles was extracted from U.S. Department of Energy (1996). This environmental impact statement estimate was not developed by SNL, and the document does not provide sufficient information to define the basis used to determine the estimate. However, the estimate is similar to the result obtained by calculation using ORIGEN2, assuming that 100 percent of the U.S. demand is met and that:

- 1,300 targets are processed per year.
- Each target is irradiated continuously with a target power of 21 kW for seven days.
- 10 percent of the noble gases in the target six hours after irradiation are released.

The “expanded” estimate for halogens was extracted from U.S. Department of Energy (1996). This environmental impact statement estimate was not developed by SNL, and the document does not provide sufficient information to define the basis used to determine the estimate. However, the estimate is similar to the result obtained by calculation using ORIGEN2, assuming that 100 percent of the U.S. demand is met and that:

- 1,300 targets are processed per year
- Each target is irradiated continuously with a target power of 21 kW for seven days.
- 10 percent of the halogens in the target six hours after irradiation are released.
- Three sets of charcoal filters are in place to capture the halogens.
- Each charcoal filter is conservatively assumed to be only 90 percent effective in halogen capture.

7.8.5.1.2 Radioactive Air Emission Scenario for I-132

Alternatives for I-132 Emissions at the Hot Cell Facility - Table 13-84 shows the alternatives for I-132 emissions at the Hot Cell Facility.

Table 13-84. Alternatives for I-132 Emissions

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0.3 Ci	0.000129 Ci	3.0 Ci	3.01.74 Ci	10.0 Ci

Operations That Generate I-132 Air Emissions **-** See “Operations That Generate I-131 Air Emissions,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

General Nature of Emissions **-** See “General Nature of Emissions,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

Emission Reduction Measures **-** See “Emission Reduction Measures.” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

Basis for Projecting the “Reduced” and “Expanded” Values **-** See “Basis for Projecting the 'Reduced' and 'Expanded' Values,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

7.8.5.1.3 Radioactive Air Emission Scenario for I-133

Alternatives for I-133 Emissions at the Hot Cell Facility - Table 13-85 shows the alternatives for the I-133 Emissions at the Hot Cell Facility.

Table 13-85. Alternatives for I-133 Emissions

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0.54 Ci	0.00951 Ci	5.4 Ci	5.4 Ci	18.0 Ci

Operations That Generate I-133 Air Emissions **-** See “Operations That Generate I-131 Air Emissions,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

General Nature of Emissions - See “General Nature of Emissions,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

Emission Reduction Measures **-** See “Emission Reduction Measures,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

Basis for Projecting the “Reduced” and “Expanded” Values **-** See “Basis for Projecting the 'Reduced' and 'Expanded' Values,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

7.8.5.1.4 Radioactive Air Emission Scenario for I-135

Alternatives for I-135 Emissions at the Hot Cell Facility **-** Table 13-86 shows the alternatives for I-135 at the Hot Cell Facility.

Table 13-86. Alternatives for I-135 Emissions

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0.33 Ci	0.00132 Ci	3.3 Ci	3.3 Ci	11 Ci

Operations That Generate I-135 Air Emissions **-** See “Operations That Generate I-131 Air Emissions,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

General Nature of Emissions **-** See “General Nature of Emissions,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

Emission Reduction Measures **-** See “Emission Reduction Measures,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

Basis for Projecting the “Reduced” and “Expanded” Values **-** See “Basis for Projecting the 'Reduced' and 'Expanded' Values.” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

7.8.5.1.5 Radioactive Air Emission Scenario for Kr-83m

Alternatives for Kr-83m Emissions at the Hot Cell Facility - Table 13-87 shows the alternatives for krypton-83m (Kr-83m) emissions for the Hot Cell Facility.

Table 13-87. Alternatives for Kr-83m Emissions

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
19.8 Ci	0.0000957 Ci	198.0 Ci	198.0 Ci	660.0 Ci

Operations That Generate Kr-83m Air Emissions **-** See “Operations That Generate I-131 Air Emissions.” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

General Nature of Emissions - See “General Nature of Emissions.” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

Emission Reduction Measures - See “Emission Reduction Measures.” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

Basis for Projecting the “Reduced” and “Expanded” Values - See “Basis for Projecting the 'Reduced' and 'Expanded' Values.” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

7.8.5.1.6 Radioactive Air Emission Scenario for Kr-85

Alternatives for Kr-85 Emissions at the Hot Cell Facility - Table 13-88 shows the alternatives for Kr-85 emissions for the Hot Cell Facility.

Table 13-88. Alternatives for Kr-85 Emissions

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0.019 Ci	0.00153 Ci	0.19 Ci	0.19 Ci	0.63 Ci

Operations That Generate Kr-85 Air Emissions - See “Operations That Generate I-131 Air Emissions,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.” The value for Kr-85 in Table 5-4 of U.S. Department of Energy (1996) appears to be an order of magnitude too high based on comparison of values calculated in ORIGEN2 relative to other krypton isotopes listed in the table. A typographical error is suspected. The values provided above have been corrected.

General Nature of Emissions - See “General Nature of Emissions,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

Emission Reduction Measures - See “Emission Reduction Measures,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

Basis for Projecting the “Reduced” and “Expanded” Values - See “Basis for Projecting the 'Reduced' and 'Expanded' Values,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.” The value for Kr-85 in Table 5-4 of U.S. Department of Energy (1996) appears to be an order of magnitude too high based on comparison of values calculated in ORIGEN2 relative to other krypton isotopes listed in the table. A typographical error is suspected. The values provided above have been corrected.

7.8.5.1.7 Radioactive Air Emission Scenario for Kr-87

Alternatives for Kr-87 Emissions at the Hot Cell Facility - Table 13-89 shows the alternatives for Kr-87 emissions for the Hot Cell Facility.

Table 13-89. Alternatives for Kr-87 Emissions

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
5.7 Ci	0.0294 Ci	57.0 Ci	57.0 Ci	190 Ci

Operations That Generate Kr-87 Air Emissions - See "Operations That Generate I-131 Air Emissions," of "7.8.5.1.1 Radioactive Air Emission Scenario for I-131."

General Nature of Emissions - See "General Nature of Emissions," of "7.8.5.1.1 Radioactive Air Emission Scenario for I-131."

Emission Reduction Measures - See "Emission Reduction Measures," of "7.8.5.1.1 Radioactive Air Emission Scenario for I-131."

Basis for Projecting the "Reduced" and "Expanded" Values - See "Basis for Projecting the 'Reduced' and 'Expanded' Values," of "7.8.5.1.1 Radioactive Air Emission Scenario for I-131."

7.8.5.1.8 Radioactive Air Emission Scenario for Kr-88

Alternatives for Kr-88 Emissions at the Hot Cell Facility - Table 13-90 shows the alternatives for Kr-88 emissions for the Hot Cell Facility.

Table 13-90. Alternatives for Kr-88 Emissions

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
48.0 Ci	0.527 Ci	480.0 Ci	480.0 Ci	1,600 Ci

Operations That Generate Kr-88 Air Emissions - See "Operations That Generate I-131 Air Emissions," of "7.8.5.1.1 Radioactive Air Emission Scenario for I-131."

General Nature of Emissions - See "General Nature of Emissions," of "7.8.5.1.1 Radioactive Air Emission Scenario for I-131."

Emission Reduction Measures - See "Emission Reduction Measures," of "7.8.5.1.1 Radioactive Air Emission Scenario for I-131."

Basis for Projecting the "Reduced" and "Expanded" Values - See "Basis for Projecting the 'Reduced' and 'Expanded' Values," of "7.8.5.1.1 Radioactive Air Emission Scenario for I-131."

7.8.5.1.9 Radioactive Air Emission Scenario for Xe-133

***Alternatives for Xe-133 Emissions at the Hot Cell Facility* -** Table 13-91 shows the alternatives for Xe-133 emissions for the Hot Cell Facility.

Table 13-91. Alternatives for Xe-133 Emissions

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
216.0 Ci	17.5 Ci	2,160.0 Ci	2,160.0 Ci	7,200.0 Ci

***Operations That Generate Xe-133 Air Emissions* -** See “Operations That Generate I-131 Air Emissions,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

***General Nature of Emissions* -** See “General Nature of Emissions,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

***Emission Reduction Measures* -** See “Emission Reduction Measures,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

***Basis for Projecting the “Reduced” and “Expanded” Values* -** See “Basis for Projecting the 'Reduced' and 'Expanded' Values,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

7.8.5.1.10 Radioactive Air Emission Scenario for Xe-133m

***Alternatives for Xe-133m Emissions at the Hot Cell Facility* -** Table 13-92 shows the alternatives for Xe-133m for the Hot Cell Facility.

Table 13-92. Alternatives for Xe-133m

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
10.2 Ci	0.768 Ci	102.0 Ci	102.0 Ci	340.0 Ci

***Operations That Generate Xe-133m Air Emissions* -** See “Operations That Generate I-131 Air Emissions,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

***General Nature of Emissions* -** See “General Nature of Emissions,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

Emission Reduction Measures **-** See “Emission Reduction Measures,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

Basis for Projecting the “Reduced” and “Expanded” Values **-** See “Basis for Projecting the 'Reduced' and 'Expanded' Values,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

7.8.5.1.11 Radioactive Air Emission Scenario for Xe-135

Alternatives for Xe-135 Emissions at the Hot Cell Facility - Table 13-93 shows the alternatives for Xe-135 emissions for the Hot Cell Facility.

Table 13-93. Alternatives for Xe-135 Emissions

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
207.0 Ci	14.7 Ci	2,070.0 Ci	2,070.0 Ci	6,900.0 Ci

Operations That Generate Xe-135 Air Emissions **-** See “Operations That Generate I-131 Air Emissions,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

General Nature of Emissions - See “General Nature of Emissions,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

Emission Reduction Measures **-** See “Emission Reduction Measures,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

Basis for Projecting the “Reduced” and “Expanded” Values **-** See “Basis for Projecting the 'Reduced' and 'Expanded' Values,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

7.8.5.1.12 Radioactive Air Emission Scenario for I-134

Alternatives for I-134 Emissions at the Hot Cell Facility - Table 13-94 shows the alternatives for I-134 emissions for the Hot Cell Facility.

Table 13-94. Alternatives for I-134 Emissions

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0.022 Ci	0 Ci	0.22 Ci	0.22 Ci	0.72 Ci

Operations That Generate I-134 Air Emissions - See “Operations That Generate I-131 Air Emissions,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

General Nature of Emissions - See Section 7.8.5.1.1.3, “General Nature of Emissions,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

Emission Reduction Measures - See “Emission Reduction Measures,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

Basis for Projecting the “Reduced” and “Expanded” Values - See “Basis for Projecting the 'Reduced' and 'Expanded' Values,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

7.8.5.1.13 Radioactive Air Emission Scenario for Xe-135m

Alternatives for Xe-135m Emissions at the Hot Cell Facility - Table 13-95 shows the alternatives for Xe-135m emissions for the Hot Cell Facility.

Table 13-95. Alternatives for Xe-135m Emissions

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
36 Ci	0.976 Ci	360 Ci	360 Ci	1,200 Ci

Operations That Generate Xe-135m Air Emissions - See “Operations That Generate I-131 Air Emissions,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.” The value for Xe-135m in Table 5-4 of U.S. Department of Energy (1996) appears to be more than an order of magnitude too high based on comparison of values calculated in ORIGEN2 relative to other xenon isotopes listed in the table. A typographical error is suspected. The values provided above have been corrected.

General Nature of Emissions - See “General Nature of Emissions,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

Emission Reduction Measures - See “Emission Reduction Measures,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

Basis for Projecting the “Reduced” and “Expanded” Values - See “Basis for Projecting the 'Reduced' and 'Expanded' Values,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.” The value for Xe-135m in Table 5-4 of U.S. Department of Energy (1996) appears to be more than an order of magnitude too high based on comparison of values calculated in ORIGEN2 relative to other xenon isotopes listed in the table. A typographical error is suspected. The values provided above have been corrected.

7.8.5.1.14 Radioactive Air Emission Scenario for Kr-85m

Alternatives for Kr-85m Emissions at the Hot Cell Facility **-** Table 13-96 shows the alternatives for Kr-85m emissions for the Hot Cell Facility.

Table 13-96. Alternatives for Kr-85m Emissions

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
29.0 Ci	0.587 Ci	290.0 Ci	290.0 Ci	970.0 Ci

Operations That Generate Kr-85m Air Emissions **-** See “Operations That Generate I-131 Air Emissions,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

General Nature of Emissions **-** See “General Nature of Emissions,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

Emission Reduction Measures **-** See “Emission Reduction Measures,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

Basis for Projecting the “Reduced” and “Expanded” Values **-** See “Basis for Projecting the 'Reduced' and 'Expanded' Values,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

7.8.5.1.15 Radioactive Air Emission Scenario for Xe-131m

Alternatives for Xe-131m Emissions at the Hot Cell Facility **-** Table 13-97 shows the alternatives for Xe-131m emissions for the Hot Cell Facility.

Table 13-97. Alternatives for Xe-131m Emissions

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0.18 Ci	0.000345 Ci	1.8 Ci	1.8 Ci	5.9 Ci

Operations That Generate Xe-131m Air Emissions **-** See “Operations That Generate I-131 Air Emissions,” of “7.8.5.1.1 Radioactive Air Emission Scenario for I-131.”

General Nature of Emissions - See "General Nature of Emissions," of"7.8.5.1.1 Radioactive Air Emission Scenario for I-131."

Emission Reduction Measures - See "Emission Reduction Measures," of "7.8.5.1.1 Radioactive Air Emission Scenario for I-131."

Basis for Projecting the "Reduced" and "Expanded" Values - See "Basis for Projecting the 'Reduced' and 'Expanded' Values," of "7.8.5.1.1 Radioactive Air Emission Scenario for I-131."

7.8.5.2 Chemical Air Emissions

Information on an extensive list of chemicals was obtained from the SNL/NM Chemical Inventory System (CIS). For the air emissions analysis, the entire annual inventory of these chemicals was assumed to have been released over a year of operations for each specific facility (i.e., the annual inventory was divided by facility operating hours). The emissions from this release were then subjected, on a chemical-by-chemical basis, to a progressive series of screening steps for potential exceedances of both regulatory and human health thresholds. For those chemicals found to exceed this screening, process knowledge was used to derive emission factors. The emission factors for these chemicals were then modeled using the U.S. Environmental Protection Agency's *Industrial Source Complex Air Quality Dispersion Model, Version 3*. The results of this modeling are discussed as part of the analysis in support of the SNL/NM site-wide environmental impact statement.

7.8.5.3 Open Burning Scenarios

The Hot Cell Facility does not have outdoor burning operations.

7.8.5.4 Process Wastewater Effluent Scenario

The Hot Cell Facility does not generate process wastewater.

7.8.6 Resource Consumption

7.8.6.1 Process Water Consumption Scenario

The Hot Cell Facility does not consume process water.

7.8.6.2 Process Electricity Consumption Scenario

The Hot Cell Facility does not consume process electricity.

7.8.6.3 Boiler Energy Consumption Scenario

The Hot Cell Facility does not consume energy for boilers.

7.8.6.4 Facility Personnel Scenario

7.8.6.4.1 Alternatives for Facility Staffing at the Hot Cell Facility

Table 13-98 shows the alternatives for facility staffing at the Hot Cell Facility.

Table 13-98. Alternatives for Facility Staffing

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
12 FTEs	12 FTEs	32 FTEs	32 FTEs	55 FTEs

7.8.6.4.2 Operations That Require Facility Personnel

The processing of targets for isotope production and the associated activities such as quality control, waste management, and packaging is very labor intensive. Under the "no action" base year, approximately 12 people staffed the Hot Cell Facility. Under the 30 percent production projected for the FY2003 and FY2008 timeframes, it is expected that an additional 20 FTEs will be required to process the projected number of targets.

7.8.6.4.3 Staffing Reduction Measures

This section is not applicable.

7.8.6.4.4 Basis for Projecting the "Reduced" and "Expanded" Values

The "reduced" alternative assumes that the staffing level will be the same as the "no action" base year levels. The "expanded" alternative would require a significant number of additional staff to process the projected number of targets. It is projected that, in addition to the normal Hot Cell Facility operations staff, approximately eight additional FTEs are required to process four targets per week. Hence, approximately 50 FTEs will be required to process 40 targets per week with an additional five people as to manage these operations.

7.8.6.5 Expenditures Scenario

7.8.6.5.1 Alternatives for Expenditures at the Hot Cell Facility

Table 13-99 shows the alternatives for expenditures for the Hot Cell Facility.

Table 13-99. Alternatives for Expenditures

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
$0	$0	$4 million	$0	$0

7.8.6.5.2 Operations That Require Expenditures

For Tech Area V facilities, SNL/NM has included only cost expenditures for projected major capital improvements. No labor costs are included in these estimates. During the no action base year timeframe, modifications to the Hot Cell Facility were being conducted but no major expenditures were made. Most of the cost associated with this activity was staff (FTE) costs. In the FY1998 to FY2000 timeframe, these modification activities will continue. It is estimated that $4 million will be spent for construction and material procurement in addition to the staff (FTE) costs to conduct these activities.

Expenditures for the FY2004 to FY2008 timeframe are for general maintenance of the facility.

7.8.6.5.3 Expenditure Reduction Measures

This section is not applicable.

7.8.6.5.4 Basis for Projecting the “Reduced” and “Expanded” Values

The “reduced” and “expanded” alternatives do not require significant expenditures beyond that addressed in the “no action” alternative.

8.0 REFERENCES

8.1 Regulations, Orders, and Laws

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49 CFR 173, *Shippers - General Requirements for Shipments and Packagings*.

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8.2 General References

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CHAPTER 14 - OUTDOOR TEST FACILITIES SOURCE INFORMATION

LIST OF TABLES

1.0 INTRODUCTION

SNL has constructed and operated test facilities as one of the technical activities to achieve its primary mission of ensuring that the nation's nuclear weapons systems meet the highest standards of safety and reliability. These facilities have been specifically designed for the validation of analytical modeling and the functional certification of weapons systems. Two of the five outdoor test facilities within the Coyote Test Field (CTF) are on the eastern portion of Kirtland Air Force Base (KAFB) in a 22,500-acre area of the Cibola National Forest that has been withdrawn from the public domain for the exclusive use of KAFB and DOE. They include the Aerial Cable Facility Complex and the Lurance Canyon Burn Site. Both of these facilities are situated in an area of high desert canyon surrounded by foothills. The remaining three facilities assigned to CTF are located outside of the withdrawn area. They include the Containment Technology Test Facility, the Explosives Applications Laboratory, and the Thunder Range Complex, all of which are located southeast of Tech Area III.

The operations and activities taking place in the CTF vary widely from facility to facility. However, all CTF capabilities fall into the basic categories of scientific research and development and various types of testing.

The Aerial Cable Facility Complex is a SNL/NM test facility for the precision testing of full-scale, air-deliverable weapon systems within realistic target engagement scenarios and for the verification of design and performance of weapon components. SNL/NM Energy Programs uses the Aerial Cable Facility Complex for transportation package certification and verification of transportation technology designs. The complex is the only known facility capable of demonstrating compliance with impact-related container test provisions of 10 CFR 71. DOE also uses this facility to support other research and development activities in the national interests.

The Lurance Canyon Burn Site includes a group of facilities within an area of about 220 acres in the easternmost part of the withdrawn area of CTF. Reinforced concrete pools are used for conducting open burn tests. Large objects are fire tested in a 30- by 60-ft concrete pool. This 36-inch deep pool can support test objects weighing up to 140 tons and accommodate objects as large as railroad cars. Intermediate-sized objects are fire tested in a 20-ft square steel pool, which has a metal test stand in the center flanked by two instrumentation towers. A number of smaller pools have also been built to meet other specific test requirements. Lurance Canyon Burn Site includes two enclosed fire testing facilities—the Small Wind Shield (SWISH), which is used for developing technology to reduce smoke and improve combustion control, and the Fire Laboratory for the Authentication of Models and Experiments (FLAME). These enclosed facilities are unique in the U.S. and were designed to meet Albuquerque/Bernalillo Air Quality regulations for visible air contaminants. Knowledge gained from operation of SWISH contributed to the design of the Smoke Emissions Reduction Facility (SMERF), a 10-foot square pool used for engulfing and conducting one-sided fire tests of intermediate-sized objects (5-ft diameter by 5-ft length).

The Containment Technology Test Facility includes two scale-model reactor containment buildings. One model is a 1:4 scale representation of a two-buttress, prestressed concrete containment structure with a flat concrete basement, cylindrical sides, and hemispheric dome, 25 ft in diameter by 43 ft in height. The other model is a 1:10 scale steel containment structure that is fabricated in Japan and shipped to SNL/NM for testing. The diameter of this model is approximately 10 ft, with an overall height of approximately 21 ft. All support facilities would be temporary and portable.

The Explosives Applications Laboratory is used for the design, assembly, and testing of explosive experiments in support of SNL-wide programs. SNL/NM needs the Explosives Application Laboratory to support the Nuclear Emergency Search Team, field test arming and fusing, incendiary warhead development, and emergency destruct systems.

