CHAPTER 6 - NEUTRON GENERATOR FACILITY SOURCE INFORMATION

LIST OF TABLES

1.0 INTRODUCTION

Operations at the Neutron Generator Facility include fabrication of war reserve neutron generators and prototype switch tubes. Neutron generators initiate nuclear fission in a nuclear weapon by providing a flux of neutrons at the proper time.

2.0 PURPOSE AND NEED

On June 16, 1992, President Bush of the United States and President Yeltsin of Russia signed an arms agreement that significantly reduced nuclear weapon stockpiles and the corresponding production operations that support them. Based on this event, the Secretary of Energy reconfigured and consolidated the nuclear weapons complex (see U.S. Department of Energy, 1993). Part of the reconfiguration strategy was to transfer neutron generator production from the Pinellas Plant in Largo, Florida, to SNL/NM. A capability to prototype switch tube fabrication was transferred from the EG&G Plant in Salem, Massachusetts, to SNL. Construction on the original scope of the Nonnuclear Reconfiguration Program at SNL was completed in January 1996. The Nonnuclear Reconfiguration Program is currently in its final stages, though the final financial accounting has not been completed. Written permission to operate the facility has been received from DOE.

The original Nonnuclear Reconfiguration Program was intended to support DOE directive schedule P&PD 94-0, which was based on an assumed stockpile level established by the START II treaty. Since the original program was envisioned, expected enduring stockpile levels have changed and are near the higher START I treaty levels. The “no action” alternative discussed below includes proposed modifications of Building 870 and other existing SNL/NM facilities to support the increased neutron generator production rates required per directive schedule P&PD 97-0, which reflects the higher START I enduring stockpile levels. Thus, the “no action” alternative includes the proposed “rapid reactivation” project as well as current facilities and operations.

The mission of the Neutron Generator Facility is to support U.S. nuclear deterrent capabilities by fabricating war reserves of the following:

- Neutron generators (external initiators for nuclear weapons)
- Neutron tubes
- Prototype switch tubes (expanded scenario only)

(U.S. Department of Energy, 1993)

3.0 DESCRIPTION

The Neutron Generator Facility is a low-hazard, nonnuclear facility located in Building 870, a two-story structure with a basement, where most processing and assembly operations take place. A variety of support operations take place in other buildings within SNL/NM, including Building 905, which houses the Neutron Generator timer-driver and mounting hardware attachment, and packaging and explosive functional testing of FE neutron generators (Sandia National Laboratories, 1997b).

4.0 PROGRAM ACTIVITIES

Table 6-1 shows the program activities at the Neutron Generator Facility.

Table 6-1. Program Activities at the Neutron Generator Facility

Program Name	Activities at the Neutron Generator Facility	Category of Program	Related Section of the *SNL Institutional Plan*
Direct Stockpile Activities	Develop neutron generators for nuclear weapon applications.	Programs for the Department of Energy	Section 6.1.1.1
Technology Transfer and Education	Conduct production testing of industry partnership processes that have been developed with part or process suppliers.	Programs for the Department of Energy	Section 6.1.1.3
Weapons Program	Develop neutron generators for nuclear weapon applications.	Programs for the Department of Energy	Section 6.1.1.4
Production Support and Capability Assurance	Produce neutron generators.	Programs for the Department of Energy	Section 6.1.1.4
Advanced Manufacturing, Design, and Production Technologies	Develop new processes.	Programs for the Department of Energy	Section 6.1.1.4
Sustaining Critical Progress in Model Validation	Conduct certification testing of the neutron generators to include characterization of encapsulation flow, brazing assembly response to furnace and fixture conditions, and characteristics of piezoelectric translators (PZT) 95/9.	Major Programmatic Initiatives	Section 7.1.3

Table 6-1. Program Activities at the Neutron Generator Facility (Continued)

Program Name	**Activities at the Neutron Generator Facility**	**Category of Program**	**Related Section of the *SNL Institutional Plan***
Reliably Meeting Pending Production and Production Support Requirements	Make neutron generators.	Major Programmatic Initiatives	Section 7.1.4
Sustaining Momentum in Advanced Design and Production Technologies	Develop and characterize advanced manufacturing processes for neutron generators. Develop and test intelligent manufacturing systems. Develop and implement advanced manufacturing information systems. Develop and test advanced materials.	Major Programmatic Initiatives	Section 7.1.5

5.0 OPERATIONS AND CAPABILITIES

Operations at the Neutron Generator Facility include fabrication of war reserve neutron generators and prototype switch tubes. Neutron generators initiate nuclear fission in a nuclear weapon by providing a flux of neutrons at the proper timing. A neutron generator consists of a neutron tube, a miniature accelerator, power supply, and timer. There are two basic types of neutron generators, which are ferroelectric and electronic.

Neutron tubes are major components of neutron generators. The primary function of neutron tubes is the production of neutrons when supplied with the proper external electrical impulse.

SNL-designed switch tubes are critical nuclear weapon components required by all weapon firing systems currently in the enduring stockpile. These components are arc discharge devices that are comprised of triggered vacuum switches and voltage threshold breakdown devices and that are used for precise initiation of weapon detonators.

Manufacture of these devices involves:

- Metallizing and screen printing - The Neutron Generator Facility does two different types of metallization. One is standard metallize (made of molybdenum and manganese powders) that is applied to ceramic to act as a plateable or brazeable interface between the ceramic and metal tube components. Currently this metallize is procured from a commercial source in two forms, a brush paint and a screen print. The brush paint is a lower viscosity so it can be painted on part geometries that are not screen printable. The screen print is used for all other flat surfaces that need to be brazed. The other type of metallize is quasi-metallize. This is a mix of manganese and titanium that is applied as a brush paint (and eventually as a robot airbrush process) to the inside surface of the ceramic tube frame as a surface modifier to enhance the tube's high-voltage breakdown characteristics.

- Chemical cleaning - The purpose of this aqueous degrease cleaning procedure is to remove all oil, grease, wax, moisture, and other foreign materials from the surface of the parts. The purpose of chemical etching is to remove oxides and burrs on the edges of the metal by acid etch.

- Vapor honing, which is the process of using an abrasive material suspended in a liquid medium delivered to a piece part by air pressure. This process is used to metallurgically clean a part for better adhesive properties.

- Lapping, which is the process of removing surface material by mechanical methods, usually a rotating flat surface containing a loose or fixed grinding media, to achieve a flat surface of a desired surface roughness. Lapping removes ceramic, cermet, and metal material from a component surface to achieve the desired length, flatness and a specified micron average surface roughness by rotating the component against a rotating diamond disk under a stream of water.

- Chemical plating, which applies a nickel deposition to the cermet and metallized areas of ceramic parts to facilitate braze wetting of the subsequent braze assembly.

- Firing, which is performed in a variety of furnaces under different temperatures and environmental conditions to remove contaminants such as organics and gases and to bond materials to ceramics.