The Thunder Range Complex has been used from 1969 through 1993; however, testing activity declined substantially during the early 1990s. The last test at the complex was conducted during the third quarter of 1993. Since 1995, The Thunder Range Complex has been used to support the disassembly and evaluation of special items and siting for radar studies. The Thunder Range Complex has a combination of essential resources that are unavailable at any other SNL/NM location. These include:

- Conductive floors and grounding provisions for explosives handling.
- Bunkers for explosives storage.
- Alarms and security provisions for “vault classification,” which allows for classified work.
- Established explosive quantity distance boundaries.
- A rating for handling up to 4,000 pounds of explosive material.

Although the facility has these capabilities and although some special test items may occasionally contain explosive material, the Thunder Range Complex is not currently used for explosive testing.

2.0 AERIAL CABLE FACILITY COMPLEX SOURCE INFORMATION

2.1 Purpose and Need

The Aerial Cable Facility Complex is an SNL/NM test facility for precision testing of full-scale, air-deliverable weapon systems to realistic target engagement scenarios for verification of design integrity and performance. It is also used by SNL/NM Energy Programs for transportation package certification and for verification of designs in transportation technology. The Aerial Cable Facility Complex is the only known facility capable of demonstrating compliance with impact-related container test provisions of 10 CFR Part 71.

The DOE needs the Aerial Cable Facility Complex to support research and development activities in the national interests on an as-available basis for:

- Precision testing of airborne sensors and sensor-fuzed weapons systems suspended in a stable platform above the ground targets.

- Precision testing of ground-based sensors and target acquisition devices directed against captive flight of simulated aircraft and aircraft targets traversing the facility cableways.

(West, 1995)

2.2 Description

The Aerial Cable Facility Complex consists of a number of cables spanning Sol Se Mete Canyon, which is located in the eastern portion of KAFB on a 22,500-acre area of the Cibola National Forest that has been withdrawn from the public domain for the exclusive use of KAFB and DOE. Access to the facility is restricted except for authorized visitors and employees. The distance to the nearest residential housing is approximately 6 mi.

The original aerial cable, installed in 1970, was a 1 3/8-in. wire rope that spanned the 5,000- ft canyon. The maximum height above the valley floor of 600 ft could achieve gravitational accelerated velocities of up to 190 ft per second.

A rocket sled track was constructed to employ a rocket pull-down technique that could achieve impact velocities up to 800 ft per second as part of the initial installation. The rocket pull-down technique utilizes towing cables that transmit accelerating forces from rocket sleds through turning sheaves at the impact point to the test items suspended from the overhead cable. The test items are released from the overhead cable as the rockets are ignited. The towing cables are explosively cut just prior to the collision of test items with the target.

A number of target positions can be utilized in the test arena under the overhead cable. Oblique impacts are achieved by positioning the release point on the overhead cable relative to the ground impact point. In 1985, an unyielding target was constructed in the test arena to provide impact characteristics that would simulate worst-case scenarios for shipping container accidents.

An early secondary use of the aerial cable was the testing of a missile warning receiver, decoys, and jammers. Test hardware is installed in trolleys that traverse the cable in captive flight. Threat missiles, launched at various ranges from the cable, are tracked by laser tracker while the warning receiver, decoy, or jammer response is recorded relative to the threat missiles' positions as determined by the laser tracker.

To accommodate a substantial increase in captive flight testing, a second, smooth track cable was installed in 1974, to eliminate the vibration generated by the trolley sheaves rolling over the original braided cable. Located parallel to the original cable (approximately 100 ft to the south), this cable was later replaced with a 2.5-in. Kevlar rope as a prototype of the White Sands Aerial Cable. Technology for that installation is developed by SNL on this prototype.

A second arena, with two aerial cables, was installed in the canyon approximately 500 ft north of the original arena. This arena is for testing anti-tank submunitions. Target tanks, required for these test, were compromising other testing in the original arena.

The Aerial Cable Facility Complex also includes the following buildings and structures:

- Building 9831 (primary control building)
- Building 9832 (explosives assembly, and rocket motor staging and assembly)
- Building 9834 (instrumentation bunker and secondary control center)
- Structure 9020 (explosives storage magazine)
- Structure 9027 (explosives storage magazine)
- Explosives storage igloos within Building 9832 yard

(West, 1995)

2.3 Program Activities

Table 14-1 shows the program activities at the Aerial Cable Facility Complex.

Table 14-1. Program Activities at the Aerial Cable Facility Complex

Program Name	**Activities at the Aerial Cable Facility Complex**	**Category of Program**	**Related Section of the *SNL Institutional Plan***
Direct Stockpile Activities	Conduct environmental, safety, and survivability testing for nuclear weapon applications.	Programs for the Department of Energy	Section 6.1.1.1
Special Projects	The DOE/DoD Memorandum of Understanding is a cooperative, jointly funded research and development effort between the DOE and DoD to exploit and transfer the technology base resident at the DOE national laboratories for the development of advanced, cost-effective, nonnuclear munitions. Areas of mutual interest to DOE and DoD include the reduction of operational hazards associated with energetic materials, advanced initiation and fuze development, munitions lifecycle engineering, hard target penetration, and computer simulation.	Programs for the Department of Energy	Section 6.1.1.1
Performance Assessment Science and Technology	Provide full-scale, highly instrumented impact environments, aircraft crash environments, and captive flight and missile intercept simulation. Provide elevated hoisting capability for advanced sensor development and parachute testing.	Programs for the Department of Energy	Section 6.1.1.1
Sustaining Critical Progress in Model Validation	Provide controlled environment for high-velocity experiments to support code validation such as penetrator performance in frozen soil.	Major Programmatic Initiatives	Section 7.1.3
Other Federal Agencies	Perform aerial target and drop/pull down tests.	Work for Non-DOE Entities (Work for Others)	Section 6.2.7

2.4 Operations and Capabilities

Operations at the Aerial Cable Facility Complex include free-fall drop, rocket pull-down, and captive flight tests, which involve the following support activities:

- Receiving, storage, and handling of explosives, pyrotechnics, and propellants
- Explosives ordnance disposal
- Assembly of rocket sleds and test items
- Photometrics
- Hazard area control
- Transporting test items to test arenas
- Transporting explosives to test arenas or launch sites
- Artillery operations
- Abort procedures
- Misfire procedures
- Receiving, storage, and handling of nuclear, radioactive, and chemical materials
- Suspended cable operations (rigging, hoisting, and winch operations)
- Electronic instrumentation and data recording
- Laser tracking
- Telemetry
- System checking of fire-control systems
- Air-to-ground ordnance testing
- Radioactive and chemical material recovery
- Ground-to-air missile launches
- Explosive arming and firing
- Post-launch procedures

The Aerial Cable Facility Complex has the capability of conducting 100 tests per year.

2.4.1 Impact Tests

Test articles are gravity-accelerated or pulled down by rockets from an overhead cable to collide with specific targets in the test arena. Impact velocities are controlled by modeling trajectories by computer. The models determine rocket motor impulse and release position on the cable relative to the impact point that will yield the desired impact velocities and angles. Response data are telemetered from the test articles to ground station recorders. Target response data are recorded directly through hard wire. Impact events are recorded by high-speed framing cameras. The rocket sleds are expendable and collide into a catch box at the end of the track.

Periodically, drop tests of joint test assemblies containing hazard category 1 amounts of fissionable material are conducted at the Aerial Cable Facility Complex. The material is typically weapons-grade uranium-235 (U-235) or plutonium-239 (Pu-239) contained in a live-pit or live-secondary configuration with mock high explosives. The identity of any of these nuclear explosives-like assemblies is “inert with live pit.”

The impact testing of a newly configured test article involves drop testing of joint test assemblies that contain depleted uranium (DU), enriched uranium, and insensitive high explosives. The test article is designed using insensitive high explosives because of the material's low probability of detonation under test conditions. In addition, the nuclear material contained in the test devices is configured to prevent a criticality event. The explosives and special nuclear materials are not configured in a way that could produce any nuclear yield, and the weapon cases are designed not to break on impact. In the extremely unlikely event of insensitive high explosives detonation, nuclear material would likely scatter and require retrieval from the surface.

2.4.2 Air-to-Ground Ordnance Testing

"Smart munitions" for military air delivery, which can "recognize" a predesignated ground target and home in on the target until firing, are suspended at a height and attitude that simulates air delivery. Special targets that present the desired profile to the smart sensors are deployed in the test arena below the aerial cable. The targets can be standard military vehicles (such as tanks, weapons carriers, or trucks) or structural targets (such as buildings, igloos, bridges, roads, or runways). Full-effects, target-penetration tests are sometimes performed by using live warheads on the munitions. For most tests, however, only the fuze is live to provide proof of firing. Some munitions packages contain multiple warheads that deploy independently and that can engage separate targets. Impact detonations from these multi-warhead arrays create a large fragment area in the target arena.

2.4.3 Captive-Flight Testing

Trolleys traverse an aerial cable in simulated flight to test airborne sensors such as missile warning receivers. Threat missiles are launched to engage the target trolleys at a predetermined position on the cable. Computer modeling of the engagement determines the launch time of the missiles relative to their slant distance to the intercept point and the velocity of the trolley. Missile jammers are deployed, and decoys such as flares are dispensed from moving trolleys to evaluate their effectiveness against heat-seeking threat missiles.

Trolleys roll across the cable tramway on sheaves. They are either gravity- or rocket-accelerated. Low-speed trolleys are allowed to roll up the cable catenary and stop before reaching the end of the cable. However, braking systems, which usually incorporate disc brakes, are require for stopping high-speed trolleys. Again, computer modeling of the trajectory determines such parameters as release point on the cable, rocket impulse, and braking pressures. Trolleys are usually rectangular containers for mounting the avionics being tested. However, they may be a surrogate or actual aircraft when the engagement scenario requires.

Stationary platforms support sensors that scan the ground for target recognition. The platforms can be equipped with auxiliary equipment, such as spin tables to rotate the sensors at design scanning rate. Scoring systems are suspended from cables to evaluate their ability to measure miss distances to passing missiles and shells.

Performance data are recorded on board or transmitted by telemetry from moving trolleys. Data from stationary platforms may be transmitted via hard wire to ground recorders. Video and motion picture photography record test events, and missile and shell trajectories are recorded by laser trackers.

2.4.4 Missile Launches

Missiles are launched on intercept trajectories with targets on the aerial cable to evaluate another device, as described above. However, a logical follow-on to those tests was missile launches for the evaluation of missile performance. The types of missile tests include:

- Tests of unguided missiles on ballistic trajectories.
- Tests of guided missiles that utilize several techniques for tracking, lock-on, and guidance toward the target.

2.4.5 Artillery Operations

The 20-mm, 3-in., 105-mm, and 155-mm guns fire shells at planned miss distances to sensors or scoring systems suspended from a cable. All of these guns have been modified for remote firing. They are military configurations usually consisting of guns on fixed stands, portable mounts, or mobile carriers. All projectile warheads are inert.

(West, 1995)

2.5 Hazards and Hazard Controls

Hazardous operations at the Aerial Cable Facility Complex include:

- Storage, handling, assembly, transporting, and testing of rocket motors and explosive devices.
- Use of missiles and artillery (with inert projectiles) that have the potential to become lethal projectiles or generate test debris of various sizes and velocities.

2.5.1 Offsite Hazards to the Public and the Environment

Missile and artillery projectiles have sufficient energy and range to present hazards to people who are anywhere in the downrange impact area, and hot missile debris can result in brush fires in the downrange impact area.

2.5.2 Onsite Hazards to the Environment

Test operations at the Aerial Cable Complex have introduced small amounts of hazardous waste materials into the air and soil of the surrounding area:

- Rocket motors for pull-down tests have emitted lead compounds and unburned particles of propellants.

- Weaponized test units that have broken open on impact have spread small quantities of lead, beryllium, and depleted uranium on two occasions. Although most of these metals have been collected and properly disposed of after each test, small particles that slowly migrate downward into the soil and move down the arroyo paths during rain runoff could possibly remain. However, a post-environmental restoration (ER) survey revealed that a "subsequent gamma survey at 100% coverage in 1994 indicated no elevated radiation at the site, except for 4 areas of naturally occurring geologic materials (rock outcrops) which were left in place. RPO conducts 100% surveys of test materials/waste if DU is used new" (Vigil, 1998).

Subsequent gamma surveys indicated no elevated radiation at the site, except for four areas of naturally occurring geologic material (rock outcrops), which were left in place. Therefore, RMMA #ER-81 has been abolished.

2.5.3 Onsite Hazards to Workers

Hazardous materials currently in use at the Aerial Cable Facility Complex include but are not limited to the following:

- Explosive materials
- Compressed gases
- Various other materials used in small quantities
- Laboratory chemicals
- Radioactive material

2.5.3.1 Chemical Materials

2.5.3.1.1 Hazards

Small amounts of chemicals are used in assembling rocket sleds and test payloads in Building 9832. For example, various adhesives and epoxies are used to fasten transducers and similar items. Cleaners, lubricants, solvents, paints, and agents that might be used in small quantities include the following:

- Alcohol
- Ampex head cleaner
- Epoxy
- Ethyl alcohol
- Isopropyl alcohol
- Methyl alcohol
- Lithium grease
- RTV

2.5.3.1.2 Hazard Controls

Chemical usage is small. Chemicals are in 1-gal containers or less. Standard procedures outlined in the Sandia National Laboratories (1999a) dictate that the amount of chemicals present in the assembly areas at any one time be limited to the minimum amount needed for the performance of the work. All chemicals are stored in approved chemical storage cabinets when not being used.

Air-to-ground ordnance testing involves hazards associated with the explosives in the munitions package deployment system and the explosives in the deployed warheads. Warheads containing high explosives present highly lethal hazards to personnel from blast and shrapnel. Unexploded ordnance remaining after a test presents a particularly severe hazard to recovery personnel.

Radioactive materials associated with testing at the Aerial Cable Facility Complex include:

- Depleted uranium is often contained in weaponized test assemblies to simulate the weight, mass properties, and other physical characteristics of fissionable material in nuclear weapons.
- Uranium alloys, which are used in mock weapon structures and which are nonfissionable.
- Thorium coatings of low specific activity are on optical lenses.

- Thorium metal alloys (such as magnesium thorium) and compounds are typically only a few percent thorium and are very weakly radioactive.

- Tritium, which is usually in the form of a solid substrate with the tritium gas adsorbed in a nonvolatile form. When the gaseous form of tritium must be simulated in a test unit, nonradioactive deuterium is always used.

- Fissionable materials in a Category 1 amount in weaponized test assemblies, as discussed in “2.4 Operations and Capabilities.” The expectation is that the sitewide environmental impact statement analysis will show a small risk, because risk is taken to be the “product of accident probability and consequence” (usually done qualitatively). Even though the consequence of an accident could be great, the probability of the event is very small, and therefore the risk is small.

Beryllium is also used in mock weapon test units in pure metallic form and in beryllium alloys such as beryllium-tin and beryllium-bronze combinations.

Small amounts of chemicals, including cleaners, lubricants, adhesives, and paints, are used for assembly of test fixtures, test payloads, and rocket sleds. Chemicals are stored in fire-resistant chemical cabinets in Building 9831 and in the Building 9832 compound. Flammable chemicals are not permitted for use in the Building 9832 highbay because of Class 2, Division 2 electrical fixtures.

2.5.3.2 Rockets

2.5.3.2.1 Hazards

The types and quantities of explosives and rocket motors are addressed in “2.8.3.4 Explosives Consumption Scenarios.” For additional details on rocket motor chemical composition and exhaust gases, see Chemical Propulsion Information Agency (1994).

2.5.3.2.2 Hazard Controls

Part of the planning for a test at the Aerial Cable Facility Complex involves establishing a worst-case safety envelope for impact of all missiles, projectiles, or test unit components. The safety envelope accounts for shrapnel that could be created by test unit high explosives and the maximum range of fly-away missiles that could mistrack or malfunction. Routine drop tests and rocket-assisted pulldown tests make use of minimum hazard areas that are derived through empirical test history and operator experience and that have radii of 200 ft for gravity drop tests and 1,000 ft for rocket-assisted pulldown tests. Dispersal of debris from test articles that contain high explosives is roughly circular in pattern. The radii of dispersal for nonreactive events average approximately 100 ft. Reactive events would be expected to result in dispersal of debris throughout a radius of 1,250 ft (U.S. Department of Defense, no date). Ground-to-air missile hazard zones are based on worst-case scenarios that use actual test results from hundreds of field firings for the particular missile type, and artillery impact hazard zones are based on worst-case ricochet of projectiles. Air-to-ground munitions hazard areas use the maximum energy ground range of the particular munitions warhead tested. At a minimum, this area always encompasses the whole target area because of the unpredictable trajectory of these devices. After completing final preparations for a test, checking telemetry systems, and setting all instrumentation, safety personnel establish hazard area access controls by putting roadblocks in place and sweeping the entire area for personnel.

Following a test and before opening the hazard area, a safing team examines the test area. Roadblocks are maintained, and the hazard area is kept clear until residual hazards are removed or safed.

(West, 1995)

2.6 Accident Analysis Summary

2.6.1 Methodology

The methodology for the aerial cable accident analysis is essentially the “binning” methodology of AL 5481.1B, which uses the four hazard severity and probability categories, an additional fifth severity category (II-A, Significant), and a fifth probability category (B-1, Occasional). The additional severity category was defined to include:

- Permanent injuries to people.
- Loss of equipment, loss of part of the facility, or loss of test program results.
- Local damage to the DOE site beyond facility boundaries.

The additional probability category was defined to have a nominal frequency between 10^{-4} per year and 10^{-3} per year. (The nominal frequency for category B in AL 5481.1B was redefined to be between 10^{-3} per year and 10^{-2} per year. See Table 14-2.)

Table 14-2. Accident Likelihood as a Function of Effectiveness Credit

Sum of Credits Per Year	Descriptor	Symbol	Nominal Frequency
1-3	Likely	A	$P_e > 10^{-2}$
4-5	Unlikely	B	$10^{-3} < P_e < 10^{-2}$
6-8	Occasional	B-1	$10^{-4} < P_e < 10^{-3}$
9-11	Extremely unlikely	C	$10^{-6} < P_e < 10^{-4}$
12	Incredible	D	$P_e < 10^{-6}$

The technique for estimating the likelihood of occurrence for an event relies on the judgment of sled track staff in evaluating the effectiveness of barriers and controls used as hazard prevention and mitigation measures. The relative effectiveness of hardware versus behavioral controls in achieving risk reduction is established by weighting factors (or “credits”). The credits are assigned as follows:

- **System Design that Minimizes Hazards (5 credits)** - Whenever possible, the design of a system should incorporate features that will either eliminate or otherwise limit the consequences of potential hazards. Design features generally include passive measures (for example, fire-retardant barriers to control the propagation of fires).

- **Multiple Safety Devices (4 credits)** - If a potential hazard cannot be controlled through passive design features, then providing multiple, independent, and reliable safety devices for hazard control is desirable.

- **Single Safety Device (3 credits)** - If only one safety device is available for hazard control, then less credit can be taken for a system with one safety device than for a system that has multiple safety devices.

- **Warning Devices (2 credits)** - Because warning devices only alert human beings that some intervention action is required, less credit can be taken for this hazard control than for one with automatic safety device actuation.

- **Procedures and Training (1 credit)** - Implementation of operating procedures and personnel training will also serve as hazard controls. However, human beings, even when properly trained and operating under effective operating procedures, are still the least reliable element in any system.

As each accident scenario was developed, the hazard controls were evaluated using the effectiveness credits. Credit for a factor was only counted once. For example, an effectiveness credit of 4 was counted for multiple redundant safety devices, or an effectiveness credit of 3 was counted for a single safety device, but both credits were not counted. The sum of the credits (for a maximum of 12) was then related to accident likelihood by the relationships shown in Table 14-2.

The hazard severity categories and the accident likelihood categories were then combined to produce the matrix of risk indices shown Table 14-3.

Table 14-3. Risk Index

Likelihood	Hazard Severity				
	Catastrophic	**Critical**	**Significant**	**Marginal**	**Negligible**
Likely	I/A	II/A	II-A/A	III/A	IV/A
Unlikely	I/B	II/B	II-A/B	III/B	IV/B
Occasional	I/B-1	II/B-1	II-A/B-1	III/B-1	IV/B-1
Extremely unlikely	I/C	II/C	II-A/C	III/C	IV/C
Incredible	I/D	II/D	II-A/D	III/D	IV/D

Using the DOE Tiger Team process for prioritizing environment, safety, and health (ES&H) findings, the four risk groups shown in Table 14-4 were established.

Table 14-4. Risk Groups and Associated Management Actions

Risk Group	Risk Index	Required Management Action
1	• I/A • I/B • I/B-1 • II/A • II/B • II/B-1 • II-A/A	All operations must be stopped. A risk management action plan and a detailed risk analysis must be prepared. A vice president's approval is required before operations may be restarted.
2	• I/C • II/C • II-A/B • II-A/B-1 • III/A • III/B	A director's approval is required to continue this operation. Additional risk assessment may be required. Improvements in preventive or mitigative measures are required.
3	• I/D • II/D • II-A/C • III/B-1 • IV/A • IV/B	Acceptable risk with review by the cognizant department manager. Improvement may be necessary.

Table 14-4. Risk Groups and Associated Management Actions (Continued)

Risk Group	Risk Index	Required Management Action
4	• II-A/D • III/C • III/D • IV/B-1 • IV/C • IV/D	Acceptable risk with routine review by the department manager.