- Joining and welding - The following are the main welding processes used by Division 14000 in the manufacturing of neutron generators. These welding processes are used to join work pieces:

    - Gas tungsten arc welding
    - Laser beam welding
    - Micro-plasma arc welding
    - Resistance welding

- Diffusion bonding, which provides a hermetic seal during final closure of a switch tube designed and produced at Pinellas for use with the electronic neutron generator.

- Carbon coating - A carbon vapor deposition process is used to produce a carbon film on a ceramic piecepart that becomes part of the switch tube triggering mechanism.

- Neutron generator testing, which involves experimental testing and production-lot sample testing of explosive neutron generators and 100 percent functional testing of electronic neutron generators. Electronic generators are reusable and typically do not generate waste when tested. Explosive generators are one-use items that are tested in a protective enclosure; testing results in the generation of classified mixed waste.

- Vacuum processing (final exhaust), which evacuates, outgases, and seals off MC4277 neutron tubes. This is done by a computer-controlled, oil-less, all-metal seal, ultra-high-vacuum processing station. This is one of the last steps in completing a neutron tube that ensures vacuum integrity before the tube goes into a generator.

- Thin film evaporation, which involves the application of a thin layer of metals onto component substrates by physical vapor deposition. This is achieved by heating the metal to be deposited in a vacuum to the point of elevated vapor pressure. At such elevated temperatures in vacuo, the metal evaporates and then condenses on any cooler surface in the line of sight, including the substrates to be coated.

- Encapsulation, which involves vacuum encapsulation of electrical components with highly filled epoxy resins that provide mechanical support, environmental protection, and high voltage hold-off.

- Inspection and testing, which involves the verification of materials or items against documented requirements within a variety of categories, which include chemical composition, physical properties (for example, tensile strength, coefficient of thermal expansion, particle size, and pot life), dimensional or configurational measurements (for example, length and diameter), electrical characteristics (for example, insulation resistance), and functional performance metrics.

- Metal flame spray. Metal coatings (for example, aluminum or zinc) are deposited on neutron generator subassemblies, which are epoxy-filled with Alumina or Glass Microspheres Filler (GMB-32) or both. An oxygen and methane flame is used to melt the metal, and high-pressure air is used to disperse and accelerate the particles. The operation is performed in an exhausted enclosure.

- X-ray fluorescence inspection - Wavelength-dispersive x-ray fluorescence spectrometry is a nondestructive analytical technique used to identify and determine the concentrations of the elements present in solids, powders, and liquids. X-rays are produced when a filament is heated to high temperatures by an electric current. The filament emits electrons. When the electrons strike a metal anode, x-rays are generated. Less than 1 percent of the electron energy is converted into x-rays, and the remainder is transformed into heat.

- Final tube assembly of the plasma arc weld of ion source and target header into the neutron tube frame assembly to form the vacuum envelope.

- Generator assembly - Metal piece parts and active ceramics are abrasive blasted and ultrasonically cleaned prior to assembly. The assembler is responsible for applying epoxy and positioning the ceramics and metal piece parts into fixturing and then curing the assemblies. There are several assembly operations involved in this assembly, and there are also several in-process tests and some resistance welding done. Upon completion, the unit is prepped for encapsulation.

- Brazing, which is an elevated-temperature joining process of metals, ceramics, cermets, and ceramic/cermet-to-metal combinations. The brazing process uses a braze filler material with a melting point above 450°C but below that of the material being joined. With no melting of the base metal, the metallurgical reaction that produces the bond is a dissolution of a thin layer of the joint or faying surface by the braze material. This reaction is intended to be a surface reaction with limited penetration into the bulk of the base metal.

- Plasma cleaning, which uses a plasma created in the cleaning gas for removing thin layers of contamination from conducting or insulating surfaces.

- Waste handling process, which involves the collection and disposal of wastes from the generation processes in accordance with the SNL *ES&H Manual*, Chapter 19 (Sandia National Laboratories, 1999).

The facility as currently configured has the capability to build approximately 600 neutron generators per year.

(Sandia National Laboratories, 1997b)

6.0 HAZARDS AND HAZARD CONTROLS

Neutron tubes contain tritium in the form of metal hydride. To control personnel exposure to tritium, the following controls are used:

- Engineered controls are used, including the following:
  - Hard plumbing of equipment for processing gaseous tritium (or equipment that has the potential to release gaseous tritium during processing) to a tritium capture system
  - Single-pass-through ventilation for rooms that have equipment for processing gaseous tritium
  - Glove boxes and fume hoods for processes that could potentially generate particulate tritium contamination
- The quantity of tritium is maintained below 1,000 Ci, or less than or equal to 0.1 g, which is below the hazard category 3 threshold of U.S. Department of Energy (1992).
- Operations that are likely to cause loose surface contamination or generate gaseous tritium are conducted within the tritium envelope (the spaces designated for tritium operations that are subject to appropriate environmental safety and health controls).
- Systematic surface-wipe sampling is done in all tritium areas to ensure that surface contamination stays within allowable levels commensurate with the potential for exposure.
- Continuous air monitoring and liquid scintillation analysis are used to monitor and evaluate radiological conditions.
- Radiological areas are established where necessary and are designated with proper postings.
- Personnel use appropriate personal protective equipment.
- Personnel bioassay and dosimetry are used as appropriate.
- Regular access to tritium areas is restricted to authorized personnel.

Hydrogen, which becomes potentially explosive when mixed with air, is used in several processing steps in the Neutron Generator Facility. To control this hazard, procedures and monitoring devices are in place at the facility to ensure that flammable or explosive mixtures do not form in the processing chambers or the laboratories, and handling practices for hydrogen comply with current codes.

Hazards from chemicals in the facility are controlled through engineering controls, such as fume hoods, local exhaust ventilation, and volume limits. The chemicals and solvents that are used in the processing of neutron generators are common industrial materials.

Operations that employ laser hazards are performed using appropriate administrative and engineering controls. These controls include but are not limited to operator training and shielding of personnel according to current requirements.

7.0 ACCIDENT ANALYSIS SUMMARY

The Neutron Generator Facility is a low-hazard nonnuclear facility and does not require accident analysis per U.S. Department of Energy (1992).

8.0 REPORTABLE EVENTS

Table 6-2 lists the occurrence reports for the Neutron Generator Facility over the past five years.

Table 6-2. Occurrence Reports for the Neutron Generator Facility

Report Number	Title	Category	Description of Occurrence
ALO-KO-SNL-NMFAC-1995-0005	Increased Radiation Levels Cause Activation of Radiation Monitors	1H and 1F	A subcontractor performing radiographic inspections as part of construction work activated radiation monitors.
ALO-KO-SNL-NMFAC-1995-0011	Discharge of Rust Inhibitor Into Storm Sewer	2E	Water containing rust inhibitor from the chilled water pumping system was improperly disposed.
ALO-KO-SNL-14000-1996-0002	Contaminated Stainless Steel Box in an Uncontrolled Area	10C	One of several boxes in an unposted area was found contaminated with radioactive material below reporting levels.
ALO-KO-SNL-14000-1996-0003	Combustible Gas Monitoring System in Furnace Room Found Inoperable	1E	A monitoring system for hydrogen was found to be inoperable during a routine walk-through.