2.6.2 Summary of Accident Analysis Results

Analysts identified no hazards associated with aerial cable operations in risk group 1. Twenty hazards were identified in risk group 2, all of which are worker hazards. This group of hazards consists primarily of standard industrial hazards (for example, crane, hoist, and rigging operations, electrical equipment operations, and forklift operations). The "nonstandard industrial hazards" in risk group 2 are associated with high explosives assembly, rocket motor assembly, and fireset activities. Although the consequences associated with these activities can be critical to catastrophic (severity category II and I, respectively) to workers, the likelihood of such consequences has been assessed to be extremely unlikely (probability category C).

No unacceptable risks to the environment or the offsite public from aerial cable operations were identified. Onsite environmental hazards from explosives and rocket motor transportation, storage, assembly, arming, and firing activities were risk group 4 hazards. These hazards represent negligible (category IV) impacts to the onsite environment, with incredible (category D) likelihoods of occurrence. The only offsite public hazard (missiles and projectiles) in risk group 3 represents a potentially catastrophic (category I) consequence, with an incredible likelihood of occurrence (category D).

These events are summarized in Table 14-5.

Table 14-5. Aerial Cable Event Results

Event	Worker	Onsite Environment	Offsite Public
Explosives transportation	I/D	IV/D	IV/D
Explosives storage	I/D	IV/D	IV/D
Explosives assembly	II/C	IV/D	NA
Explosives arming	I/D	IV/D	NA
Explosives firing	I/D	IV/D	NA
Rocket motor transportation	I/D	IV/D	IV/D
Rocket motor storage	I/D	IV/D	IV/D
Rocket motor assembly	I/C	IV/D	NA
Rocket motor arming	I/D	IV/D	NA
Fire set electrocution	I/C	NA	NA
Missiles and projectiles	I/D	IV/D	I/D

(West, 1995)

2.7 Reportable Events

Table 14-6 lists the occurrence reports for the Aerial Cable Facility Complex over the past five years.

Table 14-6. Occurrence Reports for the Aerial Cable Facility Complex

Report Number	Title	Category	Description of Occurrence
ALO-KO-SNL-2000-1994-0003	Stinger Missile Flight into Secondary Hazard Zone at Cable Facility	1C	A Stinger missile launched at a helicopter target suspended from the cable facility exceeded the primary hazard zone. No one was injured.
ALO-KO-SNL-6000-1997-0001	City of Albuquerque Alleged Burn Permit Violation Resulting in Non-Routine Notification to Outside Agency	2E	The number of burns permitted on the burn permit was discovered to have been exceeded during a records review.

2.8 Scenarios for Impact Analysis

In all of the scenarios for impact analysis in this section, base year values are for fiscal year (FY) 1996 unless otherwise noted.

2.8.1 Activity Scenarios

2.8.1.1 Scenario for Test Activities: Drop/Pull-Down

2.8.1.1.1 Alternatives for Test Activities: Drop/Pull-Down

Table 14-7 shows the alternatives for drop and pull-down tests at the Aerial Cable Facility Complex.

Table 14-7. Alternatives for Test Activities: Drop/Pull-Down

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
2 tests	21 tests	32 tests	38 tests	100 tests

2.8.1.1.2 Assumptions and Actions for the "Reduced" Values

Test objects are gravity-accelerated or pulled down by rockets from overhead cables to impact specific targets in the test arena. The rocket pull-down technique utilizes rocket sleds on a track and towing cables to accelerate test objects from an overhead cable. The towing cables run from the sleds, through turning sheaves at the impact points, and to the test objects suspended from the cable. Test objects are released from the cable at rocket ignition. The towing cables are explosively cut just prior to target collisions.

Impact data are telemetered from the test articles to ground-station recorders. Target response data are recorded directly through hard wire. Impact events are recorded by high-speed framing cameras. Design engineers and analysts use test results to certify designs and validate modeling.

The value of the "reduced" alternative represents the minimum test level required to maintain the viability of this activity. For this to occur, there would have to be a cessation of testing for weapon modifications and joint test assemblies and cessation of work for Energy Programs and the Other Federal Agencies Program.

2.8.1.1.3 Assumptions and Rationale for the "No Action" Values

Base year values are actuals. The values projected for the FY2003 and FY2008 timeframes under the "no action" alternative are based on a SNL user survey reported in Bomber *et al.* (1996). The study forecasts tests to certify weapon modifications, joint test assemblies, and transportation packages; to verify designs for transportation technology; and to support work for outside agencies. Drop tests of joint test assemblies include those containing hazard category

1 amounts of fissionable material. The material is typically weapons-grade U-235 or Pu-239 contained in a live-pit or live-secondary configuration. The explosives-like assemblies would utilize mock high explosives that will not detonate. The projection for FY2008 reflects an anticipated increase in weapons research programs.

2.8.1.1.4 Assumptions and Actions for the "Expanded" Values

The value under the "expanded" alternative represents estimates by the managers of the complex of the numbers of tests the complex could accommodate in an expanded mode of operations. This assumes an increase in weapon modifications, drop tests of joint test assemblies, container recertifications, Energy Programs activities, activities for outside agencies, and weapons research program activities. Drop tests of joint test assemblies that contain depleted uranium, enriched uranium, and insensitive high explosives represent a new test activity at the complex. These test articles would contain less than 45 pounds of depleted uranium, less than 120 pounds of enriched uranium, and less than 104 pounds of insensitive high explosives (PBX-9502 or LX-17). Test articles are designed using insensitive high explosives because of the low probability of detonation under test conditions. In addition, the nuclear material contained in the test article is configured in a manner that prevents a criticality event from occurring. The number of tests that use this kind of test article could range from one to five per year depending upon programmatic requirements.

2.8.1.2 Scenario for Test Activities: Aerial Target

2.8.1.2.1 Alternatives for Test Activities: Aerial Target

Table 14-8 shows the alternatives for aerial target tests at the Aerial Cable Facility Complex.

Table 14-8. Alternatives for Test Activities: Aerial Target

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 tests	6 tests	6 tests	6 tests	30 tests

2.8.1.2.2 Assumptions and Actions for the "Reduced" Values

Trolleys are either gravity- or rocket-accelerated across a cable tramway. Low-speed trolleys are allowed to roll up the cable catenary and stop before reaching the end of the cable. However, braking systems, which usually incorporate disc brakes, are required for stopping high-speed trolleys. Trolleys are usually rectangular containers for mounting the avionics being tested. However, they may be surrogate or actual aircraft when engagement scenarios require them.

Missiles are launched on intercept trajectories with trolleys to evaluate the missile warning receiver, jammer, and decoy performance. A logical follow-on to these tests has been the evaluation of missile performance.

No activity is projected under the “reduced” alternative. This activity is conducted on an as-needed basis. Actual testing is not required to maintain capability; however, technical skills and equipment would need to be kept current to resume this testing within a reasonable startup time.

2.8.1.2.3 Assumptions and Rationale for the “No Action” Values

These types of tests are principally conducted on demand or on an as-needed basis in support of the Other Federal Agencies Program.

The base year values are actuals. Projections provided under the FY2003 and FY2008 timeframes assume a continuation of the levels of activity provided for the base year.

2.8.1.2.4 Assumptions and Actions for the “Expanded” Values

The value under this alternative represents the estimates by the managers of the complex of the number of tests the complex could accommodate in an expanded mode of operations.

This level of activity would assume an increase in aerial target activity to support outside agencies. These activities would also occur on demand or on an as-needed and as-available basis.

2.8.1.3 Scenario for Test Activities: Scoring System Tests

2.8.1.3.1 Alternatives for Test Activities: Scoring System Tests

Table 14-9 shows the alternatives for scoring systems tests at the Aerial Cable Facility Complex.

Table 14-9. Alternatives for Test Activities: Scoring System Tests

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 series	0 series	1 series	1 series	2 series

2.8.1.3.2 Assumptions and Actions for the "Reduced" Values

This activity consists of suspending scoring systems from cables to evaluate their ability to measure "miss distances" to passing missiles and shells. The tests are conducted in series; a series may include 20 missile firings and 100 gun firings.

There will be years when there will be no request for this activity. Actual testing is not required to maintain capability; however, technical skills and equipment would need to be kept current in order to resume this testing within a reasonable startup time.

2.8.1.3.3 Assumptions and Rationale for the "No Action" Values

This is an ongoing activity for outside agencies that did not occur during the base year. The projections provided under the FY2003 and FY2008 timeframes represent planned test series.

2.8.1.3.4 Assumptions and Actions for the "Expanded" Values

Scoring system test series support is an activity that does not occur frequently; therefore, the managers of the complex believe that the two test series projection provided for this alternative is a reasonable estimate of "expanded" activities.

2.8.2 Material Inventories

2.8.2.1 Nuclear Material Inventory Scenario for Depleted Uranium

2.8.2.1.1 Alternatives for Depleted Uranium Nuclear Material Inventory

Table 14-10 shows the alternatives for depleted uranium nuclear material inventory.

Table 14-10. Alternatives for Depleted Uranium Nuclear Material Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 kg	0 kg	0 kg	0 kg	0 kg

2.8.2.1.2 Operations That Require Depleted Uranium

There are no operations at the complex that require depleted uranium or any other nuclear material. However, nuclear materials may be included in objects that are tested to authenticate certification of a system. As such, they do not contribute to the operation, but they are subjected to it.

Ownership of the materials that are tested does not transfer to the management of the complex. The materials are maintained under SNL/NM security and kept in safe-secure facilities for a period of one to a few days. The inventory function is maintained by the security organization and accountability remains with the organization that requests the tests. As such, the complex never has an administrative inventory of these materials.

2.8.2.1.3 Basis for Projecting the "Reduced" and "Expanded" Values

This section is not applicable.

2.8.2.2 Radioactive Material Inventory Scenarios

The Aerial Cable Facility Complex has no radioactive material inventories.

2.8.2.3 Sealed Source Inventory Scenarios

The Aerial Cable Facility Complex has no sealed source inventories.

2.8.2.4 Spent Fuel Inventory Scenarios

The Aerial Cable Facility Complex has no spent fuel inventories.

2.8.2.5 Chemical Inventory Scenarios

The Aerial Cable Facility Complex has no inventories of chemicals of concern.

2.8.2.6 Explosives Inventory Scenario for Bare UNO 1.3

2.8.2.6.1 Alternatives for Bare UNO 1.3 Explosives Inventory

Table 14-11 shows the inventory for bare UNO 1.3 explosives at the Aerial Cable Facility Complex.

Table 14-11. Alternatives for Bare UNO 1.3 Explosives Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 kg	0 kg	0 kg	0 kg	0 kg

2.8.2.6.2 Operations That Require Bare UNO 1.3

Explosive inventory is managed by the SNL Explosive Inventory System. Explosives are delivered to the Aerial Cable Facility Complex site on a just-in-time basis. While they are at the complex, the explosives are accounted for within the SNL Explosive Inventory System until they are consumed. Explosives that are not consumed during testing are returned to the storage complex.

2.8.2.6.3 Basis for Projecting the "Reduced" and "Expanded" Values

This section is not applicable.

2.8.2.7 Other Hazardous Material Inventory Scenarios

The Aerial Cable Facility Complex has no inventories of hazardous materials that do not fall into the categories of nuclear or radioactive material, sealed sources, spent fuel, explosives, or chemicals.

2.8.3 Material Consumption

2.8.3.1 Nuclear Material Consumption Scenario for Depleted Uranium

2.8.3.1.1 Alternatives for Depleted Uranium Consumption

Table 14-12 shows the alternatives for depleted uranium consumption at the Aerial Cable Facility Complex.

Table 14-12. Alternatives for Depleted Uranium Consumption

Reduced Alternative		No Action Alternative						Expanded Alternative	
		Base Year		FY2003		FY2008			
0 pkgs	0 kg	0 pkgs	0 kg	0 pkgs	0 kg	0 pkgs	0 kg	0 pkgs	0 kg

2.8.3.1.2 Operations That Require Depleted Uranium

No operation at the Aerial Cable Facility Complex requires depleted uranium or any other nuclear material. Nuclear materials are included within objects being tested to authenticate certification of systems. Thus, the nuclear materials are subjected to testing at the complex.

Nuclear material subjected to testing is recovered after tests and returned to the test requester.

2.8.3.1.3 Basis for Projecting the "Reduced" and "Expanded" Values

This section is not applicable.

2.8.3.2 Radioactive Material Consumption Scenarios

Radioactive material is not consumed at the Aerial Cable Facility Complex.

2.8.3.3 Chemical Consumption Scenarios

Information initially provided for this section resides in the Facility Information Manager database and will be made available to the analysts responsible for preparing the sitewide environmental impact statement.

2.8.3.4 Explosives Consumption Scenarios

2.8.3.4.1 Explosives Consumption Scenario for Bare UNO 1.4 Explosives

Alternatives for Bare UNO 1.4 Explosives Consumption - Table 14-13 shows the alternatives for bare UNO 1.4 explosives consumption at the Aerial Cable Facility Complex.

Table 14-13. Alternatives for Bare UNO 1.4 Explosives Consumption

Reduced Alternative		No Action Alternative						Expanded Alternative	
		Base Year		FY2003		FY2008			
8 pkgs	71 g	46 pkgs	410 g	48 pkgs	625 g	83 pkgs	741 g	260 pkgs	2,314 g

Operations That Require Bare UNO 1.4 Explosives - Drop and pull-down operations require UNO 1.4 explosives for the release of test objects from the overhead cables and the cutting of towing cables on rocket pull-down tests. Two cable-cutters, or explosives bolts with 8.9 g of explosives, are required to release test objects from the overhead cable on drop/pull-down tests. Two additional cable cutters with the same explosive weight are also required for cutting towing cables on rocket pull-down tests.

Basis for Projecting the "Reduced" and "Expanded" Values - The "reduced" value is based on the use of eight cable cutters (71 g) required for the two rocket pull-down tests listed in "2.8.1 Activity Scenarios."

The "expanded" value is based on the use of 140 cable cutters or explosive bolts (1,246 g) required to release test objects from the overhead cable on 70 drop-tests and the use of 120 cable cutters (1,068 g) required for 30 rocket pull-down tests.

2.8.3.4.2 Explosives Consumption Scenario for Bare UNO 1.1 Explosives

Alternatives for Bare UNO 1.1 Explosives Consumption - Table 14-14 shows the alternatives for bare UNO 1.1 explosives at the Aerial Cable Facility Complex.

Table 14-14. Alternatives for Bare UNO 1.1 Explosives Consumption

Reduced Alternative		No Action Alternative						Expanded Alternative	
		Base Year		FY2003		FY2008			
0 pkgs	0 kg	12 pkgs	18.9 kg	18 pkgs	28.4 kg	22 pkgs	34.6 kg	50 pkgs	78.8 kg

Operations That Require Bare UNO 1.1 Explosives - Operations that require bare UNO 1.1 explosives include drop tests of skeet anti-tank warheads, a UNO 1.1 explosive.

Basis for Projecting the "Reduced" and "Expanded" Values - The "reduced" value is not applicable. The "expanded" value is based on 50 test object packages (78.8 kg). These 50 test packages represent half of the tests identified in the drop/pull-down activity scenario in "2.8.1 Activity Scenarios."

2.8.3.4.3 Explosives Consumption Scenario for Bare UNO 1.3 Explosives

Alternatives for Bare UNO 1.3 Explosives Consumption - Table 14-15 shows the alternatives for bare UNO 1.3 explosives consumption at the Aerial Cable Facility.

Table 14-15. Alternatives for Bare UNO 1.3 Explosives Consumption

Reduced Alternative		No Action Alternative						Expanded Alternative	
		Base Year		FY2003		FY2008			
40 pkgs	480 kg	86 pkgs	1,514 kg	215 pkgs	3,268 kg	255 pkgs	3,814 kg	2,270 pkgs	22,930 kg

Operations That Require Bare UNO 1.3 Explosives - Pull-down tests and aerial trolley activities require UNO 1.3 explosives (rocket motors) as propulsion for accelerating test objects and trolleys. Aerial trolley and scoring system activities require UNO 1.3 explosives (rocket motors and gun propellant) for threat missiles. Aerial trolley and drop activities of skeet anti-tank warheads require UNO 1.3 explosives (flares) as countermeasures.

Basis for Projecting the "Reduced" and "Expanded" Values - The "reduced value" is for the 40 HVAR rocket motors (480 kg) for the two rocket-pull down tests that are listed in "2.8.1 Activity Scenarios."

Table 14-16 shows the breakdown of rocket motors required for the "expanded" alternative.

Table 14-16. Rocket Motors Required for the Expanded Alternative

Tests	Packages	Kilograms
30 Rocket Pull-Down Tests		
30 tests with 30 HVARs	900	10,800
30 Aerial Target Tests		
10 tests with 15 Super Zunis	150	3,000
20 tests with 15 Zunis	300	5,000
30 tests with 25 flares	750	750
50 Drop Tests		
50 tests with 1 flare	50	50
2 Scoring System Series		
20 tests with 1 Zuni	20	330
200 tests with 1 gun round	200	3,000
Totals	2,370	22,930

These are the quantities estimated to conduct the tests of the "expanded" alternatives identified in "2.8.1 Activity Scenarios." Projections are based on past history.

2.8.4 Waste

2.8.4.1 Low-Level Radioactive Waste Scenario

Low-level radioactive waste is not produced at the Aerial Cable Facility Complex.

2.8.4.2 Transuranic Waste Scenario

Transuranic waste is not produced at the Aerial Cable Facility Complex.

2.8.4.3 Mixed Waste

2.8.4.3.1 Low-Level Mixed Waste Scenario

Alternatives for Low-Level Mixed Waste at the Aerial Cable Facility Complex **-** Table 14-17 shows the alternatives for low-level mixed waste at the Aerial Cable Facility Complex.

Table 14-17. Alternatives for Low-Level Mixed Waste

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 kg	0 kg	0 kg	0 kg	0 kg

Operations That Generate Low-Level Mixed Waste **-** Normal operations do not produce low-level mixed waste. While tests are designed to preclude releases of radioactive and hazardous material under normal operations, material from test assemblies could be accidentally released to the ground following collisions or explosions. In this event, cleanup of the area would produce some low-level mixed waste. Quantitative estimates are not available.

General Nature of Waste - See “2.5 Hazards and Hazard Controls,” for a description of the materials involved.

Waste Reduction Measures - No waste reduction measures exist.

Basis for Projecting the “Reduced” and “Expanded” Values - This section is not applicable.

2.8.4.3.2 Transuranic Mixed Waste Scenario

Transuranic mixed waste is not produced at the Aerial Cable Facility Complex.

2.8.4.4 Hazardous Waste Scenario

2.8.4.4.1 Alternatives for Hazardous Waste at the Aerial Cable Facility Complex

Table 14-18 shows the alternatives for hazardous waste at the Aerial Cable Facility Complex.

Table 14-18. Alternatives for Hazardous Waste

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
5 kg	5 kg	5 kg	5 kg	9 kg

2.8.4.4.2 Operations That Generate Hazardous Waste

Operations that generate hazardous waste include:

- Cleaning of parts.
- Assembly of test packages, which involves machining operations that generate residues.
- Wiping of excess material.
- Bonding of parts with epoxies.

2.8.4.4.3 General Nature of Waste

Normal operations do not generate hazardous waste. While tests are designed to preclude releases of radioactive and hazardous material under normal operations, material from test assemblies could be accidentally released to the ground following collisions or explosions. In this event, cleanup of the area would produce some hazardous waste. Quantitative estimates are not available.

2.8.4.4.4 Waste Reduction Measures

No waste reduction measures exist.

2.8.4.4.5 Basis for Projecting the "Reduced" and "Expanded" Values

The "reduced" and "expanded" values represent a nonlinear projection of estimated generation of waste.

2.8.5 Emissions

2.8.5.1 Radioactive Air Emissions Scenarios

Radioactive air emissions are not produced at the Aerial Cable Facility Complex.

2.8.5.2 Chemical Air Emissions

Information on an extensive list of chemicals was obtained from the SNL/NM Chemical Inventory System (CIS). For the air emissions analysis, the entire annual inventory of these chemicals was assumed to have been released over a year of operations for each specific facility (i.e., the annual inventory was divided by facility operating hours). The emissions from this release were then subjected, on a chemical-by-chemical basis, to a progressive series of screening steps for potential exceedances of both regulatory and human health thresholds. For those chemicals found to exceed this screening, process knowledge was used to derive emission factors. The emission factors for these chemicals were then modeled using the U.S. Environmental Protection Agency's *Industrial Source Complex Air Quality Dispersion Model, Version 3*. The results of this modeling are discussed as part of the analysis in support of the SNL/NM site-wide environmental impact statement.

2.8.5.3 Open Burning Scenarios

The Aerial Cable Facility Complex does not have outdoor burning operations.

2.8.5.4 Process Wastewater Effluent Scenario

The Aerial Cable Facility Complex does not generate process wastewater.

2.8.6 Resource Consumption

2.8.6.1 Process Water Consumption Scenario

The Aerial Cable Facility Complex does not consume process water.

2.8.6.2 Process Electricity Consumption Scenario

The Aerial Cable Facility Complex does not consume process electricity.

2.8.6.3 Boiler Energy Consumption Scenario

The Aerial Cable Facility Complex does not consume energy for boilers.

2.8.6.4 Facility Personnel Scenario

2.8.6.4.1 Alternatives for Facility Staffing at the Aerial Cable Facility Complex

Table 14-19 shows the alternatives for staffing at the Aerial Cable Facility Complex.

Table 14-19. Alternatives for Facility Staffing

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
6 FTEs	8 FTEs	8 FTEs	10 FTEs	24 FTEs

2.8.6.4.2 Operations That Require Facility Personnel

Drop, pull-down, aerial target, and scoring system activities require facility personnel.

2.8.6.4.3 Staffing Reduction Measures

There are no current or planned staff reduction measures.

2.8.6.4.4 Basis for Projecting the "Reduced" and "Expanded" Values

The number of personnel for the "reduced" alternative is required to maintain the viability of the Aerial Cable Facility Complex. The mix would be five SNL employees and one contractor.

Table 14-20 shows the breakdown of FTEs for the "reduced" alternative.

Table 14-20. Breakdown of FTEs for the Reduced Alternative

Test	SNL Staff			Contractor
	Engineer	Technician	Administrative	
Drop/pull-down	1	1.8	0.7	1
Aerial target	0.4	0.5	0.2	0
Scoring system	0.1	0.2	0.1	0
Totals	1.5	2.5	1.0	1.0

FTE costs in FY1998 under the “reduced” alternative is $1.4 million.

Table 14-21 shows the breakdown of FTEs for the “expanded” alternative.

Table 14-21. Breakdown of FTEs for the Expanded Alternative

Test	SNL Staff			Contractor
	Engineer	Technician	Administrative	
Drop/pull-down	2.5	5	1.5	6
Aerial target	1.2	2	0.3	3
Scoring system	0.3	1	0.2	1
Totals	4	8	2	10

FTE costs in FY1998 under the “expanded“ alternative is $3.5 million.

2.8.6.5 Expenditures Scenario

2.8.6.5.1 Alternatives for Expenditures at the Aerial Cable Facility Complex

Table 14-22 shows the alternatives for expenditures at the Aerial Cable Facility Complex.

Table 14-22. Alternatives for Expenditures

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
$150,000	$250,000	$350,000	$380,000	$725,000

2.8.6.5.2 Operations That Require Expenditures

Drop, pull-down, aerial target, and scoring system activities require expenditures.

2.8.6.5.3 Expenditure Reduction Measures

No expenditure reduction measures exist.

2.8.6.5.4 Basis for Projecting the "Reduced" and "Expanded" Values

The expenditures for the "reduced" alternative are required to maintain the viability of the Aerial Cable Facility Complex.

Table 14-23 shows the expenditures for the "expanded" alternative.

Table 14-23. Breakdown of Expenditures for the Expanded Alternative

Activities	Expenditures
Drop/pull down	$500,000
Aerial target	$150,000
Scoring system	$100,000

3.0 LURANCE CANYON BURN SITE SOURCE INFORMATION

3.1 Purpose and Need

The Lurance Canyon Burn Site is the SNL/NM test facility for fire testing weapons, weapon components, and shipping containers in aviation fuel fires, propellant fires, and wood fires for verification of design integrity and performance.

The Lurance Canyon Burn Site is also used by SNL Energy Programs for transportation package certification and for verification of designs in transportation technology. The DOE needs the Lurance Canyon Burn Site to support research and development activities in the national interest on an as-available basis.

(U.S. Department of Energy, 1994; 1995a)

3.2 Description

Lurance Canyon Burn Site includes a group of facilities within an area of about 220 acres in the easternmost part of Coyote Test Field (CTF). The terrain is mountainous, with an elevation of about 6,400 ft. Foothills surround the site to the north, south, and east. Access to the site is from the west. The vegetation is that of high desert.

Pools are used for conducting open burn tests. A 30-ft by 60-ft concrete pool is used for fire testing large objects. This reinforced concrete pool is 36 in. deep. It can support objects weighing up to 140 tons and accommodate objects as large as railroad cars. A 20-ft square steel pool is used for fire testing intermediate-sized objects. The pool has a metal test stand in the center flanked by two instrumentation towers. A number of smaller pools have been built to meet specific test requirements. A 6-ft by 18-ft stainless-steel pool is used for "one-sided" fires in which only one side of a test object is exposed to fire. The facility also includes a 10-ft diameter pool and a 15-ft square pool.

There are two enclosed fire test facilities, the Small Wind Shield (SWISH) and the Fire Laboratory for the Authentication of Models and Experiments (FLAME). These enclosed facilities are unique in the U.S. and were designed to meet Albuquerque/Bernalillo County Air Quality Regulation (AQCR) #5, "Visible Air Contaminants."

SWISH is an above-ground, portable, pyramid-shaped steel structure used to conduct burn tests of nonexplosive objects and for developing technology to reduce smoke and improve combustion control. SWISH has a 26-ft square base and tapers to a 1-ft by 7-ft vertical stack, which sits on top of the pyramid structure. The total height of the structure is 29 ft.

An afterburner was installed in the exhaust stack to meet visible emissions and air quality regulations. Afterburning was achieved by the air flow at the exhaust stack being in excess of 1,700°F and baffles in the exhaust stack causing turbulence and extending the flow residence time. The information learned from the operation of SWISH was used to design the Smoke Emissions Reduction Facility (SMERF).

SMERF had a 10-ft square pool centered in the floor of a 20-ft cubical test chamber and an 8-ft square exhaust stack for afterburning. SMERF was used for engulfing and one-sided tests of intermediate-sized objects (5 ft in diameter by 5 ft long). It could accommodate explosive test objects, weapon shapes, and radiography devices.

SMERF was modified to create the Fire Laboratory for the Accreditation of Model and Experiments (FLAME). Modifications to the facility included the insertion of a 1-m diameter porous burner capable of burning various gaseous hydrocarbon fuels in well-controlled and characterized environments.

Enclosed pool fires are conducted in Building 9830, an earth-covered, concrete and metal arch structure. Data from fires of 30 minutes to two hours duration are used to validate computational models of fires in igloo-like buildings.

Lurance Canyon Burn Site has two double-walled, aboveground, enclosed 25,000-gal tanks; one contains water for open pool tests, and the other contains a water/propylene glycol mixture for circulating within the walls of FLAME for cooling during tests. Additional water is stored in two underground 5,000-gal nonpotable water tanks.

Lurance Canyon Burn Site water is supplied from a well under well permit #RG44986. Water usage is metered and reported annually to the New Mexico Office of the State Engineer. Although the water meets applicable drinking water standards, it is not used for drinking. Instead, bottled water is used for drinking. Additional nonpotable water may be trucked in to the site.

Lurance Canyon Burn Site does not have a sewer system. Instead, portable sanitary facilities, which are serviced once per week by a licensed contractor, are used.

Jet fuel for open pool tests is stored in an aboveground, enclosed 30,000-gal fuel tank located in an earthen containment berm. Some fire tests are fueled directly from this main storage tank. Others are fueled from two skid-mounted, 500-gal fuel tanks that have secondary containment. These portable tanks are moved within the site by forklift.

Three anemometers, mounted on a tower at 10 ft, 20 ft, and 40 ft above ground level, are used to record data for determining whether a burn can be conducted in compliance with Albuquerque/Bernalillo County air quality regulations. Additional meteorological data are obtained from the Nation Weather Service.

The Lurance Canyon Burn Site has a variety of trailers, transportainers, small sheds, and utility buildings for office space and equipment storage.

A below-grade bunker houses instrumentation for collecting data on temperature, heat flux, flame velocity, and fuel burn rate. Instrumentation lines are cooled by liquid nitrogen to ensure the fidelity of transmitted data. The data are transmitted by fiber optic cables and recorded by computers located in a trailer on the west side of Lurance Canyon Burn Site. Test events are recorded by video cameras and radiography.

(U.S. Department of Energy, 1994; 1995a)

3.3 Program Activities

Table 14-24 shows the program activities at the Lurance Canyon Burn Site.

Table 14-24. Program Activities at the Lurance Canyon Burn Site

Program Name	Activities at the Lurance Canyon Burn Site	Category of Program	Related Section of the *SNL Institutional Plan*
Direct Stockpile Activities	Environmental, safety, and survivability testing for nuclear weapon applications.	Programs for the Department of Energy	Section 6.1.1.1
Performance Assessment Science and Technology	Simulate fuel fire environments for testing and certification of weapon systems and components.	Programs for the Department of Energy	Section 6.1.1.1
Environmental Technology Development	No description provided by program manager.	Programs for the Department of Energy	Section 6.1.4.3
Sustaining Critical Progress in Model Validation	Validate models for fire characterization such as air and fuel mixing, vortices, soot production and destruction, soil and fuel interactions, and enclosure fires driving a hot-gas layer as a function of ventilation. Model validation of component and system response, such as fire-induced response of polyurethane foam, devolitization processes, and burn front movement.	Major Programmatic Initiatives	Section 7.1.3
Other Federal Agencies	Activities include support to DOE and other government agencies for research and development activities in the national interest.	Work for Non-DOE Entities (Work for Others)	Section 6.2.7
Energy Programs	Energy Program activities include support to transportation package certification programs to verify designs in transportation technology.	Major Programmatic Initiatives	Section 7.2.1

3.4 Operations and Capabilities

Generally, operations at the Lurance Canyon Burn Site include the following:

- Defining test parameters with customers (for example, cost, schedule, and performance).
- Designing and fabricating hardware.
- Preparing the data acquisition system.
- Conducting post-test activities, including data reduction and analysis and post-test cleanup, which includes removal of any hazardous or nonhazardous waste.
- Completing and submitting environmental and safety documentation necessary to obtain approvals to perform the test.
- Setting up instruments and test units.
- Documenting tests and other activities (for example, hazardous waste removal).

Outdoor tests are performed in the following areas:

- A 30-ft by 60-ft rectangular pool
- A 10-ft diameter pool
- A 6-ft by 18-ft pool
- A 20-ft square pool

Enclosed fire tests are performed in the SWISH, FLAME, and Building 9830. Propellant and wood fire tests are performed in cleared areas.

Open pool fires are used to simulate transportation accidents, which may involve pooling of spilled motor oil or gasoline. Gasoline is not used as a test fuel at Lurance Canyon Burn Site because it is too volatile. Aviation fuel produces the same test results with less danger to site personnel. The fuel for the majority of the tests is JP-8 aviation fuel, which is a distillate produced by blending gasoline and kerosene stocks with an average molecular weight of 125. It is introduced into the test setup by gravity flow through a steel pipe system just prior to conducting the test. The valves for controlling the flow are hand- or air-operated. The amount of fuel used in a test is based on the length of test time required and known fuel burn rates.

Tests may be conducted in two ways. In the first technique, all required fuel is placed in the pool and is ignited. In these tests, fuel burnout is the normal method of test fire extinction. In the second technique, a portion of the fuel is placed in the pool and fuel is added as the test progresses. This technique permits technicians to cut off the fuel supply and terminate the test.

Fires must fully engulf test objects as stipulated by specific regulatory requirements. Temperatures range from 1,400° to 1,800°F. The size of the pool used is tailored to the size of the object tested. Most fire tests are 30 minutes in duration, a typical length for an accidental fire according the NRC (10 CFR 71). Fires of 60 to 150 minutes duration have been performed. For a one-hour test in the largest pool, the quantity of fuel burned is approximately 16,000 gal.

Stainless-steel test stands within the pool support the test objects at the applicable standard distance above the fuel (1-yard national standard or 1-m international standard).

Instrumentation towers are coated with thick blankets of ceramic fiber insulation. Cooling water is circulated through the inside of the instrumentation towers during the burn.

Portable 20-ft chain-link and metal-strip wind screens are set up around the open pools to reduce wind effects. The screens can cut wind velocity by 50 percent and prevent sudden winds from invalidating the test.

Prior to a test, the pool is filled to a specified depth with water from the storage tank. The layer of water protects the pool structure from the intense heat of the fire. When all test preparations have been made, the fuel is added to the pool to float on the surface of the water because it is lighter than the water. When sufficient fuel has be added to the pool, it is ignited and allowed to burn until the fuel supplied to the pool is consumed. Water from the pool is pumped through the instrumentation towers as a coolant. The data transmission lines are cooled by liquid nitrogen.

Temperatures in open pool fires are limited by thermal radiation from the flames and the action of air flow as it draws particulates out to the open air. Because of the poor fuel-air mixing inherent in such fires and the temperatures of 1,400°F, approximately 3 percent of the fuel carbon is converted to soot. Because it dominates the heat transfer processed, high soot concentrations within the fire are essential for developing the proper test environment. The major combustion products of aviation fuel fires are soot, carbon dioxide, and very small amounts of carbon monoxide.

Enclosed facility tests can reproduce the environment of a large, open pool fire. SNL has developed the SWISH and SMERF/FLAME enclosed fire test facilities to eliminate wind effects and to reduce soot concentration in the smoke plume. Eliminating wind effects permits the use of smaller fires that use less fuel and emit less soot. Most of the soot from an enclosed fire is consumed in the afterburner located in the exhaust stack.

The enclosed facilities use the same test methods as open pools: within the test chamber, the test object is placed in a fixture above a pool of water, and fuel is floated on top of the pool and ignited. During tests in SWISH, water is sprayed on the sides of the structure to prevent structural degradation. A water/propylene glycol mixture is circulated through a closed-loop system in the FLAME walls to cool the walls and simulate the cool surroundings of an open pool fire.

During tests in FLAME, air flow into the chamber is supplied by four variable-speed fans that can be controlled manually or by computer to provide the desired flow of air to the fire. Instrumentation lines to test objects are run through a tunnel under the pool floor. Observation ports in the walls of the facility provide viewing of the test objects for real-time radiography or optical instrumentation.

FLAME is being used to develop and validate the next generation of computational tools to investigate fire phenomenology. A large, laser-based technique to measure velocity and density fields in turbulent, reacting, buoyant plumes is being developed in the facility. Experiments are conducted with respirable seed particles and nonflammable and flammable gases. Velocity fields in gaseous flows are imaged by the scattering of laser light with the respirable particles. Acetone is sprayed into helium plums to fluoresce under the laser light, marking the plume boundary.

Pool fires of up to two hours in duration are conducted inside Building 9830. They utilize the same technology as the enclosed facilities. These fires are conducted for the validation of computational models of fires in igloo-like buildings.

Fire tests involving rocket propellant evaluate the vulnerability of weapons and satellites to accident scenarios, such as a missile fire on a launch pad. Propellants are ignited on a steel plate on the ground, and test objects are supported above the propellants. Rocket propellant fires last up to 10 minutes. Up to 3,000 lb of propellant can be consumed, depending upon the size of the test object.

Fire suppression tests can be conducted in any of the enclosed facilities to evaluate the effectiveness of proposed, nontoxic, nonpolluting suppressants.

Fuel-air mixture tests are conducted to qualify electronic equipment to National Electrical Code standards. Electronic equipment is operated in an explosive atmosphere to evaluate whether the equipment will cause a spark that could ignite fuel vapors.

Wood fire or crib tests are conducted as a DOT requirement for explosive component shipping containers.

(U.S. Department of Energy, 1994; 1995a; Tieszen, 1996)

3.5 Hazards and Hazard Controls

3.5.1 Radioactive Materials

3.5.1.1 Hazards

Weapon mockups may contain depleted uranium. Depleted uranium is used as a substitute for materials such as plutonium and enriched uranium found in actual nuclear weapons because it exhibits the mechanical and thermochemical properties needed to measure the performance of weapons components during a fire. Other test objects may also contain depleted uranium (for example, radioisotope thermoelectric generators that provide electrical power for space vehicles).

3.5.1.2 Hazard Controls

Site- and test-specific technical work documents describe safety measures to follow for tests involving depleted uranium. The depleted uranium in test objects is usually in the form of a large mass that is expected to be contained. However, if the fire causes a test object to rupture, a release may occur. The containment of depleted uranium is confirmed by pre- and post-test sampling of a test object and the surrounding area. The probability of release is one event in ten years involving less than 25 kg covering an area of up to 1,000 square feet.

A facility at the site, the Explosive Item Burner, is presently contaminated with depleted uranium and a nonhazardous amount of lithium. It is posted with warning signs, and chain barriers prevent personnel from approaching it. It has been identified for decontamination and decommissioning. The extent of contaminated soil area is unknown, as are concentrations. The contamination of the facility was the result of a planned test and was not accidental.

3.5.2 Explosive Materials

3.5.2.1 Hazards

Rocket propellant fire tests require handling and ignition of rocket propellant, which is a Class 1.3 explosive. Typically, these tests last for several minutes and consume approximately 500 lb of propellant; however, tests at the facility have consumed up to 2,500 lb of propellant.

3.5.2.2 Hazard Controls

Written technical work documents are utilized for all handling of explosive materials. These procedures are routinely developed by operating organizations and reviewed and approved by the various safety disciplines prior to commencing activities involving the handling of explosive materials. All personnel involved in a given activity are required to read and follow applicable technical work documents if they are to work with explosive materials.

3.5.3 Fuel Storage

3.5.3.1 Hazards

Up to 25,000 gal of JP-8 aviation fuel may be stored in the main storage tank at Lurance Canyon Burn Site.

3.5.3.2 Hazards Controls

All fuel tanks at Lurance Canyon Burn Site are double-walled, except for the large 25,000-gal tank. This tank is single-walled, but is within an engineered containment pond large enough to contain a spill. In addition, earth berm barriers have been placed around the tank to prevent a runaway vehicle from hitting and rupturing the tank. Multiple valves prevent a valve leak from escalating into a fuel spill from the 25,000-gal tank. A chain lock has been installed on the main valve to secure it against inadvertent operation. "No Smoking" signs are posted at the tank.

Fuel is not stored in the 500-gal portable tanks that are used to transport fuel to a small, open-pool test or SWISH. Excess fuel remaining in these tanks after tests is returned to the main storage tank.

Lurance Canyon Burn Site operates under a spill prevention plan as described in Sandia National Laboratories (1999a). Secondary containment is designed to achieve zero residual leakage to the soil. In the unlikely event of a spill penetrating the barriers, volatile organic compounds would be released into the ground. Because of the depth of the water table, the volatile organic compounds would not be expected to penetrate to the ground water. Lurance Canyon Burn Site and spill response personnel would clean up the spill in compliance with the *ES&H Manual*. There have been no spills to date in operating the facility.

3.5.4 Fueling Operations

3.5.4.1 Hazards

JP-8 is the primary fuel used at Lurance Canyon Burn Site. Accidental ignitions during fueling operation prior to a fire test are the principal hazards. Fuel vapor is heavier than air and can collect in low areas and be ignited by a spark or excessive heat.

3.5.4.2 Hazard Controls

Written technical work documents are utilized for all fueling operations. These procedures are routinely developed by operating organizations and reviewed and approved by the various safety disciplines prior to commencing fire test activities. All personnel involved in a fire test are required to read and follow applicable technical work documents.

Lurance Canyon Burn Site personnel receive extensive training to reduce the probability of accidental fuel ignition. Videotapes are employed to inform personnel about fire protection and recognizing ignition sources.

Fire extinguishers rated for Class A, B or C fires, fire blankets, and first aid kits are available at the site. Other flammable materials involved in testing must be identified and labeled. Class D fire extinguishers are provided if combustible metals are involved in a test.

Grounding straps are used between portable tanks and the main supply tank during fuel transfer to prevent electrostatic discharge. Fueling operations are not initiated or are discontinued if there is a potential for lightning as determined from the Lightning Early Warning System. Before fueling operations begin, the test area is posted with "No Smoking" signs, checked for ignition sources, barricaded, and cleared of all nonessential personnel.

3.5.5 Blast Waves and Fragments

3.5.5.1 Hazards

Test objects containing explosive or pressurized components could detonate, deflagrate, or rupture, causing blast waves and fragments.

3.5.5.2 Hazard Controls

Fire tests that have blast and fragment potential are conducted under special technical work documents. Special hazard zones are established for tests that may exceed the boundary of Lurance Canyon Burn Site but do not exceed the boundary of CTF. The hazard zone for overpressure limits exposure to 1/4 psi. The hazard zone for fragments must limit hazards to acceptable risks. Barriers are erected to contain fragments whenever practical.

3.5.6 Radiography

3.5.6.1 Hazards

Use of radiography as diagnostic instrumentation on fire tests could accidentally expose personnel to x-rays.

3.5.6.2 Hazard Controls

Radiography is performed by the Nondestructive Testing Technology Department. Lurance Canyon Burn Site personnel follow procedures developed by that department to prevent accidental exposure from x-rays. A hazard zone is established and marked by a rope barrier and warning signs. Procedures prohibit personnel from the hazard zone during operation of the x-ray source. The boundary that is established ensures that personnel are exposed to less that 5 mrem per hour. The boundary limits are verified by survey meters.

3.5.7 Air Contaminants

3.5.7.1 Hazards

Burning JP-8 generates toxic pollutants of carbon monoxide and carbon particulate.

3.5.7.2 Hazard Controls

Open pool fire tests and enclosed fire tests in Building 9830 require a open burn permit, which is obtained in accordance with Sandia National Laboratories (1999a), Chapter 17, "Air Emissions." Tests are postponed in the event of poor ambient air quality conditions.