Table 6-2. Occurrence Reports for the Neutron Generator Facility (Continued)

Report Number	Title	Category	Description of Occurrence
ALO-KO-SNL-14000-1997-0001	Inadequate Procedure Resulting in Evacuation of Room 1206, Building 870 Due to Unanticipated Release of Tritium	1F	A small amount of tritium was released from a tritium source.
ALO-KO-SNL-14000-1998-0001	Electrical Shock Results in Inpatient Hospitalization	3A	An electrical shock occurred in the Building 870 Tube Test Area that resulted in an inpatient hospitalization.
ALO-KO-SNL-14000-1998-0002	Radioactive Contamination Identified Outside of a Controlled Area	1D	Radioactive contamination was identified outside of a controlled radiological buffer zone in Building 870.
ALO-KO-SNL-14000-1998-0003	Equipment Damage Exceeding Value Basis Reporting Criteria	7A	Equipment damage to the mass spectrometer inlet manifold system for the tritium capture system was discovered.
ALO-KO-SNL-14000-1998-0004	Performance Degradation of Non-Nuclear Safety System UPS	1E	Safety system performance was degraded due to the failure of the UPS that provides short-duration, transfer power to the system.

9.0 SCENARIOS FOR IMPACT ANALYSIS

9.1 Activity Scenario for Development or Production of Devices, Processes, and Systems: Neutron Generators

9.1.1 Alternatives for Development or Production of Devices, Processes, and Systems: Neutron Generators

Table 6-3 shows the alternatives for production of neutron generators.

Table 6-3. Alternatives for Development or Production of Devices, Processes, and Systems: Neutron Generators

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
2,000 neutron generators	600 neutron generators	2,000 neutron generators	2,000 neutron generators	2,000 neutron generators

9.1.2 Assumptions and Actions for the "Reduced" Values

The operating level under the "reduced" alternative is estimated at 2,000 neutron generators per year. Although the facility could manufacture significantly less than the projected number, mission requirements would not allow production levels to drop below the 2,000 limit.

9.1.3 Assumptions and Rationale for the "No Action" Values

The base year used for the Neutron Generator Facility is an estimate for 1998, the first year in which the facility will achieve its initially planned level of production. All other base year estimates in this chapter pertain to corresponding 1998 estimates unless otherwise noted.

For the 2003 and 2008 timeframes under the "no action" alternative, the facility would increase production to maximum capability or 2,000 units per year in response to Defense Program requirements.

9.1.4 Assumptions and Actions for the "Expanded" Values

Production level under the "expanded" alternative would continue at the maximum level of effort of 2,000 units per year.

Under the 2003 and 2008 timeframes and the "expanded" alternative, the Neutron Generator Facility will utilize renovated SNL buildings for war reserve production and development. Building 870 will be most affected by this project and will undergo fairly extensive renovations. Portions of Buildings 700, 905, 878, and 841 will also be renovated, although the scope of alterations proposed for these buildings is significantly less than that for Building 870. Building 700 will also be modified to support some ancillary processes that can be moved from Building 870 and to support staging, characterization, and qualification for new equipment. Details of proposed renovations are provided in Sandia National Laboratories (1997b).

The operating levels specified under the 2003 and 2008 timeframes and the "expanded" scenario are sufficient to replace units at end of life and maintain current stockpile levels. By prebuilding units during periods of low production to reduce peaks of high production, it is possible to stabilize at the operating levels indicated. These operating levels can then be supported within the existing facility by rearranging and relocating certain operations. The tritium envelope must be expanded to provide space for increased tube exhaust and processing capacity. Two additional product testers will be required, making it necessary to also expand the tester area. These expansions will be accommodated by relocating offices, conference rooms, and some neutron generator operations to the Advanced Manufacturing Processes Laboratory. This will also free up space in the Neutron Generator Facility for additional brazing capacity.

9.2 Material Inventories

9.2.1 Nuclear Material Inventory Scenario for Tritium

9.2.1.1 Alternatives for Tritium Nuclear Material Inventory

Table 6-4 shows the alternatives for the tritium inventory at the Neutron Generator Facility.

Table 6-4. Alternatives for Tritium Nuclear Material Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
836 Ci	682 Ci	836 Ci	836 Ci	836 Ci

9.2.1.2 Operations That Require Tritium

Tritium is used in the Neutron Generator Facility in both the elemental form and as a metal hydride in tritium-loaded occluder films, which are also called targets. The targets are an integral part of a weapon component neutron generator. Elemental tritium gas is used to calibrate analytical equipment in the target loading verification laboratory.

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

The quantities provided here describe on hand material necessary to fulfill the stated production mission. Tritium use is generally proportional to activity levels within certain limits and thresholds. The relationship varies slightly, depending on the nature of the work.

9.2.2 Radioactive Material Inventory Scenarios

This facility has no radioactive material inventories.

9.2.3 Sealed Source Inventory Scenarios

9.2.3.1 Sealed Source Inventory Scenario for Am-241

9.2.3.1.1 Alternatives for Am-241 Sealed Source Inventory

Table 6-5 shows the alternatives for the Am-241 sealed source inventory at the Neutron Generator Facility.

Table 6-5. Alternatives for Am-241 Sealed Source Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
101 µCi	101 µCi	101 µCi	101 µCi	101 µCi

9.2.3.1.2 Operations That Require Am-241

Operations that require Am-241 include instrument calibration and operational checks for radiation detection equipment.

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

Inventory is independent of production rates and is not expected to change over time.

9.2.3.2 Sealed Source Inventory Scenario for Ba-133

9.2.3.2.1 Alternatives for Ba-133 Sealed Source Inventory

Table 6-6 shows the alternatives for the Ba-133 sealed source inventory at the Neutron Generator Facility.

Table 6-6. Alternatives for Ba-133 Sealed Source Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
49.2 µCi	49.2 µCi	49.2 µCi	49.2 µCi	49.2 µCi

9.2.3.2.2 Operations That Require Ba-133

Operations that require Ba-133 include lead probe calibration.

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

Increased production rates may require additional product testers, which will require addition of lead probes and Ba-133 sources.

9.2.3.3 Sealed Source Inventory Scenario for C-14

9.2.3.3.1 Alternatives for C-14 Sealed Source Inventory

Table 6-7 shows the alternatives for the C-14 sealed source inventory at the Neutron Generator Facility.