Personnel are restricted from the hazard zone around the test setup during and immediately after the fire to avoid exposure to the smoke plume. For large fires, the carbon monoxide production rate is estimated to be 9 g per second, and the carbon production rate is estimated to be 39 g per second. Total releases at these production rates, even for fires of two hours duration, are well below the Bernalillo County ambient air standards, which are the most stringent to be met.

3.5.8 FLAME Operations (Air Contaminants)

3.5.8.1 Hazards

The experiments conducted in FLAME are manned operations. However, the following hazards are present in high concentrations during testing:

- Inert gases (nitrogen, helium)
- Combustion products (smoke, carbon monoxide [CO], carbon dioxide [CO_2])
- Respirable particles (up to 67 g/m^3).
- Combustible gases (hydrogen, acetone, methane)

3.5.8.2 Hazard Controls

Self-contained breathing apparatus is used to enter the facility whenever gas or particles are flowing. Audio/video monitoring equipment is used to observe personnel who enter the facility whenever gases or particles are flowing. An experiment attendant is designated who monitors operations through the audio/video monitoring equipment. The "two-man rule" is followed at all times for manned operations when gases are introduced in the facility.

3.5.9 FLAME Operations (Open Flame)

3.5.9.1 Hazards

The open flame base is 1 m, and flame height can be up to 3 m. Hazards from the open flame include:

- Thermal infrared radiation

- Hot gases

- Ignition potential from the flame source

3.5.9.2 Hazard Controls

The tops of FLAME and air inlet dampers are open prior to tests to allow ventilation. The thermal radiation loads to the walls of the facility from the small fires of these operations do not present a thermal hazard to the facility because it was designed to handle larger fires. However, coolant can be circulated through the walls if necessary to maintain a constant wall temperature.

Personnel wear cotton long-sleeve shirts and long pants whenever open flame is present in the facility. Exposed skin is covered with sunscreen SPF 30 or better, and a Gardon-type heat flux gage is used to determine safe heat flux levels for entry into the facility.

3.5.10 FLAME Operations (Laser Light)

3.5.10.1 Hazards

A 200-mJ per pulse, 200-pulse per second, XeCl Excimer laser operating in the ultraviolet (UV) at 308 nm is used to create a light sheet for experiments. The laser is a Class IV laser and the beam is invisible. The hazards are blindness and severe skin burns.

3.5.10.2 Hazard Controls

Personnel wear protective goggles around the facility when the laser is operational. The laser operation is detailed in an ES&H SOP.

3.5.11 FLAME Operations (Pressurized Gas Systems)

3.5.11.1 Hazards

Pressurized gas systems are used to supply the gases and acetone for the experiments.

3.5.11.2 Hazard Controls

The systems are designed for manned operation in accordance with Sandia National Laboratories (1995). A pressure data package identifies system components, and safety relief valves prevent overpressurization. Pressurized gas cylinders and the primary gas manifold are located outside FLAME, and all piping is thermally shielded.

3.5.12 FLAME Operations (Materials)

3.5.12.1 Hazards

Industrial gases (nitrogen, helium, hydrogen, and methane) are used to create plumes, and acetone is sprayed into helium plumes at low concentrations (< 2.6% flammable limit) to fluoresce under the laser light to mark the plume boundary. Respirable particles are used to seed the plumes to scatter the laser light for imaging.

Solvents are used for cleaning optics.

3.5.12.2 Hazard Controls

Inert and combustible gases are stored separately outside FLAME per Sandia National Laboratories (1995), and acetone and solvents are stored in a designated area for flammable materials. Respirable particles are stored in closed cans.

3.5.13 Insulation

3.5.13.1 Hazard

High-temperature refractory ceramic fiber (RCF) is used extensively as insulation in test setups. Long-term exposure to RCF causes no known chronic health problems. However, after service above 1,600°F, RCF may undergo conversion to cristobalite, a form of crystalline silica that can cause the respiratory disease pneumoconiosis.

3.5.13.2 Hazard Controls

The material safety data sheet for RCF insulation recommends use of dust respirators in compliance with 29 CFR 1910.134. Respirators are used at all times when fabricating and dismantling test setups that use RCF insulation. Although insulation removed from test setups is not a hazardous waste, it is disposed of as hazardous waste.

3.5.14 Wastewater

3.5.14.1 Hazards

After a fire test, the pool water could contain residual jet fuel, ceramic fibers, solid particulate combustion products, and material from the test items.

3.5.14.2 Hazard Controls

The pool water is reused several times before disposal. The water is fed to the pools by gravity and pumped to the storage tank after tests. However, if a test object contains radioactive material, the pool water is tested for radioactivity prior to being returned to the storage tank. The pool water is removed from the tank before it exceeds standards set by the City of Albuquerque's sewer use and wastewater control ordinance. It is transported by tank truck to a preapproved discharge point designated by the City of Albuquerque.

(U.S. Department of Energy, 1994; 1995a; Tieszen, 1996)

3.6 Accident Analysis Summary

The Lurance Canyon Burn Site has been found to be a low-hazard nonnuclear facility by the SNL primary hazard screening process and does not require a safety analysis report. A follow-up hazards analysis is planned but is not expected to change the earlier finding.

(Gill, 1997)

3.7 Reportable Events

Lurance Canyon Burn Site has had no occurrences over the past five years.

3.8 Scenarios for Impact Analysis

In all of the scenarios for impact analysis in this section, base year values are for FY1996 unless otherwise noted.

3.8.1 Activity Scenarios

3.8.1.1 Scenario for Test Activities: Certification Testing

3.8.1.1.1 Alternatives for Test Activities: Certification Testing

Table 14-25 shows the alternatives for certification testing at the Lurance Canyon Burn Site.

Table 14-25. Alternatives for Test Activities: Certification Testing

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
1 test	12 tests	12 tests	12 tests	55 tests

3.8.1.1.2 Assumptions and Actions for the "Reduced" Values

Open pool fires simulate transportation accidents, which may cause pooling of spilled motor oil and gasoline. Gasoline is not used as a test fuel at Lurance Canyon Burn Site because it is too volatile. Aviation fuel, such as JP-8, can produce the same test results with less danger to site personnel. The amount of fuel used in a test is based on the size of the pool and the required test duration.

Rocket propellant fire tests evaluate the vulnerability of weapons and satellites to accident scenarios such as a missile fire on a launch pad. Propellants are ignited on a steel plate that is placed on the ground, and test objects are supported above the propellants. Rocket propellant fires may last up to 10 minutes. Up to 3,000 lb of propellant can be consumed, depending upon the size of the test object.

Wood fire or crib tests are conducted as a DOT requirement for explosive component shipping containers.

The value for the "reduced" alternative represents the minimum test level required to maintain the viability of this activity. For this to occur, certification testing for weapon modifications, work for Energy Programs, and work for the Other Federal Agencies Program would cease.

3.8.1.1.3 Assumptions and Rationale for the "No Action" Values

Base year values are actuals. Projections for the FY2003 and FY2008 timeframes assume that open pool fires for certification testing will remain equivalent to that of the base year projection with little change in level of activity.

3.8.1.1.4 Assumptions and Actions for the "Expanded" Values

The value for the "expanded" alternative assumes an increase in certification testing of weapon modifications and increased work for Energy Programs, Other Federal Agencies Program, and weapons research programs. Managers of the complex believe this to be a reasonable estimate of expanded activities. The quantity of fuel consumed and expenditures would increase, and additional personnel would be required.

3.8.1.2 Scenario for Test Activities: Model Validation

3.8.1.2.1 Alternatives for Test Activities: Model Validation

Table 14-26 shows the alternatives for model validation at the Lurance Canyon Burn Site.

Table 14-26. Alternatives for Test Activities: Model Validation

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 tests	56 tests	56 tests	56 tests	100 tests

3.8.1.2.2 Assumptions and Actions for the "Reduced" Values

The FLAME facility is being used to develop and validate the next generation of computational tools to investigate fire phenomenology. A large, laser-based technique to measure velocity and density fields in turbulent, reacting, buoyant plumes is being developed in the facility. Experiments are conducted with respirable seed particles and nonflammable and flammable gases. Velocity fields in gaseous flows are imaged by the scattering of laser light with the respirable particles. Acetone is sprayed into helium plumes to fluoresce under the laser light, marking the plume boundary.

Pool fires of up to two hours in duration are conducted inside Building 9830. These fires are conducted for the validation of computational models of fires in igloo-like buildings.

Actual testing is not required to maintain capability; however, technical skills and equipment would need to be kept current in order to resume this testing within a reasonable startup time. The "reduced" alternative assumes a cessation of model validation activity.

3.8.1.2.3 Assumptions and Rationale for the "No Action" Values

Base year values are actuals. The "no action" alternative assumes that model validation testing would remain equivalent to that of the base year with little to no change in levels of activity.

3.8.1.2.4 Assumptions and Actions for the "Expanded" Values

Managers of the complex believe the "expanded" value to be a reasonable estimate of expanded activities for this facility. The "expanded" alternative assumes a conservative increase in model validation activity of approximately double that of the "no action" timeframe. Expenditures would increase, and additional personnel would be required.

3.8.1.3 Scenario for Test Activities: User Testing

3.8.1.3.1 Alternatives for Test Activities: User Testing

Table 14-27 shows the alternatives for user testing at the Lurance Canyon Burn Site.

Table 14-27. Alternatives for Test Activities: User Testing

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 tests	37 tests	37 tests	37 tests	50 tests

3.8.1.3.2 Assumptions and Actions for the "Reduced" Values

Outside agencies use the SWISH facility on an as-available basis with no impact on expenditures and very little demand on staff. Actual testing is not required to maintain capability; however, technical skills and equipment would need to be kept current in order to resume this testing within a reasonable startup time. The "reduced" alternative assumes a cessation of user activity.

3.8.1.3.3 Assumptions and Rationale for the "No Action" Values

Base year values are actuals. The values for the FY2003 and FY2008 timeframes assume that user activity would remain equivalent to that of the base year, with little to no change in levels of activity.

3.8.1.3.4 Assumptions and Actions for the "Expanded" Values

Managers of the complex believe that the "expanded" alternative value is a reasonable and conservative estimate of expanded activities. The "expanded" alternative assumes an increase in user activity. However, no increase in expenses or personnel would be required because this activity is on an as-available basis.

There would be no increase in open burn permitting because the SWISH facility meets visible emissions and air quality regulations.

3.8.2 Material Inventories

3.8.2.1 Nuclear Material Inventory Scenario for Depleted Uranium

3.8.2.1.1 Alternatives for Depleted Uranium Nuclear Material Inventory

Table 14-28 shows the alternatives for depleted uranium inventory at the Lurance Canyon Burn Site.

Table 14-28. Alternatives for Depleted Uranium Nuclear Material Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 kg	0 kg	0 kg	0 kg	0 kg

3.8.2.1.2 Operations That Require Depleted Uranium

No operation at the complex requires depleted uranium or any other nuclear material. However, nuclear material may be included in test objects to authenticate certification of a system. As such, the material does not contribute to the operation, but it is subjected to it.

Ownership of the material being tested does not transfer to the management of the Lurance Canyon Burn Site. The material is maintained under SNL/NM security and kept in safe-secure facilities for a period of one to a few days. The inventory function is maintained by the security organization and accountability remains with the test request organization. As such, there is never an administrative inventory of nuclear material at Lurance Canyon Burn Site.

3.8.2.1.3 Basis for Projecting the “Reduced” and “Expanded” Values

This section is not applicable.

3.8.2.2 Radioactive Material Inventory Scenarios

The Lurance Canyon Burn Site has no radioactive material inventories.

3.8.2.3 Sealed Source Inventory Scenarios

The Lurance Canyon Burn Site has no sealed source inventories.

3.8.2.4 Spent Fuel Inventory Scenarios

The Lurance Canyon Burn Site has no spent fuel inventories.

3.8.2.5 Chemical Inventory Scenarios

The Lurance Canyon Burn Site has no inventories of chemicals of concern.

3.8.2.6 Explosives Inventory Scenarios

The Lurance Canyon Burn Site has no explosives inventories.

3.8.2.7 Other Hazardous Material Inventory Scenarios

The Lurance Canyon Burn Site has no inventories of hazardous materials that do not fall into the categories of nuclear or radioactive material, sealed sources, spent fuel, explosives, or chemicals.

3.8.3 Material Consumption

3.8.3.1 Nuclear Material Consumption Scenario for Depleted Uranium

3.8.3.1.1 Alternatives for Depleted Uranium Consumption

Table 14-29 shows the alternatives for depleted uranium consumption at the Lurance Canyon Burn Site.

Table 14-29. Alternatives for Depleted Uranium Consumption

Reduced Alternative		No Action Alternative						Expanded Alternative	
		Base Year		FY2003		FY2008			
0 pkgs	0 kg	0 pkgs	0 kg	0 pkgs	0 kg	0 pkgs	0 kg	0 pkgs	0 kg

3.8.3.1.2 Operations That Require Depleted Uranium

No operation at the Lurance Canyon Burn Site requires depleted uranium or any other nuclear material. Nuclear material is included within test objects to authenticate certification of systems. Thus, the nuclear material is subjected to testing at the complex. Nuclear material subjected to testing is recovered after tests and returned to the test requester.

3.8.3.1.3 Basis for Projecting the “Reduced” and “Expanded” Values

This section is not applicable.

3.8.3.2 Radioactive Material Consumption Scenarios

Radioactive material is not consumed at the Lurance Canyon Burn Site.

3.8.3.3 Chemical Consumption Scenarios

Information initially provided for this section resides in the Facility Information Manager database and will be made available to the analysts responsible for preparing the sitewide environmental impact statement.

3.8.3.4 Explosives Consumption Scenarios

Explosives are not consumed at the Lurance Canyon Burn Site.

3.8.4 Waste

3.8.4.1 Low-Level Radioactive Waste Scenario

Low-level radioactive waste is not produced at the Lurance Canyon Burn Site.

3.8.4.2 Transuranic Waste Scenario

Transuranic waste is not produced at the Lurance Canyon Burn Site.

3.8.4.3 Mixed Waste

3.8.4.3.1 Low-Level Mixed Waste Scenario

Alternatives for Low-Level Mixed Waste at the Lurance Canyon Burn Site **-** Table 14-30 shows the alternatives for low-level mixed waste at the Lurance Canyon Burn Site.

Table 14-30. Alternatives for Low-Level Mixed Waste

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 g	0 g	0 g	0 g	0 g

Operations That Generate Low-Level Mixed Waste **-** Normal operations do not generate low-level mixed waste. While tests are designed to preclude releases or radioactive and hazardous material under normal operations, materials from test assemblies could be accidentally released to the ground following impacts or explosions. In this event, cleanup of the area would produce some low-level mixed waste. Quantitative estimates are not available.

General Nature of Waste **-** Wastes could include depleted uranium and chemicals used in tests.

Waste Reduction Measures **-** No waste reduction measures exist.

Basis for Projecting the "Reduced" and "Expanded" Values - This section is not applicable.

3.8.4.3.2 Transuranic Mixed Waste Scenario

Transuranic mixed waste is not produced at the Lurance Canyon Burn Site.

3.8.4.4 Hazardous Waste Scenario

3.8.4.4.1 Alternatives for Hazardous Waste at the Lurance Canyon Burn Site

Table 14-31 shows the alternatives for hazardous waste at the Lurance Canyon Burn Site.

Table 14-31. Alternatives for Hazardous Waste

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
900 kg	900 kg	900 kg	900 kg	900 kg

3.8.4.4.2 Operations That Generate Hazardous Waste

High-temperature refractory ceramic fiber (RCF) is used extensively as insulation in test setups. Although the insulation removed from test setups is not a hazardous waste, it is disposed of as hazardous waste.

3.8.4.4.3 General Nature of Waste

After service above 1,600°F, RCF may undergo conversion to cristobalite, a form of crystalline silica that can cause pneumoconiosis, a respiratory disease.

3.8.4.4.4 Waste Reduction Measures

No waste reduction measures exist.

3.8.4.4.5 Basis for Projecting the "Reduced" and "Expanded" Values

The quantity of annual usage of RCF insulation does not depend on test activity levels because it is replaced periodically.

3.8.5 Emissions

3.8.5.1 Radioactive Air Emissions Scenarios

Radioactive air emissions are not produced at the Lurance Canyon Burn Site.

3.8.5.2 Chemical Air Emissions

Information on an extensive list of chemicals was obtained from the SNL/NM Chemical Inventory System (CIS). For the air emissions analysis, the entire annual inventory of these chemicals was assumed to have been released over a year of operations for each specific facility (i.e., the annual inventory was divided by facility operating hours). The emissions from this release were then subjected, on a chemical-by-chemical basis, to a progressive series of screening steps for potential exceedances of both regulatory and human health thresholds. For those chemicals found to exceed this screening, process knowledge was used to derive emission factors. The emission factors for these chemicals were then modeled using the U.S. Environmental Protection Agency's *Industrial Source Complex Air Quality Dispersion Model, Version 3*. The results of this modeling are discussed as part of the analysis in support of the SNL/NM site-wide environmental impact statement.

3.8.5.3 Open Burning Scenarios

3.8.5.3.1 Open Burning Scenario for JP-8 Aviation Fuel

Alternatives for JP-8 Aviation Fuel Open Burning at the Lurance Canyon Burn Site **-** Table 14-32 shows the alternatives for JP-8 aviation fuel open burning at the Lurance Burn Canyon Burn Site.

Table 14-32. Alternatives for JP-8 Aviation Fuel Open Burning

Reduced Alternative		No Action Alternative						Expanded Alternative	
		Base Year		FY2003		FY2008			
1 burn	1,500 gal	15 burns	5,000 gal	15 burns	5,000 gal	15 burns	5,000 gal	50 burns	25,000 gal

Description of JP-8 Aviation Fuel Open Burning Operations **-** There were 15 open pool fires during the base year:

- Two of 400 ft^2
- Six of 100 ft^2
- Seven of 80 ft2

A cumulative total of 5,000 gal of fuel was burned.

Basis for Projecting the "Reduced" and "Expanded" Values **-** The "reduced" value assumes one 1,500-gal open pool fire to maintain viability of the Lurance Canyon Burn Site. The "expanded" value assumes 50 open pool fires with an average of 500 gal of fuel burned per fire (one fire per week over a 50-week operational year).

3.8.5.3.2 Open Burning Scenario for Wood

Alternatives for Wood Open Burning at the Lurance Canyon Burn Site **-** Table 14-33 shows the alternatives for wood open burning at the Lurance Canyon Burn Site.

Table 14-33. Alternatives for Wood Open Burning

Reduced Alternative		No Action Alternative						Expanded Alternative	
		Base Year		FY2003		FY2008			
0 burns	0 kg	2 burns	1,000 kg	2 burns	1,000 kg	2 burns	1,000 kg	10 burns	5,000 kg

Description of Wood Open Burning Operations **-** Wood or crib fire tests are conducted as a DOT certification requirement for explosive component shipping containers.

Basis for Projecting the "Reduced" and "Expanded" Values **-** The "reduced" value assumes that no wood or crib fire tests are conducted. Actual wood or crib fire tests are not required to maintain capability; however, technical skills and equipment would need to be kept current in order to resume this testing within a reasonable startup time.

The value for the "expanded" alternative assumes that 10 wood or crib fire tests are conducted because of an increase in certification testing for explosive component shipping containers. Managers of the complex believe that this is a reasonable estimate of expanded activities for this facility.

3.8.5.3.3 Open Burning Scenario for Rocket Propellant

Alternatives for Rocket Propellant Open Burning at the Lurance Canyon Burn Site - Table 14-34 shows the alternatives for rocket propellant open burning at the Lurance Canyon Burn Site.

Table 14-34. Alternatives for Rocket Propellant Open Burning

Reduced Alternative		No Action Alternative						Expanded Alternative	
		Base Year		FY2003		FY2008			
0 burns	0 kg	0 burns	0 kg	0 burns	0 kg	0 burns	0 kg	5 burns	7,500 kg

Description of Rocket Propellant Open Burning Operations - Rocket propellant fire tests are conducted to evaluate the vulnerability of weapons and satellites to accident scenarios such as a missile fire on a launch pad. Fires may last up to 10 minutes and consume up to 1,500 kg of propellant.

Basis for Projecting the "Reduced" and "Expanded" Values - The value projected for the "reduced" alternative assumes that no propellant fire tests are conducted. Actual rocket propellant fire tests are not required to maintain capability; however, technical skills and equipment would need to be kept current in order to resume this testing within a reasonable startup time.

The value for the "expanded" alternative assumes that five 1,500-kg propellant fire tests of weapons or satellites are conducted. Managers of the complex believe that this is a reasonable estimate of expanded activities for this facility.

3.8.5.4 Process Wastewater Effluent Scenario

3.8.5.4.1 Alternatives for Process Wastewater at the Lurance Canyon Burn Site

Table 14-35 shows the alternatives for process wastewater at Lurance Canyon Burn Site.

Table 14-35. Alternatives for Process Wastewater

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
25,000 gal	25,000 gal	25,000 gal	25,000 gal	25,000 gal

3.8.5.4.2 Operations That Generate Process Wastewater

Water is used to protect pool structures during fire tests. Fuel is floated on the water for the fire.

3.8.5.4.3 General Nature of Effluents

After fire tests, the pool water could contain residual jet fuel, ceramic fibers, solid particulate combustion products, and materials from the test items.

3.8.5.4.4 Effluent Reduction Measures

No effluent reduction measures exist.

3.8.5.4.5 Basis for Projecting the "Reduced" and "Expanded" Values

Projections for water use remain unchanged across all scenarios because the water is continually recycled for reuse with all pool fire testing. The water is disposed of once per year independent of the number of tests. The increased numbers of pool fires assumed under the "expanded" alternative would not be anticipated to increase water use or disposal above the projected numbers (25,000 gal of water disposed of and replenished once annually).

3.8.6 Resource Consumption

3.8.6.1 Process Water Consumption Scenario

3.8.6.1.1 Alternatives for Process Water Consumption at the Lurance Canyon Burn Site

Table 14-36 shows the alternatives for process water consumption at the Lurance Canyon Burn Site.

Table 14-36. Alternatives for Process Water Consumption

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 gal	0 gal	0 gal	0 gal	0 gal

3.8.6.1.2 Operations That Consume Process Water

The amount of pool fire water lost to evaporation is not sufficient to drive water use, disposal, or replenishment above the numbers projected in "3.8.5.3 Open Burning Scenarios."

3.8.6.1.3 Consumption Reduction Measures

This section is not applicable.

3.8.6.1.4 Basis for Projecting the “Reduced” and “Expanded” Values

This section is not applicable.

3.8.6.2 Process Electricity Consumption Scenario

The Lurance Canyon Burn Site does not consume process electricity.

3.8.6.3 Boiler Energy Consumption Scenario

The Lurance Canyon Burn Site does not consume energy for boilers.

3.8.6.4 Facility Personnel Scenario

3.8.6.4.1 Alternatives for Facility Staffing at the Lurance Canyon Burn Site

Table 14-37 shows the alternatives for facility staffing at the Lurance Canyon Burn Site.

Table 14-37. Alternatives for Facility Staffing

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
3.5 FTEs	4.5 FTEs	4.5 FTEs	4.5 FTEs	11 FTEs

3.8.6.4.2 Operations That Require Facility Personnel

Certification testing and model validations require personnel. User testing is essentially the use of the site by outside federal agencies and requires a minimum of involvement from facility personnel. The “no action” alternative has a mix of 2.5 SNL and 2 contractor personnel.

3.8.6.4.3 Staffing Reduction Measures

No staffing reduction measures exist.

3.8.6.4.4 Basis for Projecting the “Reduced” and “Expanded” Values

Table 14-38 shows the breakdown of the number of staff indicated in the “reduced” alternative, which is the minimum to maintain the viability of the Lurance Canyon Burn Site.

Table 14-38. Breakdown of Staffing for the Reduced Alternative

Test	SNL Staff			Contractor
	Engineer	Technician	Administrative	
Certification testing	1	1	0.2	1
Model validation	0.3	0	0	0

Total costs for the reduced alternative in FY1998 dollars is $600,000.

Table 14-39 shows the breakdown of FTEs for the “expanded” alternative.

Table 14-39. Breakdown of FTEs for the Expanded Alternative

Test	SNL Staff			Contractor
	Engineer	Technician	Administrative	
Certification testing	2	2	0.3	3
Model validation	1	1	0.2	1

Total costs in FY1998 dollars for the expanded alternative is $1.7 million.

The user scenario (see “3.8.1 Activity Scenarios”) does not result in any additional FTEs because the designated user group provides its own support personnel.

3.8.6.5 Expenditures Scenario

3.8.6.5.1 Alternatives for Expenditures at the Lurance Canyon Burn Site

Table 14-40 shows the alternatives for expenditures at the Lurance Canyon Burn Site.

Table 14-40. Alternatives for Expenditures

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
$150,000	$250,000	$275,000	$300,000	$625,000

3.8.6.5.2 Operations That Require Expenditures

These expenditures are for certification testing and model validation.

3.8.6.5.3 Expenditure Reduction Measures

No expenditure reduction measures exist.

3.8.6.5.4 Basis for Projecting the "Reduced" and "Expanded" Values

The expenditures for the "reduced" alternative are the minimum to maintain the viability of the Lurance Canyon Burn Site.

Table 14-41 shows the breakdown of the expenditures listed in the "Expanded" column (of Table 14-40).

Table 14-41. Breakdown of Expenditures for the Expanded Alternative

Activities	Expenditures
Certification testing	$425,000
Model validation	$200,000

4.0 CONTAINMENT TECHNOLOGY TEST FACILITY SOURCE INFORMATION

4.1 Purpose and Need

Containment Technology Test Facility - West conducts containment model testing for the U.S. Nuclear Regulatory Commission and the Nuclear Power Engineering Corporation, Tokyo, Japan. This research is needed to support reactor containment research and development.

(Emerson, 1992; U.S. Department of Energy, 1992a)

4.2 Description

The Containment Technology Test Facility - West is located in Coyote Test Field of Kirtland Air Force Base and includes two scale-model containment buildings. One model is a 1:4 scale representation of a two-buttress, prestressed concrete containment structure with a flat concrete basemat, cylindrical sides, and hemispheric dome and dimensions of 25 ft (diameter) by 43 ft (height). The other model is a 1:10 scale steel containment structure that will be fabricated in Japan and shipped to SNL for testing. The diameter of this model will be approximately 10 ft, and the overall height will be approximately 21 ft.

All support facilities will be temporary and portable. Following the test program, the sites will be restored.

(Emerson, 1992; U.S. Department of Energy, 1992a)

4.3 Program Activities

Table 14-42 shows the program activities at the Containment Technology Test Facility - West.

Table 14-42. Program Activities at the Containment Technology Test Facility – West

Program Name	Activities at the Containment Technology Test Facility - West	Category of Program	Related Section of the *SNL Institutional Plan*
Nuclear Regulatory Commission	Test reactor containment building models.	Work for Non-DOE Entities (Work for Others)	Section 6.2.2

4.4 Operations and Capabilities

Both the prestressed concrete containment structure and steel containment were constructed to be tested to failure by pneumatic overpressurization with nitrogen gas (Sandia National Laboratories, 1997b).

4.5 Hazards and Hazard Controls

For testing of the prestressed concrete containment structure, an exclusion zone of 2,000-ft radius is required to accommodate the travel distance of possible fragments in the event of catastrophic failure.

For testing of the steel containment structure, an exclusion zone of 1,500-ft radius and a physical barrier is required during the test to accommodate the travel distance of possible fragments from the model in the event of a catastrophic failure.

The exclusion zones will be required only during the actual testing, which is expected to last less than four days.

Noise generation during construction should be moderate, and the sound pressure wave from catastrophic failure of the models will dissipate to below 145 decibels at the boundary of the exclusion zones.

(Kromer, 1997)

4.6 Accident Analysis Summary

The Containment Technology Test Facility - West has been found to be a low-hazard nonnuclear facility by SNL primary hazard screening process and does not require a safety analysis report. A follow-up hazards analysis is planned but is not expected to change the earlier finding (Kromer, 1997).

4.7 Reportable Events

The Containment Technology Test Facility - West has had no occurrences over the past five years.

4.8 Scenarios for Impact Analysis

In all of the scenarios for impact analysis in this section, base year values are for FY1996 unless otherwise noted.

4.8.1 Scenario for Test Activities: Survivability Testing

4.8.1.1 Alternatives for Test Activities: Survivability Testing

Table 14-43 shows the alternatives for survivability testing at the Containment Technology Test Facility - West.

Table 14-43. Alternatives for Test Activities: Survivability Testing

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
1 test	0 tests	2 tests	0 tests	2 tests

4.8.1.2 Assumptions and Actions for the “Reduced” Values

To maintain technical capability, the facility would need at least one test in the facility cycle. Time from initiating planning to completion of the test would be six years for most testing efforts.

4.8.1.3 Assumptions and Rationale for the “No Action” Values

Planning for the two tests began in 1991. Each test involves a series of successive events leading up to ultimate failure of the two test vessels. The first test was completed in FY1997 and the second is scheduled for completion in FY2000. After the second test, there are no further plans for additional testing.

4.8.1.4 Assumptions and Actions for the "Expanded" Values

The current program, which involves two overlapping test cycles, represents the capacity of the Containment Technology Test Facility - West.

4.8.2 Material Inventories

4.8.2.1 Nuclear Material Inventory Scenarios

The Containment Technology Test Facility - West has no nuclear material inventories.

4.8.2.2 Radioactive Material Inventory Scenarios

The Containment Technology Test Facility - West has no radioactive material inventories.

4.8.2.3 Sealed Source Inventory Scenarios

The Containment Technology Test Facility - West has no sealed source inventories.

4.8.2.4 Spent Fuel Inventory Scenarios

The Containment Technology Test Facility - West has no spent fuel inventories.

4.8.2.5 Chemical Inventory Scenarios

The Containment Technology Test Facility - West has no inventories of chemicals of concern.

4.8.2.6 Explosives Inventory Scenarios

The Containment Technology Test Facility - West has no explosives inventories.

4.8.2.7 Other Hazardous Material Inventory Scenario for Adhesives

4.8.2.7.1 Alternatives for Adhesives Inventory

Table 14-44 shows the alternatives for adhesives inventory at the Containment Technology Test Facility - West.

Table 14-44. Alternatives for Adhesives Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
500 g	500 g	500 g	0 g	500 g

4.8.2.7.2 Operations That Require Adhesives

Small amounts of adhesives are used to install strain gages on the models. First, a conditioner that contains 10 percent phosphoric acid and a neutralizer that contains 10 percent ammonium hydroxide are applied. The conditioner has been identified as a carcinogen. The adhesive used to actually mount the gage is an epoxy. Finally, a wax, RTV, and epoxy coating is used over the gages.

4.8.2.7.3 Basis for Projecting the “Reduced” and “Expanded” Values

The small amounts of adhesives needed would not vary with the range of tests that are planned.

4.8.3 Material Consumption

4.8.3.1 Nuclear Material Consumption Scenarios

Nuclear material is not consumed at the Containment Technology Test Facility - West.

4.8.3.2 Radioactive Material Consumption Scenarios

Radioactive material is not consumed at the Containment Technology Test Facility - West.

4.8.3.3 Chemical Consumption Scenarios

Information initially provided for this section resides in the Facility Information Manager database and will be made available to the analysts responsible for preparing the sitewide environmental impact statement.

4.8.3.4 Explosives Consumption Scenarios

Explosives are not consumed at the Containment Technology Test Facility - West.

4.8.4 Waste

4.8.4.1 Low-Level Radioactive Waste Scenario

Low-level radioactive waste is not produced at the Containment Technology Test Facility - West.

4.8.4.2 Transuranic Waste Scenario

Transuranic waste is not produced at the Containment Technology Test Facility - West.

4.8.4.3 Mixed Waste

4.8.4.3.1 Low-Level Mixed Waste Scenario

Low-level mixed waste is not produced at the Containment Technology Test Facility - West.

4.8.4.3.2 Transuranic Mixed Waste Scenario

Transuranic mixed waste is not produced at the Containment Technology Test Facility - West.

4.8.4.4 Hazardous Waste Scenario

4.8.4.4.1 Alternatives for Hazardous Waste at the Containment Technology Test Facility - West

Table 14-45 shows the alternatives for hazardous waste at the Containment Technology Test Facility - West.

Table 14-45. Alternatives for Hazardous Waste

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
100 g	100 g	100 g	0 g	100 g

4.8.4.4.2 Operations That Generate Hazardous Waste

The waste-generating operation is the installation of the strain gage and disposal of debris after model destruction.

4.8.4.4.3 General Nature of Waste

The waste includes phosphorous acid, ammonium hydroxide, and adhesive.

4.8.4.4.4 Waste Reduction Measures

No waste reduction measures exist.

4.8.4.4.5 Basis for Projecting the "Reduced" and "Expanded" Values

The projections of the "reduced" and "expanded" values are based on process knowledge.

4.8.5 Emissions

4.8.5.1 Radioactive Air Emissions Scenarios

Radioactive air emissions are not produced at the Containment Technology Test Facility - West.

4.8.5.2 Chemical Air Emissions

Information on an extensive list of chemicals was obtained from the SNL/NM Chemical Inventory System (CIS). For the air emissions analysis, the entire annual inventory of these chemicals was assumed to have been released over a year of operations for each specific facility (i.e., the annual inventory was divided by facility operating hours). The emissions from this release were then subjected, on a chemical-by-chemical basis, to a progressive series of screening steps for potential exceedances of both regulatory and human health thresholds. For those chemicals found to exceed this screening, process knowledge was used to derive emission factors. The emission factors for these chemicals were then modeled using the U.S. Environmental Protection Agency's *Industrial Source Complex Air Quality Dispersion Model, Version 3*. The results of this modeling are discussed as part of the analysis in support of the SNL/NM site-wide environmental impact statement.

4.8.5.3 Open Burning Scenarios

The Containment Technology Test Facility - West does not have outdoor burning operations.

4.8.5.4 Process Wastewater Effluent Scenario

The Containment Technology Test Facility - West does not generate process wastewater.

4.8.6 Resource Consumption

4.8.6.1 Process Water Consumption Scenario

The Containment Technology Test Facility - West does not consume process water.

4.8.6.2 Process Electricity Consumption Scenario

The Containment Technology Test Facility - West does not consume process electricity.

4.8.6.3 Boiler Energy Consumption Scenario

The Containment Technology Test Facility does not consume energy for boilers.

4.8.6.4 Facility Personnel Scenario

4.8.6.4.1 Alternatives for Facility Staffing at the Containment Technology Test Facility - West

Table 14-46 shows the alternatives for facility staffing at the Containment Technology Test Facility - West.

Table 14-46. Alternatives for Facility Staffing

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
12 FTEs	12 FTEs	12 FTEs	0 FTEs	12 FTEs

4.8.6.4.2 Operations That Require Facility Personnel

Operations that require staff include planning, analysis, instrumentation, pressure testing, and data acquisition.

4.8.6.4.3 Staffing Reduction Measures

No staffing reduction measures exist other than those associated with planned termination of the program.

4.8.6.4.4 Basis for Projecting the “Reduced” and “Expanded” Values

If the program is to continue at any level, the number of personnel needed would remain constant.

4.8.6.5 Expenditures Scenario

4.8.6.5.1 Alternatives for Expenditures at the Containment Technology Test Facility - West

Table 14-47 shows the alternatives for expenditures for the Containment Technology Test Facility - West.

Table 14-47. Alternatives for Expenditures

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
$2 million	$2 million	$2 million	$0	$2 million

4.8.6.5.2 Operations That Require Expenditures

Operations that require expenditures include planning, analysis, instrumentation, pressure testing, and data acquisition.

4.8.6.5.3 Expenditure Reduction Measures

No expenditure reduction measures exist other than those associated with planned termination of the program.

4.8.6.5.4 Basis for Projecting the “Reduced” and “Expanded” Values

If the program is to continue at any level, the level of expenditures would remain constant.

5.0 EXPLOSIVES APPLICATIONS LABORATORY SOURCE INFORMATION

5.1 Purpose and Need

The Explosives Applications Laboratory in the Coyote Canyon Test Field is used for the design, assembly, and testing of explosive experiments in support of SNL-wide programs. SNL/NM needs the Explosives Application Laboratory for support of the Nuclear Emergency Search Team, field test arming and fusing, incendiary warhead development, and development of emergency destruct systems.

5.2 Description

The Explosives Applications Laboratory is located at Building 9930 at Coyote Test Field. Equipment at the facility includes the following:

- Digital oscilloscopes
- Electronic monitoring devices
- Video equipment
- High-speed cameras and other photography equipment
- Lasers
- X-ray equipment
- Darkroom
- Electrical/soldering benches
- Chemical storage cabinets

The facility also includes:

- A small complex of offices housed in temporary buildings MO216/217
- Five explosives storage igloos
- Milling machines
- Belt sander
- Micro-lathe
- Electric and gas welding equipment
- Miterbox saw
- A machine shop with the following equipment:
    - Lathe
    - Two drill presses
    - Pedestal grinder
    - Band saws
    - Forklifts and hoists
    - Hand tools

(U.S. Department of Energy, 1995b)

5.3 Program Activities

Table 14-48 shows the program activities at the Explosives Applications Laboratory.

Table 14-48. Program Activities at the Explosives Applications Laboratory

Program Name	Activities at the Explosives Applications Laboratory	Category of Program	Related Section of the *SNL Institutional Plan*
Direct Stockpile Activities	Conduct research, development, application, and surveillance of energetic materials and components.	Programs for the Department of Energy	Section 6.1.1.1
Experimental Activities	The Explosive Applications Laboratory is used for the development and testing of a full range of explosive devices, components, subsystems, and complete systems. This site is used primarily in support of the Nuclear Safety testing requirements, Nuclear Emergency Search Team (NEST) and similar programs.	Programs for the Department of Energy	Section 6.1.1.1
Other Federal Agencies	The Explosive Applications Laboratory is used for the development and testing of explosive devices, components, subsystems, and complete systems in the support of nuclear safety testing requirements.	Work for Non-DOE Entities (Work for Others)	Section 6.2.7

5.4 Operations and Capabilities

Work at the facility involves arming, fuzing, and firing of explosives and the testing of components of explosive systems. Additional operations in accomplishing these tasks include:

- Working with low-voltage (28 V DC or less) electronic circuits.
- Working with intermediate- and high-voltage circuitry such as those associated with firesets to initiate explosives (typically 3,000 V).
- Performing x-ray analysis which, depending on the system, can involve working with systems that operate at 150,000 V or 300,000 V.
- Fabricating a small number of electronic assemblies, which involves soldering and subsequent cleaning of electronic circuitry.

- Handling and assembly of explosive experiments on a daily basis.

- Developing film in the facility darkroom in an automatic film processor and producing a limited amount of black-and-white still photography prints as part of x-ray analysis.

- Operating a small machine shop.

(U.S. Department of Energy, 1995b)

5.5 Hazards and Hazard Controls

The following summarizes hazards and hazard controls at the Explosives Applications Laboratory:

- Building 9930 and each of the four storage igloos is limited to 50 lb of explosives with the exception of Building 9932, which is approved to store up to 1,000 lb of explosives. All explosives and associated operations are only handled in strict accordance with SNL, DOE, U.S. Air Force, and facility-specific requirements and procedures. Personnel are adequately trained and knowledgeable in handling and assembling explosive experiments, and procedures are outlined in ES&H procedures. An explosives safety officer makes all safety decisions on the handling, assembly, disassembly, disposal, or other operations connected with any explosive or explosive device.

- Occasionally, welding operations are performed using either electric arc or oxygen and acetylene. Acetylene is uniquely hazardous because it is shock-sensitive when pressurized above 15 psi and because it can explode without any oxidizer or heat. Therefore, personnel maintain strict compliance with the applicable ES&H procedures. Operators set the gas pressure and flow rates as prescribed in the manufacturer's handbook to maintain safety, and the oxygen and acetylene gas lines have flashback arrestors. All equipment exposed to acetylene gas is Factory Mutual certified and approved for acetylene.

- The two commercially available flash x-ray analysis systems that operate at 150 kV and 300 kV are properly shielded, monitored, and maintained to limit exposures that are as low as reasonably achievable (ALARA). Potential exposures to radiation are mitigated by engineering controls, personal protective equipment, training, and administrative controls.

- All operations and precautions for working with intermediate- and high-voltage systems are covered by ES&H procedures.

- Soldering and cleaning of electronic circuitry is done within the shop area where a soldering station vent is present. To solder and clean electronic circuitry correctly, the department maintains a limited collection of solvents and solders (lead/tin alloy). Procedures and precautions for these operations are covered by ES&H procedures.

- Chemicals used in this facility are primarily limited to adhesives, cleaning solvents, and lubricants, some of which are flammable liquids. Flammable materials are stored only in approved flammable material storage cabinets. All chemicals are handled and stored in strict accordance with Sandia National Laboratories (1988; 1999a) and material safety data sheets.

- The chemicals associated with photography processes are maintained in an orderly manner and covered by ES&H procedures.

- The facility disposes of wastes only through SNL waste management processes following established ES&H procedures. Under routine operations, there are no explosive wastes.

(U.S. Department of Energy, 1995b)

5.6 Accident Analysis Summary

The Explosives Application Laboratory has been found to be a low-hazard nonnuclear facility by SNL primary hazard screening process and does not require a safety analysis report. A follow-up hazards analysis is planned but is not expected to change the earlier finding.

5.7 Reportable Events

The Explosives Applications Laboratory has had no occurrences over the past five years.

5.8 Scenarios for Impact Analysis

In all of the scenarios for impact analysis in this section, base year values are for FY1996 unless otherwise noted.

5.8.1 Activity Scenario for Test Activities: Explosive Testing

5.8.1.1 Alternatives for Test Activities: Explosive Testing

Table 14-49 shows the alternatives for explosives testing at the Explosives Applications Laboratory.

Table 14-49. Alternatives for Test Activities: Explosive Testing

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
50 tests	240 tests	240 tests	240 tests	275 to 360 tests

5.8.1.2 Assumptions and Actions for the "Reduced" Values

Maintaining the site capability and qualifications of firing officers and personnel would require approximately 50 tests per year to ensure that personnel maintain minimum qualifications for arming, fusing, and firing of explosives and explosives components.