Table 6-7. Alternatives for C-14 Sealed Source Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0.1427 µCi	0.1427 µCi	0.1427 µCi	0.1427 µCi	0.1427 µCi

9.2.3.3.2 Operations That Require C-14

Operations that require C-14 include instrument calibration and operational checks for radiation detection equipment.

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

Inventory is independent of production rates and is not expected to change over time.

9.2.3.4 Sealed Source Inventory Scenario for Cl-36

9.2.3.4.1 Alternatives for Cl-36 Sealed Source Inventory

Table 6-8 shows alternatives for the Cl-36 sealed source inventory at the Neutron Generator Facility.

Table 6-8. Alternatives for Cl-36 Sealed Source Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0.0225 µCi	0.0225 µCi	0.0225 µCi	0.0225 µCi	0.0225 µCi

9.2.3.4.2 Operations That Require Cl-36

Operations that require Cl-36 include instrument calibration and operational checks for radiation detection equipment.

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

Inventory is independent of production rates and is not expected to change over time.

9.2.3.5 Sealed Source Inventory Scenario for Co-60

9.2.3.5.1 Alternatives for Co-60 Sealed Source Inventory

Table 6-9 shows the alternatives for Co-60 sealed source inventory at the Neutron Generator Facility.

Table 6-9. Alternatives for Co-60 Sealed Source Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
43.8 µCi	43.8 µCi	43.8 µCi	43.8 µCi	43.8 µCi

9.2.3.5.2 Operations That Require Co-60

Operations that require Co-60 include instrument calibration and operational checks for radiation detection equipment.

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

Inventory is independent of production rates and is not expected to change over time.

9.2.3.6 Sealed Source Inventory Scenario for Cs-137

9.2.3.6.1 Alternatives for Cs-137 Sealed Source Inventory

Table 6-10 shows the alternatives for Cs-137 sealed source inventory at the Neutron Generator Facility.

Table 6-10. Alternatives for Cs-137 Sealed Source Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0.993 µCi	0.993 µCi	0.993 µCi	0.993 µCi	0.993 µCi

9.2.3.6.2 Operations That Require Cs-137

Operations that require Cs-137 include instrument calibration and operational checks for radiation detection equipment.

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

Inventory is independent of production rates and is not expected to change over time.

9.2.3.7 Sealed Source Inventory Scenario for Fe-55

9.2.3.7.1 Alternatives for Fe-55 Sealed Source Inventory

Table 6-11 shows the alternatives for the Fe-55 sealed source inventory at the Neutron Generator Facility.

Table 6-11. Alternatives for Fe-55 Sealed Source Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0.42 µCi	0.42 µCi	0.42 µCi	0.42 µCi	0.42 µCi

9.2.3.7.2 Operations That Require Fe-55

Operations that require Fe-55 include instrument calibration and operational checks for radiation detection equipment.

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

Inventory is independent of production rates and is not expected to change over time.

9.2.3.8 Sealed Source Inventory Scenario for H-3

9.2.3.8.1 Alternatives for H-3 Sealed Source Inventory

Table 6-12 shows the alternatives for the H-3 sealed source inventory at the Neutron Generator Facility.

Table 6-12. Alternatives for H-3 Sealed Source Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0.283 µCi	0.283 µCi	0.283 µCi	0.283 µCi	0.283 µCi

9.2.3.8.2 Operations That Require H-3

Operations that require H-3 include instrument calibration and operational checks for radiation detection equipment.

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

Inventory is independent of production rates and is not expected to change over time.

9.2.3.9 Sealed Source Inventory Scenario for Pm-147

9.2.3.9.1 Alternatives for Pm-147 Sealed Source Inventory

Table 6-13 shows the alternatives for the Pm-147 sealed source inventory at the Neutron Generator Facility.

Table 6-13. Alternatives for Pm-147 Sealed Source Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
288 µCi	288 µCi	288 µCi	288 µCi	288 µCi

9.2.3.9.2 Operations That Require Pm-147

Pm-147 is an analytical device electron source.

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

Inventory is independent of production rates and is not expected to change over time.

9.2.3.10 Sealed Source Inventory Scenario for Pu-239

9.2.3.10.1 Alternatives for Pu-239 Sealed Source Inventory

Table 6-14 shows the alternatives for the Pu-239 sealed source inventory at the Neutron Generator Facility.

Table 6-14. Alternatives for Pu-239 Sealed Source Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0.01716 µCi	0.01716 µCi	0.01716 µCi	0.01716 µCi	0.01716 µCi

9.2.3.10.2 Operations That Require Pu-239

Operations that require Pu-239 include instrument calibration and operational checks for radiation detection equipment.

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

Inventory is independent of production rates and is not expected to change over time.

9.2.3.11 Sealed Source Inventory Scenario for Sr-90

9.2.3.11.1 Alternatives for Sr-90 Sealed Source Inventory

Table 6-15 shows the alternatives for Sr-90 sealed source inventory at the Neutron Generator Facility.

Table 6-15. Alternatives for Sr-90 Sealed Source Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
4.96629 µCi	4.96629 µCi	4.96629 µCi	4.96629 µCi	4.96629 µCi

9.2.3.11.2 Operations That Require Sr-90

Operations that require Sr-90 include instrument calibration and operational checks for radiation detection equipment.

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

Inventory is independent of production rates and is not expected to change over time.

9.2.3.12 Sealed Source Inventory Scenario for Tc-99

9.2.3.12.1 Alternatives for Tc-99 Sealed Source Inventory

Table 6-16 shows the alternatives for the Tc-99 sealed source inventory at the Neutron Generator Facility.

Table 6-16. Alternatives for Tc-99 Sealed Source Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0.00851 µCi	0.00851 µCi	0.00851 µCi	0.00851 µCi	0.00851 µCi

9.2.3.12.2 Operations That Require Tc-99

Operations that require Tc-99 include instrument calibration and operational checks for radiation detection equipment.

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

Inventory is not expected to change over time and is independent of production rates.

9.2.4 Spent Fuel Inventory Scenarios

This facility has no spent fuel inventories.

9.2.5 Chemical Inventory Scenarios

The list of chemicals provided in this section does not represent the comprehensive list of chemicals that are used at this facility. After reviewing a comprehensive list of chemicals that was derived from sources of information on corporate chemical inventories (for example, the SNL/NM Chemical Information System and procurement records), DOE and the contractor responsible for preparing the sitewide environmental impact statement selected "chemicals of concern," which are those chemicals that are most likely to affect human health and the environment. Table 6-17 shows the alternatives for chemicals of concern at the Neutron Generator Facility.