5.8.1.3 Assumptions and Rationale for the "No Action" Values

Program demands for testing explosives are projected to be stable over the period of 1996 to 2008. The estimate is based on an assessment of the likely requirements of the various programs served by the facility.

5.8.1.4 Assumptions and Actions for the "Expanded" Values

Activities under the "expanded" alternative could range from 275 to 360 tests with the facility operating at its maximum capacity.

5.8.2 Material Inventories

5.8.2.1 Nuclear Material Inventory Scenarios

The Explosives Applications Laboratory has no nuclear material inventories.

5.8.2.2 Radioactive Material Inventory Scenarios

The Explosives Applications Laboratory has no radioactive material inventories.

5.8.2.3 Sealed Source Inventory Scenarios

The Explosives Applications Laboratory has no sealed source inventories.

5.8.2.4 Spent Fuel Inventory Scenarios

The Explosives Applications Laboratory has no spent fuel inventories.

5.8.2.5 Chemical Inventory Scenarios

The Explosives Applications Laboratory has no inventories of chemicals of concern.

5.8.2.6 Explosives Inventory Scenarios

5.8.2.6.1 Explosives Inventory Scenario for Bare UNO 1.1

Alternatives for Bare UNO 1.1 Explosives Inventory - Table 14-50 shows the alternatives for bare UNO 1.1 explosives inventory at the Explosives Applications Laboratory.

Table 14-50. Alternatives for Bare UNO 1.1 Explosives Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
219, 000 g	327,000 g	327,000 g	327,000 g	490,000 g

Operations That Require Bare UNO 1.1 **-** Explosives testing operations require the arming, fusing, and firing of explosives and explosives components.

Basis for Projecting the "Reduced" and "Expanded" Values **-** Levels of explosives inventories are approximately proportional to the number of explosive tests conducted except under the "reduced alternative," where the ratio of inventory to shots will be greater.

5.8.2.6.2 Explosives Inventory Scenario for Bare UNO 1.2

Alternatives for Bare UNO 1.2 Explosives Inventory - Table 14-51 shows the alternatives for bare UNO 1.2 explosives at the Explosives Applications Laboratory.

Table 14-51. Alternatives for Bare UNO 1.2 Explosives Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
44,000 g	65,500 g	65,500 g	65,500 g	98,250 g

Operations That Require Bare UNO 1.2 **-** Explosives testing operations require the arming, fusing, and firing of explosives and explosives components.

Basis for Projecting the "Reduced" and "Expanded" Values **-** Levels of explosives inventories are approximately proportional to the number of explosive tests conducted except under the "reduced" alternative, where the ratio of inventory to shots will be greater.

5.8.2.6.3 Explosives Inventory Scenario for Bare UNO 1.3

***Alternatives for Bare UNO 1.3 Explosives Inventory* -** Table 14-52 shows the alternatives for bare UNO 1.3 explosives inventory at the Explosives Applications Laboratory.

Table 14-52. Alternatives for Bare UNO 1.3 Explosives Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
1,430,000 g	2,140,000 g	2,140,000 g	2,140,000 g	3,210,000 g

***Operations That Require Bare UNO 1.3* -** Explosives testing operations require the arming, fusing, and firing of explosives and explosives components.

***Basis for Projecting the "Reduced" and "Expanded" Values* -** Levels of explosives inventories are approximately proportional to the number of explosive tests conducted except under the "reduced" alternative, where the ratio of inventory to shots will be greater.

5.8.2.6.4 Explosives Inventory Scenario for Bare UNO 1.4

***Alternatives for Bare UNO 1.4 Explosives Inventory* -** Table 14-53 shows the alternatives for bare UNO 1.4 explosives inventory at the Explosives Applications Laboratory.

Table 14-53. Alternatives for Bare UNO 1.4 Explosives Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
1,800,000 g	2,700,000 g	2,700,000 g	2,700,000 g	4,050,000 g

***Operations That Require Bare UNO 1.4* -** Explosives testing operations require the arming, fusing, and firing of explosives and explosives components.

***Basis for Projecting the "Reduced" and "Expanded" Values* -** Levels of explosives inventories are approximately proportional to the number of explosive tests conducted except under the "reduced" alternative, where the ratio of inventory to shots will be greater.

5.8.2.7 Other Hazardous Material Inventory Scenario for Film Developer/Fixer

5.8.2.7.1 Alternatives for Film Developer/Fixer Inventory

Table 14-54 shows the alternatives for film developer and fixer at the Explosives Applications Laboratory.

Table 14-54. Alternatives for Film Developer/Fixer Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
10 gal	10 gal	10 gal	10 gal	20 gal

5.8.2.7.2 Operations That Require Film Developer/Fixer

Film developer and fixer are used only when flash x-ray photography of tests takes place.

5.8.2.7.3 Basis for Projecting the “Reduced” and “Expanded” Values

The amount of chemical indicated under the “reduced” alternative would likely remain in inventory even if no x-ray photography were to take place. For the “expanded” alternative, the amount of chemical indicated reflects an increase in x-ray flash photography double that of “no action” values. This is possible but is considered unlikely.

5.8.3 Material Consumption

5.8.3.1 Nuclear Material Consumption Scenarios

Nuclear material is not consumed at the Explosives Applications Laboratory.

5.8.3.2 Radioactive Material Consumption Scenarios

Radioactive material is not consumed at the Explosives Applications Laboratory.

5.8.3.3 Chemical Consumption Scenarios

Information initially provided for this section resides in the Facility Information Manager database and will be made available to the analysts responsible for preparing the sitewide environmental impact statement.

5.8.3.4 Explosives Consumption Scenarios

5.8.3.4.1 Explosives Consumption Scenario for Bare UNO 1.1 Explosives

Alternatives for Bare UNO 1.1 Explosives Consumption - Table 14-55 shows the alternatives for bare UNO 1.1 explosives consumption at the Explosives Applications Laboratory.

Table 14-55. Explosives Consumption Scenario

Reduced Alternative		No Action Alternative						Expanded Alternative	
		Base Year		FY2003		FY2008			
86 pkgs	117,000 g	128 pkgs	175,000 g	128 pkgs	175,000 g	128 pkgs	175,000 g	192 pkgs	263,000 g

***Operations That Require Bare UNO 1.1 Explosives* -** Explosives testing operations require the arming, fusing, and firing of explosives and explosives components.

***Basis for Projecting the "Reduced" and "Expanded" Values* -** Levels of explosives consumption are approximately proportional to the number of explosive tests conducted.

5.8.3.4.2 Explosives Consumption Scenario for Bare UNO 1.2 Explosives

***Alternatives for Bare UNO 1.2 Explosives Consumption* -** Table 14-56 shows the alternatives for bare UNO 1.2 explosives at the Explosives Applications Laboratory.

Table 14-56. Alternatives for Bare UNO 1.2 Explosives Consumption

Reduced Alternative		No Action Alternative						Expanded Alternative	
		Base Year		FY2003		FY2008			
34 pkgs	670 g	50 pkgs	1,000 g	50 pkgs	1,000 g	50 pkgs	1,000 g	75 pkgs	1,500 g

***Operations That Require Bare UNO 1.2 Explosives* -** Explosive testing operations require the arming, fusing, and firing of explosives and explosives components.

***Basis for Projecting the "Reduced" and "Expanded" Values* -** Levels of explosives consumption are approximately proportional to the number of explosive tests conducted.

5.8.3.4.3 Explosives Consumption Scenario for Bare UNO 1.3 Explosives

***Alternatives for Bare UNO 1.3 Explosives Consumption* -** Table 14-57 shows the alternatives for bare UNO 1.3 explosives consumption at the Explosives Application Laboratory.

Table 14-57. Alternatives for Bare UNO 1.3 Explosives Consumption

Reduced Alternative		No Action Alternative						Expanded Alternative	
		Base Year		FY2003		FY2008			
170 pkgs	6700 g	250 pkgs	10,000 g	250 pkgs	10,000 g	250 pkgs	10,000 g	375 pkgs	15,000 g

Operations That Require Bare UNO 1.3 Explosives **-** Explosives testing operations require the arming, fusing, and firing of explosives and explosives components.

Basis for Projecting the "Reduced" and "Expanded" Values **-** Levels of explosives consumption are approximately proportional to the number of explosive tests conducted.

5.8.3.4.4 Explosives Consumption Scenario for Bare UNO 1.4 Explosives

Alternatives for Bare UNO 1.4 Explosives Consumption **-** Table 14-58 shows the alternatives for bare UNO 1.4 explosives consumption at the Explosives Applications Laboratory.

Table 14-58. Alternatives for Bare UNO 1.4 Explosives Consumption

Reduced Alternative		No Action Alternative						Expanded Alternative	
		Base Year		FY2003		FY2008			
34 pkgs	670 g	50 pkgs	1,000 g	50 pkgs	1,000 g	50 pkgs	1,000 g	75 pkgs	1,500 g

Operations That Require Bare UNO 1.4 Explosives **-** Explosives testing operations require the arming, fusing, and firing of explosives and explosives components.

Basis for Projecting the "Reduced" and "Expanded" Values **-** Levels of explosives consumption are approximately proportional to the number of explosive tests conducted.

5.8.4 Waste

5.8.4.1 Low-Level Radioactive Waste Scenario

Low-level radioactive waste is not produced at the Explosives Applications Laboratory.

5.8.4.2 Transuranic Waste Scenario

Transuranic waste is not produced at the Explosives Applications Laboratory.

5.8.4.3 Mixed Waste

5.8.4.3.1 Low-Level Mixed Waste Scenario

Low-level mixed waste is not produced at the Explosives Applications Laboratory.

5.8.4.3.2 Transuranic Mixed Waste Scenario

Transuranic mixed waste is not produced at the Explosives Applications Laboratory.

5.8.4.4 Hazardous Waste Scenario

5.8.4.4.1 Alternatives for Hazardous Waste at the Explosives Applications Laboratory

Table 14-59 shows the alternatives for hazardous waste at the Explosives Applications Laboratory.

Table 14-59. Alternatives for Hazardous Waste

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0.5 kg	1 kg	1 kg	1 kg	1.5 to 2 kg

5.8.4.4.2 Operations That Generate Hazardous Waste

Minimal amounts of hazardous waste may be generated through the use of solvents for cleaning, the use of developer and fixer chemicals for x-ray flash photography, and the generation of residual amounts of explosives.

5.8.4.4.3 General Nature of Waste

This waste is in the form of paper rags, plastic gloves, and scrap components.

5.8.4.4.4 Waste Reduction Measures

The generation of hazardous waste from these operations is minimal. The only possible decrease on an annual basis would be zero, which is viewed as unlikely. However, operations at the Explosives Application Laboratory participate in SNL/NM-mandated waste minimization practices, which include the use of environmentally friendly cleansers and disposal of waste through SNL/NM-regulated disposal mechanisms.

5.8.4.4.5 Basis for Projecting the “Reduced” and “Expanded” Values

For the “reduced” alternative, the decrease in waste generation reflects the relative decrease in numbers of tests, and the decrease is not intended to be proportional. For the “expanded” alternative, the increase in waste generation reflects the relative increase in numbers of tests and is also not intended to be proportional.

5.8.5 Emissions

5.8.5.1 Radioactive Air Emissions Scenarios

Radioactive air emissions are not produced at this facility.

5.8.5.2 Chemical Air Emissions

Information on an extensive list of chemicals was obtained from the SNL/NM Chemical Inventory System (CIS). For the air emissions analysis, the entire annual inventory of these chemicals was assumed to have been released over a year of operations for each specific facility (i.e., the annual inventory was divided by facility operating hours). The emissions from this release were then subjected, on a chemical-by-chemical basis, to a progressive series of screening steps for potential exceedances of both regulatory and human health thresholds. For those chemicals found to exceed this screening, process knowledge was used to derive emission factors. The emission factors for these chemicals were then modeled using the U.S. Environmental Protection Agency's *Industrial Source Complex Air Quality Dispersion Model, Version 3*. The results of this modeling are discussed as part of the analysis in support of the SNL/NM site-wide environmental impact statement.

5.8.5.3 Open Burning Scenarios

The Explosives Applications Laboratory does not have outdoor burning operations.

5.8.5.4 Process Wastewater Effluent Scenario

The Explosives Applications Laboratory does not generate process wastewater.

5.8.6 Resource Consumption

5.8.6.1 Process Water Consumption Scenario

The Explosives Applications Laboratory does not consume process water.

5.8.6.2 Process Electricity Consumption Scenario

The Explosives Applications Laboratory does not consume process electricity.

5.8.6.3 Boiler Energy Consumption Scenario

The Explosives Applications Laboratory does not consume energy for boilers.

5.8.6.4 Facility Personnel Scenario

5.8.6.4.1 Alternatives for Facility Staffing at the Explosives Applications Laboratory

Table 14-60 shows the alternatives for facility staffing at the Explosives Applications Laboratory.

Table 14-60. Alternatives for Facility Staffing

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
2 FTEs	3 FTEs	3 FTEs	3 FTEs	6 FTEs

5.8.6.4.2 Operations That Require Facility Personnel

Explosives testing operations require the arming, fusing, and firing of explosives and explosives components.

5.8.6.4.3 Staffing Reduction Measures

No staffing reduction measures exist.

5.8.6.4.4 Basis for Projecting the “Reduced” and “Expanded” Values

Two FTEs would be needed to maintain the minimum testing capability under the “reduced” alternative. For safety reasons, the “expanded” scenario would require more personnel than implied by the proportional increase in the testing level.

5.8.6.5 Expenditures Scenario

5.8.6.5.1 Alternatives for Expenditures at the Explosives Applications Laboratory

Table 14-61 shows the alternatives for expenditures at the Explosives Applications Laboratory.

Table 14-61. Alternatives for Expenditures

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
$435,500	$650,000	$747,500	$859,625	$975,000

5.8.6.5.2 Operations That Require Expenditures

While the level of program effort and the number of personnel remain constant over the "no action" period, additional expenditures are projected for facility upgrades and equipment, such as a new forklift and hoist, and general improvements to the maintenance program.

5.8.6.5.3 Expenditure Reduction Measures

No expenditure reduction measures exist at this time.

5.8.6.5.4 Basis for Projecting the "Reduced" and "Expanded" Values

Expenditures are approximately proportional to the cost of materials and vary with numbers of tests.

6.0 THUNDER RANGE COMPLEX SOURCE INFORMATION

6.1 Purpose and Need

The Thunder Range Complex was used from 1969 through 1993 to support development, safety, reliability, and certification tests of Atomic Energy Commission (AEC)/DOE weapon systems. These tests used conventional high explosives to simulate extremely harsh environments that the systems might be subjected to during storage, transportation, or use. The facility supported Department of Defense explosive tests of anti-armor warheads, foreign rocket motors, and enactment of terrorist scenarios. The facility also supported National Aeronautics and Space Administration (NASA) safety certification tests of spacecraft batteries, which contained hazardous materials. The site was used for explosive tests of up to 4,000 lb of high explosives on the surface and 11,000 lb subsurface.

The testing activity at the complex declined substantially during the early 1990s, and the last test at the complex was conducted during the third quarter of 1993. In April 1995, all equipment and furniture was removed from the facilities, and the site was reassigned to support the current activities and missions. The current use is for the disassembly and evaluation of special items and siting for radar studies. Although the special items may contain explosives materials, the site is not used for explosives testing.

The facilities currently in use on the Thunder Range Complex have a combination of essential characteristics that are not available all together in other SNL/NM locations. These characteristics include the following:

- Conductive floors and grounding provisions for explosive handling
- Bunkers for explosive storage
- Alarms and security provisions for “vault classification,” which allow for classified work
- Established explosive quantity distance boundaries
- A rating for handling up to 4,000 lb of explosive materials

(Dunbar, 1998; Garcia-Sanchez, 1998; Keystone Environmental Planning Inc., 1996; Sandia National Laboratories, 1995-1997)

6.2 Description

Although the area south of SNL/NM Tech Area III is sometimes generally referred to as the “Thunder Range Complex,” the term “Thunder Range” will be used in this document to mean the area used by SNL/NM under permit PERM/O-KI-90-0014 (also known as DACA47-4-70-6) between the Kirtland Air Force Base (KAFB) and DOE/Kirtland Area Office. The original land use permit was for a period of five years beginning July 1, 1969 and was amended periodically to continue through August 31, 1995. DOE/Kirtland Area Office has requested that KAFB renew the permit.

The Thunder Range Complex is located to the southeast of Tech Area III, in Sections 4 and 5, R.4.E, T.8.N, and Sections 28, 32, and 33, R.4.E, T.9.N. The Thunder Range Complex is generally bounded on the north by Magazine Road, although a triangular area north of Magazine Road (North Thunder Range) is also part of the permitted parcel. The complex is bounded on the southeast by a fence along Isleta Road. The portion of the Thunder Range Complex closest to the Isleta Pueblo is about half a mile north of that boundary. (See Sandia National Laboratories [1999b], Figures 2-1, 2-6, 2-13, and 2-16.) The site is flat, open terrain covered with shrub grassland.

Only three structures (Building 9967, Building 9968, and Building 9969) are currently being used by SNL/NM. These are located on the northeastern side of Thunder Range Complex, south of Magazine Road. The list of structures on the Thunder Range Complex in Table 14-62 is taken from an environmental baseline survey dated August 1997. For reference, those structures that are associated with environmental restoration sites have the environmental restoration site number indicated. A listing of the environmental restoration sites is given in Table 14-63. (See U.S. Department of Energy [1996]. Information about environmental restoration sites and contaminants at those sites is provided in U.S. Department of Energy [1996] and will not be repeated here.)

Table 14-62. Thunder Range Complex Structures

Facility	ER Site
Explosive Test Facility, Building 9927	Sites 86 and 148
• Explosive Storage Bunkers 9919, 9928, 9968, and 9969 • Explosive Storage Magazine 9929 • Storage Igloo 9956A • Signal Conditioning Bunker 9964	Sites 90 and 139
Concrete Signal Conditioning Bunker 9964A	Sites 90 and 139
Control Building for the Shock Facility 9965 along with several shock tubes and chambers	Sites 17c and 140
Access Building to Vault 9965B	Sites 17c and 140
Storage Buildings 9965C, 9965H, 9965I, 9965K, 9965E, and 9965O	Sites 90 and 140
Equipment Testing Building 9965L	Sites 17c and 140
Underground Instrument Bunkers 9966, 9966C, and 9966D	Site 6
Test Structure S/9966A	Site 6
• High Explosives Assembly Building 9967 • Transportainers TP43 and TP55 • Bunker B63	Site 141

Table 14-63. Environmental Restoration Sites on or Adjacent to the Thunder Range Complex

ER Number	Name of Site
6	Gas Cylinder Disposal Pit (Building 9966)
17A-H	Scrap Yards/Open Dump (Thunder Range)
56	Old Thunderwells (Thunder Range)
86	Firing Site (Building 9927)
89	Shock Tube Site (Thunder Range)
90	Beryllium Firing Site (Thunder Range)
91	Lead Firing Site (Thunder Range)
139	Bldg. 9964 Septic System
140	Bldg. 9965 Septic System
141	Bldg. 9967 Septic System
148	Bldg. 9927 Septic System
193	Sabotage Test Area
54	Pickax Site (Thunder Range)
55	Red Towers Site (Thunder Range)
191	Equus Red

Building 9967 is not connected to the sanitary sewer system. Sanitary facilities are provided by portable toilets. Potable water for drinking and hand washing is bottled water. All sanitary effluents are removed from the Thunder Range Complex and disposed of appropriately.

The site is used periodically rather than continuously (see “6.4 Operations and Capabilities”). During periods of use, a trailer may be brought into the Thunder Range Complex and located in proximity to Building 9967 to provide office space for the workers. The trailer may be equipped with a diesel generator to provide power. The air emissions from the generator are included in the overall SNL Air Quality Program, and separate registration or permitting of the generator is therefore not required.

Located to the southwest of the Thunder Range Complex is the Conventional High Explosives & Simulation Test (CHEST) Site, which is also shown on maps as Chestnut Site or Range. The Chestnut Range is used for explosive tests. Although SNL/NM explosive testing activities have ceased at the Thunder Range Complex, Chestnut Range continues to be used as an active explosives testing site by the U.S. Air Force and its contractors. (See Sandia National Laboratories [1999b], Figure 2-6. The Air Force Research Laboratory was formerly known as Phillips Laboratory and as the Air Force Weapons Laboratory.)

South of Tech Area III and west of the Thunder Range Complex area, the U.S. Air Force also operates an Auxiliary Field Heliport and Temporary Airport.

(Dunbar, 1998; Sandia National Laboratories, 1995-1997; Garcia-Sanchez, 1998)

6.3 Program Activities

Table 14-64 shows the program activities at the Thunder Range Complex.

Table 14-64. Program Activities at the Thunder Range Complex

Program Name	Activities at the Thunder Range Complex	Category of Program	Related Section of the *SNL Institutional Plan*
Direct Stockpile Activities	In the past, Thunder Range was used for environmental, safety, and survivability testing for nuclear weapon applications. Thunder Range is not currently used in support of this program.	Programs for the Department of Energy	Section 6.1.1.1
Arms Control and Nonproliferation	Similar disassembly and inspection work to that performed under the Intelligence Work for Others (IWFO) Program may also be performed directly for DOE with DOE funding.	Programs for the Department of Energy	Section 6.1.3.3
Nonproliferation and Verification Research and Development	Aerial observations may be funded by DOE in support of Nonproliferation and Verification Research and Development or jointly with DoD agencies through the WFO program.	Programs for the Department of Energy	Section 6.1.3.1

Table 14-64. Program Activities at the Thunder Range Complex (Continued)

Program Name	Activities at the Thunder Range Complex	Category of Program	Related Section of the *SNL Institutional Plan*
Other Federal Agencies	Funding for disassembly activities currently performed at the Thunder Range Facility is received by Sandia National Laboratories through the IWFO Program. Three buildings (9967, 9968, and 9969) are currently used to perform disassembly, inspection, and documentation of special items, including but not limited to special nonnuclear munitions. Some of these programs include joint work with the Air Force Research Laboratory (formerly called Phillips Laboratory or Air Force Weapons Laboratory, AFWL). Use of Thunder Range for placement of targets to test airborne sensors may be funded by DoD agencies through WFO or may be funded by DOE.	Work for Non-DOE Entities (Work for Others)	Section 6.2.7

6.4 Operations and Capabilities

No SNL-sponsored outdoor explosive or shock tube testing occurs or is planned on the Thunder Range Complex site in the foreseeable future. Continuing activities on the site are primarily associated with disassembly, inspection, and documentation of special items, such as special nonnuclear munitions, in Building 9967. No new construction is anticipated.

The number of items to be received by SNL/NM for evaluation and testing under the current program is expected to be less than 200 per year. These vary in size from the smallest, which are a few cubic inches, to the largest, which are not expected to exceed 30 ft^3. The total volume of special material to be received by SNL/NM is expected to be less than 300 ft^3 per year.

The items sent to SNL/NM are examined and documented, and the data is used for further analysis. The evaluation is expected to involve physical examination, cleaning, mechanical disassembly, physical measurement, sampling, and photography. After completion of all evaluations, all materials are returned to the sponsor or disposed of in accordance with existing rules and regulations. All liquid and solid material involved in the process is considered to be of continuing interest and its disposition would be determined by the sponsor. No chemical analysis is performed in the Thunder Range Complex. If chemical analysis of samples were required, the items would be analyzed at the appropriate laboratories elsewhere.

Examination of objects is done on an as-needed basis and is therefore done periodically rather than continuously. The site may be used continuously once per year for 30 to 60 days. The site may also be used one to two days per month throughout the year.

In addition to the disassembly program, the following activities are expected to be performed by SNL on or near the Thunder Range Complex:

- **Airborne Observation -** SNL uses portions of the Thunder Range Complex for ground truthing activities, such as radar return collection studies. This involves the use of “targets” such as vehicles or passive calibration sources (corner reflectors) placed on the ground surface. Targets may also be placed on adjoining KAFB property with permission from KAFB, including preparation and review of Air Force NEPA Form 813 when required. SNL research equipment is then flown over the area at different altitudes and airspeeds while collecting radar return or other sensor data. Observations may occur from one to six times per year. Activities take from one day to two weeks to complete. Targets are removed from the Thunder Range Complex when measurements are complete.

- **Optical Observation Associated with the Chestnut Range -** SNL has observed explosive tests done at the Chestnut Range using optical instruments in the past. Project plans call for continued observation of some future tests on a noninterference basis by SNL. The amount and scope of these observations will be determined by funding. Observation locations could be on the Thunder Range Complex but normally are not. Observation locations tend to be on higher-elevation property, such as the hill to the northeast of the Thunder Range Complex. Use of KAFB property for observation requires permission from KAFB, including preparation and review of Air Force NEPA Form 813 if required.

Sealed sources are not kept at the Thunder Range facility. During operations, portable radiation detection devices may be brought into the facility. These devices may include sealed sources within them that are used for device self-calibration.

Sealed sources would be in the facility according to both the number of workdays the facility is operated and the number of days that radiation detection devices are required. Even within the “no action” alternative, the number of days in which radiation-containing items are examined depends upon which items the sponsors wish to have examined.

(Dunbar, 1998; Sandia National Laboratories, 1995-1997; U.S. Department of Energy, 1996)

6.5 Hazards and Hazard Controls

Some items disassembled and handled at Building 9967 may contain radioactive materials or explosive materials with a United Nations Organization hazard classification and compatibility group. Some items may contain both radioactive materials and explosive materials. Some items disassembled and handled at Building 9967 may be "inert," or contain neither radioactive nor explosive materials. Quantities of explosives handled would never exceed 1,000 lb. Quantities of radioactive materials would never exceed the hazard category 3 thresholds defined in U.S. Department of Energy (1992b); therefore, the facility is categorized as a nonnuclear facility.

When items that are handled contain radioactive materials, both engineered and administrative controls are employed to reduce the likelihood of unintended release of radioactive materials from the building. Typically, a physical radiological control area would be constructed within Building 9967 (a "tent" or "bubble"), and activities would proceed within the control area. Design features include single-pass-through ventilation with exhaust air passing through HEPA filters.

A radiological control technician is in constant attendance during operations involving radioactive materials. Systematic surface-wipe sampling is done in all radioactive control areas to ensure that surface contamination stays within allowable levels commensurate with the potential for exposure. Continuous air monitoring may also be used as appropriate to the conditions.

Regular access to radioactive areas is restricted to authorized personnel. Personnel use appropriate personal equipment, and personnel bioassay and dosimetry are used as appropriate.

Thunder Range Complex access is controlled (the public is not admitted), but access to individual sites is uncontrolled to workers.

(Dunbar, 1998)

6.6 Accident Analysis Summary

The Thunder Range Complex has been found to be a low-hazard, nonnuclear facility by the SNL primary hazard screening process and does not require a safety analysis report. A follow-up hazard analysis is planned but is not expected to change the earlier finding.

Quantities of radioactive materials handled in Building 9967 would never exceed the hazard category 3 thresholds defined in U.S. Department of Energy (1992b); therefore, the facility is categorized as a nonnuclear facility.

Quantity distance safety zones shown in Sandia National Laboratories (1999b), Figure 2-6 are based upon surface explosive tests of up to 4,000 lb. No more than 1,000 lb of explosives would be handled in Building 9967 at any given time. The Thunder Range Complex is not currently used to perform explosives tests. Detonation of explosives would occur only under accident conditions.

(Sandia National Laboratories, 1995-1997)

6.7 Reportable Events

The Thunder Range Complex has had no reportable events over the past five years.

6.8 Scenarios for Impact Analysis

In all of the scenarios for impact analysis in this section, base year values are for FY1996 unless otherwise noted.

6.8.1 Activity Scenarios

6.8.1.1 Scenario for Other: Equipment Disassembly and Evaluation

6.8.1.1.1 Alternatives for Other: Equipment Disassembly and Evaluation

Table 14-65 shows the alternatives for equipment disassembly and evaluation at the Thunder Range Complex.

Table 14-65. Alternatives for Other: Equipment Disassembly and Evaluation

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
42 days/year	60 days/year	82 days/year	82 days/year	144 days/year

6.8.1.1.2 Assumptions and Actions for the "Reduced" Values

The "reduced" value assumes that in order to maintain the capability to do this work at the Thunder Range Complex, one 30-day campaign and six 2-day campaigns would be required per year.

6.8.1.1.3 Assumptions and Rationale for the "No Action" Values

Examination of objects is done on an as-needed basis and is therefore done periodically rather than continuously. The site may be used continuously for 30 to 60 days once per year and may be used one to two days per month throughout the year.

The "no action" alternative is based on a base year activity level of approximately 60 days of operation, which represents one longer campaign and six shorter (one to two day) campaigns. The "no action" alternative assumes that each of the years between FY2003 and FY2008 would include a 60-day campaign and twelve 2-day campaigns.

A slight increase in work is expected under the "no action" alternative relative to the FY1996 base year because FY1996 represented a transition from the prior Thunder Range Complex functions to the present functions, and work load is expected to be slightly higher on an ongoing basis than what was experienced in FY1996.

6.8.1.1.4 Assumptions and Actions for the "Expanded" Values

The "expanded" scenario assumes a moderate increase in workload requiring two 60-day campaigns and twelve 2-day campaigns per year.

6.8.1.2 Scenario for Test Activities: Ground Truthing Tests

6.8.1.2.1 Alternatives for Test Activities: Ground Truthing Tests

Table 14-66 shows the alternatives for ground truthing tests at the Thunder Range Complex.

Table 14-66. Alternatives for Test Activities: Ground Truthing Tests

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
1 test series	1 test series	5 test series	8 test series	10 test series

6.8.1.2.2 Assumptions and Actions for the "Reduced" Values

The "reduced" level assumes that one fly-over observation event per year would be needed to maintain capability. This may be an overestimate with respect to the Thunder Range Complex, as ground truthing is conducted at other locations in addition to the Thunder Range Complex.

6.8.1.2.3 Assumptions and Rationale for the "No Action" Values

"No action" values assume that the activity would continue in the future and that there might be a need for a slightly increased number of observation fly-over events consistent with levels in the last few years. Center 2500 conducts up to 12 ground truthing events per year, but not all events use targets sited at the Thunder Range Complex.

6.8.1.2.4 Assumptions and Actions for the "Expanded" Values

The "expanded" alternative assumes that the overall level of ground truthing activities increase or a greater proportion of testing occurs at the Thunder Range Complex.

(U.S. Department of Energy, 1997)

6.8.2 Material Inventories

6.8.2.1 Nuclear Material Inventory Scenarios

6.8.2.1.1 Nuclear Material Inventory Scenario for Plutonium-239

Alternatives for the Plutonium-239 Nuclear Material Inventory - Table 14-67 shows the alternatives for the plutonium-239 inventory at the Thunder Range Complex.

Table 14-67. Alternatives for Plutonium-239 Nuclear Material Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 Ci	≤0.52 Ci	≤0.52 Ci	≤0.52 Ci	0.52 Ci

Operations That Require Plutonium-239 - Exact quantities of materials kept in inventory may be classified but would be limited by administrative requirements and would be maintained below the levels for "nonnuclear" facility status as defined in U.S. Department of Energy (1992b). See "Operations That Require Plutonium-238" in "6.8.2.1.2 Nuclear Material Inventory Scenario for Plutonium-238." The quantities of nuclear material in this facility are also below the limits for accountable nuclear material.

Basis for Projecting the "Reduced" and "Expanded" Values - See "Basis for Projecting the "Reduced" and "Expanded" Values" in "6.8.2.1.2 Nuclear Material Inventory Scenario for Plutonium-238."

6.8.2.1.2 Nuclear Material Inventory Scenario for Plutonium-238

***Alternatives for Plutonium-238 Nuclear Material Inventory* -** Table 14-68 shows the alternatives for plutonium-238 inventory at the Thunder Range Complex.

Table 14-68. Alternatives for Plutonium-238 Nuclear Material Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 Ci	≤0.62 Ci	≤0.62 Ci	≤0.62 Ci	0.62 Ci

***Operations That Require Plutonium-238* -** Operations that require Pu-238 include disassembly and evaluation of special items. Exact quantities of materials kept in inventory may be classified but would be limited by administrative requirements and would be maintained below the levels for “nonnuclear” facility status as defined in U.S. Department of Energy (1992b). The quantities of nuclear material in this facility are also below the limits for accountable nuclear material.

***Basis for Projecting the “Reduced” and “Expanded” Values* -** The bases for projecting the “expanded” and “reduced” values are the operational limits of the facility as established by the facility authorization basis.

6.8.2.1.3 Nuclear Material Inventory Scenario for Americium-241

Alternatives for Americium-241 Nuclear Material Inventory - Table 14-69 shows the alternatives for americium-241 inventory at the Thunder Range Complex.

Table 14-69. Alternatives for Americium-241 Nuclear Material Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 Ci	≤0.52 Ci	≤0.52 Ci	≤0.52 Ci	0.52 Ci

***Operations That Require Americium-241* -** Operations that require americium-241 include disassembly and evaluation of special items. Exact quantities of materials kept in inventory may be classified but would be limited by administrative requirements and would be maintained below the levels for “nonnuclear” facility status as defined in U.S. Department of Energy (1992b). The quantities of nuclear material in this facility are also below the limits for accountable nuclear material.

***Basis for Projecting the "Reduced" and "Expanded" Values* -** The bases for projecting the "expanded" and "reduced" values are the operational limits of the facility as established by the facility authorization basis.

6.8.2.1.4 Nuclear Material Inventory Scenario for Americium-243

***Alternatives for Americium-243 Nuclear Material Inventory* -** Table 14-70 shows the alternatives for americium-243 inventory at the Thunder Range Complex.

Table 14-70. Alternatives for Americium-243 Nuclear Material Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 Ci	≤0.52 Ci	≤0.52 Ci	≤0.52 Ci	0.52 Ci

***Operations That Require Americium-243* -** Operations that require americium-243 include disassembly and evaluation of special items. Exact quantities of materials kept in inventory may be classified but would be limited by administrative requirements and would be maintained below the levels for "nonnuclear" facility status as defined in U.S. Department of Energy (1992b). The quantities of nuclear material in this facility are also below the limits for accountable nuclear material.

***Basis for Projecting the "Reduced" and "Expanded" Values* -** The bases for projecting the "expanded" and "reduced" values are the operational limits of the facility as established by the facility authorization basis.

6.8.2.1.5 Nuclear Material Inventory Scenario for Normal Uranium

***Alternatives for Normal Uranium Nuclear Material Inventory* -** Table 14-71 shows the alternatives for normal uranium at the Thunder Range Complex.

Table 14-71. Alternatives for Normal Uranium Nuclear Material Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 Ci	≤4.2 Ci	≤4.2 Ci	≤4.2 Ci	4.2 Ci

***Operations That Require Normal Uranium* -** Operations that require normal uranium include disassembly and evaluation of special items. Exact quantities of materials kept in inventory may be classified but would be limited by administrative requirements and would be maintained below the levels for "nonnuclear" facility status as defined in U.S. Department of Energy

(1992b). The quantities of nuclear material in this facility are also below the limits for accountable nuclear material.

***Basis for Projecting the "Reduced" and "Expanded" Values* -** The bases for projecting the "expanded" and "reduced" values are the operational limits of the facility as established by the facility authorization basis.

6.8.2.2 Radioactive Material Inventory Scenarios

The Thunder Range Complex has no radioactive material inventories.

6.8.2.3 Sealed Source Inventory Scenarios

The Thunder Range Complex has no sealed source inventories.

6.8.2.4 Spent Fuel Inventory Scenarios

The Thunder Range Complex has no spent fuel inventories.

6.8.2.5 Chemical Inventory Scenarios

The Thunder Range Complex has no inventories of chemicals of concern.

6.8.2.6 Explosives Inventory Scenario for Bare UNO 1.1

6.8.2.6.1 Alternatives for Bare UNO 1.1 Explosives Inventory

Table 14-72 shows the alternatives for the bare UNO 1.1 explosives inventory at the Thunder Range Complex.

Table 14-72. Alternatives for Bare UNO 1.1 Explosives Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 kg	436 kg	436 kg	436 kg	436 kg

6.8.2.6.2 Operations That Require Bare UNO 1.1

Items for disassembly and examination may contain up to 436 kg (1,000 lb) of explosives. Not all items examined contain explosives. Explosives would not be in the facility except during disassembly and examination campaigns. No change in the maximum building explosive limit is foreseen.

Disassembly and examination of items would not result in the detonation of explosives under normal conditions. Detonation of explosives would represent an accident.

6.8.2.6.3 Basis for Projecting the “Reduced” and “Expanded” Values

Items for disassembly and examination may contain up to 436 kg (1,000 lb) of explosives. Not all items examined contain explosives. Explosives would not be in the facility except during disassembly and examination campaigns. No change in the maximum building explosive limit is foreseen.

Disassembly and examination of items would not result in the detonation of explosives under normal conditions. Detonation of explosives would represent an accident.

6.8.2.7 Other Hazardous Material Inventory Scenarios

The Thunder Range Complex has no inventories of hazardous materials that do not fall into the categories of nuclear or radioactive material, sealed sources, spent fuel, explosives, or chemicals.

6.8.3 Material Consumption

6.8.3.1 Nuclear Material Consumption Scenarios

Nuclear material is not consumed at the Thunder Range Complex.

6.8.3.2 Radioactive Material Consumption Scenarios

Radioactive material is not consumed at the Thunder Range Complex.

6.8.3.3 Chemical Consumption Scenarios

Information initially provided for this section resides in the Facility Information Manager database and will be made available to the analysts responsible for preparing the sitewide environmental impact statement.

6.8.3.4 Explosives Consumption Scenarios

Explosives are not consumed at the Thunder Range Complex.

6.8.4 Waste

6.8.4.1 Low-Level Radioactive Waste Scenario

Low-level radioactive waste is not produced at the Thunder Range Complex.

6.8.4.2 Transuranic Waste Scenario

Transuranic waste is not produced at the Thunder Range Complex.

6.8.4.3 Mixed Waste

6.8.4.3.1 Low-Level Mixed Waste Scenario

Low-level mixed waste is not produced at the Thunder Range Complex.

6.8.4.3.2 Transuranic Mixed Waste Scenario

Transuranic mixed waste is not produced at the Thunder Range Complex.

6.8.4.4 Hazardous Waste Scenario

Hazardous waste is not produced at the Thunder Range Complex.

6.8.5 Emissions

6.8.5.1 Radioactive Air Emissions Scenarios

Radioactive air emissions are not produced at the Thunder Range Complex.

6.8.5.2 Chemical Air Emissions

Information on an extensive list of chemicals was obtained from the SNL/NM Chemical Inventory System (CIS). For the air emissions analysis, the entire annual inventory of these chemicals was assumed to have been released over a year of operations for each specific facility (i.e., the annual inventory was divided by facility operating hours). The emissions from this release were then subjected, on a chemical-by-chemical basis, to a progressive series of screening steps for potential exceedances of both regulatory and human health thresholds. For those chemicals found to exceed this screening, process knowledge was used to derive emission factors. The emission factors for these chemicals were then modeled using the U.S.

Environmental Protection Agency's *Industrial Source Complex Air Quality Dispersion Model, Version 3*. The results of this modeling are discussed as part of the analysis in support of the SNL/NM site-wide environmental impact statement.

6.8.5.3 Open Burning Scenarios

The Thunder Range Complex does not have outdoor burning operations.

6.8.5.4 Process Wastewater Effluent Scenario

The Thunder Range Complex does not generate process wastewater.

6.8.6 Resource Consumption

6.8.6.1 Process Water Consumption Scenario

The Thunder Range Complex does not consume process water.

6.8.6.2 Process Electricity Consumption Scenario

The Thunder Range Complex does not consume process electricity.

6.8.6.3 Boiler Energy Consumption Scenario

The Thunder Range Complex does not consume energy for boilers.

6.8.6.4 Facility Personnel Scenario

6.8.6.4.1 Alternatives for Facility Staffing at the Thunder Range Complex

Table 14-73 shows the alternatives for facility staffing at the Thunder Range Complex.

Table 14-73. Alternatives for Facility Staffing

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0.8 FTEs	1.1 FTEs	1.5 FTEs	1.5 FTEs	2.6 FTEs

6.8.6.4.2 Operations That Require Facility Personnel

Ground truthing activities take essentially no staff. For each day of operation for the equipment disassembly and evaluation activity, the facility requires four FTEs. These include a researcher, a research technician, 1.75 ES&H and other support technicians, and 0.25 administrative staff, for a total of 32 hours of staff time per day of operation of the Thunder Range Complex. It is assumed that each worker works an 8-hour day and that there are 1,800 work hours per year. FTEs are calculated as total hours divided by 1,800 and rounded to the nearest tenth of an FTE.

6.8.6.4.3 Staffing Reduction Measures

Staffing levels represent fractions of work performed by personnel who work in other areas of SNL/NM when campaigns are not being conducted at the Thunder Range Complex. Assumptions for the “reduced,” “no action,” and “expanded” alternatives are carried through using assumptions described above. No staffing reductions are planned.

6.8.6.4.4 Basis for Projecting the “Reduced” and “Expanded” Values

Staffing levels represent fractions of work performed by personnel who work in other areas of SNL/NM when campaigns are not being conducted at the Thunder Range Complex. Assumptions for the “reduced,” “no action,” and “expanded” alternatives are carried through using assumptions described above.

6.8.6.5 Expenditures Scenario

6.8.6.5.1 Alternative for Expenditures at the Thunder Range Complex

Table 14-74 shows the alternatives for expenditures a the Thunder Range Complex.

Table 14-74. Alternatives for Expenditures

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
$10,000	$50,000	$10,000	$10,000	$300,000

6.8.6.5.2 Operations that Require Expenditures

No upgrades to the facility are envisioned at this time. Routine maintenance will continue at the current level.

6.8.6.5.3 Expenditure Reduction Measures

No expenditure reduction measures exist at this time.

6.8.6.5.4 Basis for Projecting the “Reduced” and “Expanded” Values

Expenditure levels are driven by project requirements. The estimates are based on historical cost data.

7.0 REFERENCES

7.1 Regulations, Orders, and Laws

10 CFR 71, *Packaging and Transportation of Radioactive Material*.

29 CFR 1910.134, *Occupational Health and Safety Standards*, Sec. 1910.134, Respiratory protection.

AL 5481.1B, Safety Analysis and Review System, Change 1, May 19, 1987.

7.2 General References

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