Table 6-17. Chemical Inventory Scenarios

Chemical (units)	Reduced Alternative	No Action Alternative			Expanded Alternative
		Base Year	FY2003	FY2008	
Acetone (liters)	8,175	2,725	8,175	8,175	8,175
Alcohol, benzyl (liters)	757	252	757	757	757
Alcohol, butyl (liters)	15	5	15 l	15	15
Alcohol, ethyl (liters)	37,850	12,617	37,850	37,850	37,850
Alcohol, isopropyl (liters)	333	100	333	333	333
Alcohol, methyl (liters)	2,102	630	2,102	2,102	2,102
Cellosolve acetate (liters)	6.7	2	6.7	6.7	6.7
Iso amyl acetate (liters)	908	303	908	908	908
Methylene chloride (liters)	56	18	56	56	56
MIBK (liters)	80	24	80	80	80
1-methyl-2-pyrrolidinone (liters)	15	5	15	15	15
Perchloroethylene (liters)	624	624	624	624	624
Ultima Gold-Packard (alkylnapthalene) (liters)	1,650	550	1,650	1,650	1,650
Acetic acid (liters)	100	33	100	100	100
Acetic acid, glacial (liters)	110	37	110	110	110
Boric acid (kilograms)	120	40	120	120	120
Hydrochloric acid (liters)	100	33	100	100	100
Hydrofluoric acid (liters)	100	33	100	100	100
Nitric acid (liters)	165	50	165	165	165
Phosphoric acid (liters)	60	20	60	60	60
Sulfuric acid (liters)	60	20	60	60	60
Ammonium hydroxide (liters)	15	5	15	15	15
Potassium hydroxide (kilograms)	15	5	15	15	15
Sodium hydroxide (kilograms)	15	5	15	15	15
CTBN epoxy resin (kilograms)	300	100	300	300	300
Curing agent Z (37% MDA) (kilograms)	454	151	454	454	454
DEA curing agent (kilograms)	360	120	360	360	360
Di-p xylene (kilograms)	909	273	909	909	909
Ethylene Glycol (liters)	20	20	20	20	20
Aluminum (kilograms)	666	200	666	666	666
Aluminum oxide (kilograms)	300	100	300	300	300
Cerric ammonium nitrate (kilograms)	2,000	600	2,000	2,000	2,000
Chromium (kilograms)	15	5	15	15	15
Chromium trioxide (kilograms)	9	3	9	9	9
Copper (kilograms)	666	200	666	666	666
Erbium (kilograms)	15	5	15	15	15
Kovar (kilograms)	60	20	60	60	60
Manganese (kilograms)	13	4	13	13	13
Molybdenum (kilograms)	6.6	2	6.6	6.6	6.6
Nickel chloride (kilograms)	800	267	800	800	800
Nickel sulfate (kilograms)	800	267	800	800	800
Scandium (kilograms)	15	5	15	15	15
Silver epoxy (kilograms)	15	5	15	15	15
Titanium hydride (kilograms)	3.3	1	3.3	3.3	3.3

9.2.5.1 Operations That Require Chemical Inventories

The programs and operations that utilize these chemicals are described in detail in "4.0 PROGRAM ACTIVITIES," "5.0 OPERATIONS AND CAPABILITIES," and "6.0 HAZARDS AND HAZARD CONTROLS."

9.2.5.2 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. In most cases, the values for the "no action," "reduced," and "expanded" alternatives were derived by adjusting the base year information in proportion to the changes in activity levels provided in "9.1 Activity Scenario for Development or Production of Devices, Processes, and Systems: Neutron Generators." However, where facility managers used process knowledge to estimate chemical applications, this more specific information was used instead.

Projections for highly toxic chemicals or those used in large quantity may have deviated from this methodology and used estimated values if deemed appropriate by the facility representatives.

9.2.5.3 Basis for Projecting the Values in the "Reduced" Column

Baseline values for the chemicals listed in this table were obtained from the SNL Chemical Information System. In most cases, the values for the "no action," "reduced," and "expanded" alternatives were derived by adjusting the base year information in proportion to the changes in activity levels provided in "9.1 Activity Scenario for Development or Production of Devices, Processes, and Systems: Neutron Generators." However, where facility managers used process knowledge to estimate chemical applications, this more specific information was used instead.

Projections for highly toxic chemicals or those used in large quantity may have deviated from this methodology and used estimated values if deemed appropriate by the facility representatives.

9.2.5.4 Basis for Projecting the Values in the "Expanded" Column

Baseline values for the chemicals listed in this table were obtained from the SNL Chemical Information System. In most cases, the values for the "no action," "reduced," and "expanded" alternatives were derived by adjusting the base year information in proportion to the changes in activity levels provided in "9.1 Activity Scenario for Development or Production of Devices, Processes, and Systems: Neutron Generators." However, where facility managers used process knowledge to estimate chemical applications, this more specific information was used instead.

Projections for highly toxic chemicals or those used in large quantity may have deviated from this methodology and used estimated values if deemed appropriate by the facility representatives.

9.2.6 Explosives Inventory Scenarios

This facility has no explosives inventories.

9.2.7 Other Hazardous Material Inventory Scenarios

This 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.

9.3 Material Consumption

9.3.1 Nuclear Material Consumption Scenario for Tritium

9.3.1.1 Alternatives for Tritium Consumption

Table 6-18 shows the alternatives for tritium consumption at the Neutron Generator Facility.

Table 6-18. Alternatives for Tritium Consumption

<table>
<tr><th colspan="2" rowspan="2">Reduced Alternative</th><th colspan="6">No Action Alternative</th><th colspan="2" rowspan="2">Expanded Alternative</th></tr>
<tr><th colspan="2">Base Year</th><th colspan="2">FY2003</th><th colspan="2">FY2008</th></tr>
<tr><td>100 pkgs</td><td>652 Ci</td><td>60 pkgs</td><td>386 Ci</td><td>100 pkgs</td><td>652 Ci</td><td>100 pkgs</td><td>652 Ci</td><td>100 pkgs</td><td>652 Ci</td></tr>
</table>

9.3.1.2 Operations That Require Tritium

Tritium is used in the Neutron Generator Facility in both the elemental form and as a metal hydride in tritium-loaded occluder films, which are also called targets. The targets are an integral part of a weapon component neutron generator. Elemental tritium gas is used to calibrate analytical equipment in the target-loading verification laboratory.

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

The quantities represent the receipt of tritium-loaded occluder films from Los Alamos and the gaseous tritium calibration standards from Savannah River. Target deliveries from Los Alamos are in production lots and occur throughout the year. Gaseous tritium is ordered as needed and delivered in quantities that may be used over several years. The amount of each type of material received is proportional to production quantities within certain limits and thresholds.

9.3.2 Radioactive Material Consumption Scenarios

Radioactive material is not consumed at this facility.

9.3.3 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.

9.3.4 Explosives Consumption Scenarios

Explosives are not consumed at this facility.

9.4 Waste

9.4.1 Low-Level Radioactive Waste Scenario

9.4.1.1 Alternatives for Low-Level Radioactive Waste at the Neutron Generator Facility

Table 6-19 shows the alternatives for low-level radioactive waste at the Neutron Generator Facility.

Table 6-19. Alternatives for Low-Level Radioactive Waste

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
4,000 kg	3,000 kg	4,000 kg	4,000 kg	4,000 kg

9.4.1.2 Operations That Generate Low-Level Radioactive Waste

Low-level radioactive waste at the Neutron Generator Facility results from maintenance activities.

9.4.1.3 General Nature of Waste

Low-level radioactive waste at the Neutron Generator Facility includes quantities of contaminated personal protective equipment, scrap neutron generator parts, and scrap equipment parts.

9.4.1.4 Waste Reduction Measures

The Neutron Generator Facility is a new facility and was designed to minimize the generation of low-level radioactive waste.

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

Within certain limits and thresholds, the amount of waste produced is proportional to production quantities.

9.4.2 Transuranic Waste Scenario

Transuranic waste is not produced at this facility.

9.4.3 Mixed Waste

9.4.3.1 Low-Level Mixed Waste Scenario

9.4.3.1.1 Alternatives for Low-Level Mixed Waste at the Neutron Generator Facility

Table 6-20 shows the alternatives for low-level mixed waste at the Neutron Generator Facility.

Table 6-20. Alternatives for Low-Level Mixed Waste

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
300 kg	150 kg	300 kg	300 kg	300 kg

9.4.3.1.2 Operations That Generate Low-Level Mixed Waste

Most operations described in "5.0 OPERATIONS AND CAPABILITIES" could produce low-level mixed waste.

9.4.3.1.3 General Nature of Waste

Mixed waste at the Neutron Generator Facility consists of tritium-contaminated chromium thermocouples, cadmium-plated bolts, tin- and lead-solder circuit boards, HEPA filters with entrapped lead dust, and acid solutions containing *Resource Conservation and Recovery Act (RCRA)* metals. These wastes are inorganic in nature.

9.4.3.1.4 Waste Reduction Measures

The Neutron Generator Facility is a new facility and was designed to minimize waste.

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

Within certain limits and thresholds, the amount of waste produced is proportional to production quantities.

9.4.3.2 Transuranic Mixed Waste Scenario

Transuranic mixed waste is not produced at this facility.

9.4.4 Hazardous Waste Scenario

9.4.4.1 Alternatives for Hazardous Waste at the Neutron Generator Facility

Table 6-21 show the alternatives for hazardous waste at the Neutron Generator Facility.

Table 6-21. Alternatives for Hazardous Waste

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
3,680 kg	2,760 kg	3,680 kg	3,680 kg	3,680 kg

9.4.4.2 Operations That Generate Hazardous Waste

All operations described in "5.0 OPERATIONS AND CAPABILITIES" may generate hazardous waste.

9.4.4.3 General Nature of Waste

Hazardous waste generated at the Neutron Generator Facility consists of acid solutions used in chemical cleaning operations, spent plating baths, off-spec chemicals, expired chemicals, spent solvents, spent alcohol solutions, spent acetone solutions, and wipes contaminated with alcohol and acetone.

9.4.4.4 Waste Reduction Measures

The Neutron Generator Facility is a new facility and was designed to minimize hazardous waste.

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

Within certain limits and thresholds, the amount of waste produced is proportional to production quantities.

9.5 Emissions

9.5.1 Radioactive Air Emissions Scenarios

9.5.1.1 Radioactive Air Emission Scenario for H-3

9.5.1.1.1 Alternatives for H-3 Emissions at the Neutron Generator Facility

Table 6-22 shows the alternatives for H-3 emissions at the Neutron Generator Facility.

Table 6-22. Alternatives for H-3 Emissions

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
156 Curies	94 Curies	156 Curies	156 Curies	156 Curies

9.5.1.1.2 Operations That Generate H-3 Air Emissions

Radioactive air emissions are generated by process equipment operation, equipment maintenance, equipment calibration, destructive testing, and component outgassing.

9.5.1.1.3 General Nature of Emissions

The majority of the radioactive emissions released to the environment is elemental tritium gas. A small portion of the overall emissions is tritium oxide and metal tritide particulates.

9.5.1.1.4 Emission Reduction Measures

Specific equipment is connected to a tritium capture system (TCS) that can remove tritium from process equipment effluents. The emissions stated above are very conservative in that they do not account for use of the TCS. Use of the TCS can reduce stated effluents by 80 percent or more.

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

Tritium emissions are directly proportional to the number of neutron generators produced within certain limits and thresholds. However, the relationship varies slightly, depending on the nature of the work conducted.

9.5.2 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.

9.5.3 Open Burning Scenarios

This facility does not have outdoor burning operations.

9.5.4 Process Wastewater Effluent Scenario

9.5.4.1 Alternatives for Process Wastewater at the Neutron Generator Facility

Table 6-23 shows the alternatives for process wastewater at the Neutron Generator Facility.

Table 6-23. Alternatives for Process Wastewater

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
5 million gal	3 million gal	5 million gal	5 million gal	5 million gal

9.5.4.2 Operations That Generate Process Wastewater

All operations listed in “5.0 OPERATIONS AND CAPABILITIES,” would generate process wastewater (for example, chemical cleaning, vapor honing, lapping, chemical plating, firing, and neutron generator testing). Process wastewater is accounted for within the total water use of the facility. The values in Table 6-23 indicate total water use, including process wastewater.

9.5.4.3 General Nature of Effluents

It is estimated that between 10,000 gal and 14,000 gal of the process wastewater effluent from this facility is tritiated. The tritiated process wastewater is handled and stored separately from the remaining process water.

The level of radioactivity in the tritiated process wastewater is below the EPA drinking water limit of 20,000 pCi per liter. However, the City of Albuquerque's wastewater regulations specify a zero limit. Therefore, the tritiated water is stored in two 1,000-gal tanks in the basement of Building 870 and evaporated.

9.5.4.4 Effluent Reduction Measures

The Neutron Generator Facility continues to pursue measures directed at improving the efficiency of all processes, including pollution prevention and waste reduction.

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

The amount of waste produced is not proportional to production quantities because of changing limits and thresholds.

9.6 Resource Consumption

9.6.1 Process Water Consumption Scenario

9.6.1.1 Alternatives for Process Water Consumption at the Neutron Generator Facility

Table 6-24 shows the alternatives for process water consumption at the Neutron Generator Facility.

Table 6-24. Alternatives for Process Water Consumption

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
5 million gal	3 million gal	5 million gal	5 million gal	5 million gal

9.6.1.2 Operations That Consume Process Water

The projections for consumption of process water are consistent with those provided for generation of wastewater; the facility's total water use includes wastewater. All operations listed in "5.0 OPERATIONS AND CAPABILITIES" would consume process water (for example, chemical cleaning, vapor honing, lapping, chemical plating, firing, and neutron generator testing).

9.6.1.3 Consumption Reduction Measures

The Neutron Generator Facility continues to pursue measures directed at improving the efficiency of all processes, including pollution prevention and waste reduction.

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

The amount of water used is not proportional to production quantities because of changing limits and thresholds.

9.6.2 Process Electricity Consumption Scenario

This facility does not consume process electricity.

9.6.3 Boiler Energy Consumption Scenario

This facility does not consume energy for boilers.

9.6.4 Facility Personnel Scenario

9.6.4.1 Alternatives for Facility Staffing at the Neutron Generator Facility

Table 6-25 shows the alternatives for facility staffing at the Neutron Generator Facility.

Table 6-25. Alternatives for Facility Staffing

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
280 FTEs	180 FTEs	280 FTEs	280 FTEs	280 FTEs

9.6.4.2 Operations That Require Facility Personnel

Neutron Generator Facility operations require the support of scientists, technicians, engineers, administrative staff, and other staff. The estimates of FTEs in Table 6-25 are based on the assignments of personnel who support Neutron Generator Facility production activities in the Defense Programs Products and Services Division (14000). The estimates do not include 15 to 20 workers who support Neutron Generator Facility Operations and who are located in other facilities. These workers are accounted for in discussions of other selected facilities.

9.6.4.3 Staffing Reduction Measures

There are no current or planned staffing reduction measures.

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

Resource use is proportional to level of production within certain limits and thresholds.

9.6.5 Expenditures Scenario

9.6.5.1 Alternatives for Expenditures at the Neutron Generator Facility

Table 6-26 shows the alternatives for expenditures at the Neutron Generator Facility.

Table 6-26. Alternatives for Expenditures

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
$55 million	$30 million	$55 million	$55 million	$55 million

9.6.5.2 Operations That Require Expenditures

Expenditure projections are based on salaries and material unit costs.

9.6.5.3 Expenditure Reduction Measures

Information on expenditure reduction measures is currently unavailable.

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

Resource use is proportional to level of production within certain limits and thresholds.

10.0 REFERENCES

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CHAPTER 7 - MICROELECTRONICS DEVELOPMENT LABORATORY SOURCE INFORMATION

Contents

LIST OF TABLES

1.0 INTRODUCTION

The broad range of microtechnology development and engineering capabilities at the Microelectronics Development Laboratory (MDL) are divided into four broad subprocesses:

- Film deposition
- Etching
- Photolithography
- Ion implantation

Integrated circuits, micromechanical structures, and sensors are formed entirely on silicon dies or chips through various steps that could involve some or all of the above subprocesses.

2.0 PURPOSE AND NEED

The Microelectronics Development Laboratory (MDL) provides research and development capability with a variety of state-of-the-art microelectronics production methods. Each project performed in the MDL may use a distinct combination of the manufacturing techniques available at a prototype level, depending on the purpose of the project (Sandia National Laboratories, 1997b; 1998).

Under the “expanded” alternative for the MDL (see “9.1.4 Assumptions and Actions for the ‘Expanded’ Values”), DOE has proposed to construct the Microsystems and Engineering Science Applications (MESA) Complex, an integration of SNL/NM capabilities to support the areas of stockpile stewardship and management, the Stockpile Life Extension Program (SLEP), and the Defense Program’s Enhanced Surety Campaign. Development of the MESA Complex would overcome the lack of adequate facilities and infrastructure to support the required integration of three critical disciplines: microsystems technology development, computational and engineering sciences and analysis, and weapon design, system integration and certification.

Current planning calls for combining the existing capabilities of the Compound Semiconductor Research Laboratory with elements of the MDL into several new facilities referred to as the MESA Complex. These facilities are proposed to be constructed nearby the MDL (Sandia National Laboratories, 1999).

3.0 DESCRIPTION

The Microelectronics Development Laboratory (MDL) is in Building 858 north, adjacent to 858 south, which contains offices and light labs. The light labs, deal primarily with wafer test equipment, die packaging, scanning electron microscopy, device radioactive source exposure, and device inspection. Constructed in 1988, the MDL contains 30,000 ft^2 of clean room, consisting of 22 independent bays separated by 8-ft-wide utility chases. Also associated with the MDL are the following:

- A central plant (a single-story building connected to the MDL)
- A nitrogen plant leased from Praxair
- A basement that contains acid waste neutralization equipment, utilities tunnels, an intrusion alarm system, and a protected distribution system
- Several chemical storage tanks, including a 6,500-gal tank of hydrochloric acid and another 6,500-gal tank of sodium hydroxide
- A liquid hydrogen storage tank (4,500 gal) leased from Praxair
- A support area that includes the Remote Safety Center
- An exhaust fan room with three acid exhaust fans and two solvent exhaust fans

(Sandia National Laboratories, 1998)

The remainder of this chapter refers to operations carried out in Building 858 north.

4.0 PROGRAM ACTIVITIES

Table 7-1 shows the program activities at the Microelectronics Development Laboratory (MDL).

Table 7-1. Program Activities at the Microelectronics Development Laboratory

Program Name	Activities at the Microelectronics Development Laboratory	Category of Program	Related Section of the *SNL Institutional Plan*
Direct Stockpile Activities	Conduct research and development on microelectronic devices for nuclear weapon applications. Also provide limited capability for production of radiation-hardened microelectronics. Could be considered as a backup production facility to those facilities available in private industry.	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 both 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
System Components Science and Technology	Fabricate integrated circuits, microsensors/controllers, and micromachines. Study and improve silicon semiconductor processing.	Programs for the Department of Energy	Section 6.1.1.1
Technology Transfer and Education	Process and product development for microelectronic systems.	Programs for the Department of Energy	Section 6.1.1.3
Weapons Program	Develop microelectronic devices for weapon components.	Programs for the Department of Energy	Section 6.1.1.4
Enhanced Surveillance	Examine corrosion.	Programs for the Department of Energy	Section 6.1.1.4
Advanced Manufacturing, Design, and Production Technologies	Develop new processes and build prototypes.	Programs for the Department of Energy	Section 6.1.1.4
Catalysis and Separations Science and Engineering	Develop miniature fuel cells and fuel processors.	Programs for the Department of Energy	Section 6.1.5.6

Table 7-1. Program Activities at the Microelectronics Development Laboratory (Continued)

Program Name	Activities at the Microelectronics Development Laboratory	Category of Program	Related Section of the *SNL Institutional Plan*
Integrated Micromachine Technology	Design, manufacture, and test integrated microsystems.	Laboratory-Directed Research and Development	Section 6.3.5.3
Sustaining National Capabilities in Radiation-Hardened Microelectronics	Design, fabricate, test, and package radiation-hardened semiconductors, integrated microelectromechanical devices, and integrated sensors for use in Defense Programs (DP) and Work for Others (WFO) systems.	Major Programmatic Initiatives	Section 7.1.1
Reliably Meeting Pending Production and Production Support Requirements	Conduct microelectronics testing, burning, and failure analyses.	Major Programmatic Initiatives	Section 7.1.4
Sustaining Momentum in Advanced Design and Production Technologies	Characterize current and advanced manufacturing processes for microelectronic devices (including microelectromechanical systems [MEMS] and radiation-hardened devices). Develop advanced processes and advanced process control systems for microelectronic devices.	Major Programmatic Initiatives	Section 7.1.5

5.0 OPERATIONS AND CAPABILITIES

Microelectronics Development Laboratory (MDL) processes use silicon, which is grown as a large, single, crystal ingot. The ingot is sliced into wafers of highly uniform thickness and polished to a mirror-like finish. The ability of silicon to conduct electricity is controlled by placing chemicals called dopants into its crystalline structure. Precisely placed dopants create negative and positive regions that control the flow of current within the wafer. Silicon's semiconducting nature allows alteration of its electrical properties to create very small electronic components, such as transistors, on the wafer surface. The combination of resistors, capacitors, and electronic circuits produced within a silicon wafer make up an integrated circuit.

The basic method for producing an integrated circuit is to physically etch a pattern of the circuit into the wafer surface. This is usually done with techniques that are analogous to those of photography. The wafer is coated with a light-sensitive material that is exposed to light in a pattern that is a “negative” of the pattern for the circuit. When the light-sensitive material is “developed,” areas that are not to be part of the circuit are coated with a material that resists etching to protect those areas. The bare areas can then be etched with the pattern of the circuit. The etched areas are more receptive to the dopants, which control the flow of electricity. Depending on the purpose of the wafer, various materials may be deposited on the surface of the wafer to alter its function. Examples of materials and methods of depositing them on the wafer surface are described below. In all phases, the wafer surface must be kept meticulously clean. Cleaning methods usually involve acid baths or other rigorous treatments.

The broad range of microtechnology development and engineering capabilities are broken down into four broad subprocesses:

- Film deposition
- Etching
- Photolithography
- Ion implantation

Integrated circuits, micromechanical structures, and sensors are formed entirely on a silicon die or chip through various steps that could involve some or all of the previously mentioned subprocesses.

Preparing the surface for film deposition requires four steps. The first step involves depositing very thin uniform layers of silicon dioxide and silicon nitride on the wafer surface. The second step covers the surface layers with a light-sensitive liquid called photoresist. The photoresist reacts to light exposure and forms areas that resist removal of the silicon dioxide and silicon nitride to form a protective barrier for the material beneath it.

The third step transfers the layer pattern to the photoresist layer on the wafer by passing the light through a reticle and focusing the image onto the photoresist. Special lenses reduce the reticle's image and expose it many times across the wafer surface. Exposed areas of the photoresist are removed with chemical developers, leaving accurate reproductions of the reticle's pattern in the photoresist.

Etching transfers the pattern in the photoresist to the thin film or films on the surface of the wafer. The etching process involves placing the wafer in an atmosphere of reactant gases or submerging the wafer in reactant liquids, which etches away the areas that the photoresist does not protect.

Transferring the layer patterns to silicon by photolithography requires a process similar to photography that involves creating a series of chrome-coated glass plates called photo masks or reticles. Each reticle holds the pattern for one layer. The reticle acts as a negative to expose light-sensitive material on the surface of the wafer.

The next step is ion implantation, in which electrically active chemical dopants are implanted through openings in the etched pattern. This process creates regions in the wafer's crystalline silicon called wells that store electrical charges and direct the flow of current. Connecting these wells to the rest of the integrated circuit requires the formation of conductive metallic layers. Microscopic layers of metal are deposited on the wafer's surface through a plasma deposition process in which metals such as aluminum are energized into a gaseous plasma state of ions and electrons. These atomic particles form a thin metallic film, coating every minute contour on the wafer's surface.

Next, the wafer is covered with photoresist, exposed using the appropriate reticle, and etched, removing the unwanted areas of the metallic layer. The result is a complex series of conductive metal pathways interconnecting the circuit components. Layer by layer, over and over again, the process of deposition, exposing, and etching continues until the circuitry is complete and the wafer is finished.

Within a new, adjoining facility known as the Microsystems and Engineering Science Applications (MESA) Complex, some MDL research activities would be integrated with activities previously performed at the Compound Semiconductor Research Lab (CSRL). The MESA facility would add the capacity to develop and produce prototype microsystems devices, and provide backup capability (when primary suppliers are unavailable) to provide these devices for stockpile maintenance. Microsystem devices include electronics, micromachines, optoelectronics, and sensors on individual, microelectronic-based chips (wafers). The processes for building microsystems devices, which currently exist within both the MDL and the CSRL, would be combined along with state-of-the-art safety and pollution-control equipment in the MESA facility.

Development of the MESA facility would include upgrades to the existing MDL Reverse Osmosis Deionized Ultra Pure Water (RO/DI/UPW) system by replacing the mixed bed ion exchangers with an electrodeionization (EDI) process. This method would eliminate the current mixed bed regeneration process, resulting in a savings of approximately 2M gallons of process water annually.

An added benefit of EDI is the elimination of the bulk consumption of hydrochloric acid (HCl) and sodium hydroxide (NaOH) needed for mixed bed regeneration. Existing 6,500-gal HCl and 6,500-gal NaOH tanks at the MDL would be removed. Although quantities of HCl and NaOH would still be needed for the industrial waste treatment process at the Acid Waste Neutralization (AWN) plant, modifications of this process could be supported by using 55-gal drums or 330-gal totes of sulfuric acid and sodium hydroxide.

Within the MESA facility, new ion implanters could use sub-atmospheric, gas-delivery-system technology, eliminating the need for high-pressure gas cylinders for the implant gases of arsine (AsH_3), phosphine (PH_3), and boron trifluoride (BF_3). The system also uses in-cylinder absorbent technology that reduces the potential of cylinder leakage.

Numerous Class III and IV lasers, currently used in the CSRL, would be transferred for use in the proposed MESA Complex. These lasers represent existing capacity at SNL/NM and would only be relocated to the proposed new facility.

(Sandia National Laboratories, 1998; Sandia National Laboratories, 1993)

6.0 HAZARDS AND HAZARD CONTROLS

The hazards associated with the Microelectronics Development Laboratory (MDL) are generic to microelectronics operations and primarily involve hazardous material storage and handling. SNL/NM has provided engineering controls and administrative restraints to reduce the risk of negative impacts from abnormal events involving toxic materials.

The hazardous chemicals located at the MDL include but are not limited to toxic, flammable, or pyrophoric gases, such as the following:

- Anhydrous hydrogen fluoride
- Ammonia
- Arsine
- Boron trifluoride
- Chlorine
- Diborane
- Bromotrifluoromethane
- Fluorine
- Silane
- Carbon tetrafluoromethane
- Phosphine
- Disilane

- Sulfur hexafluoride
- Diethyl silane
- Triethyl borate

The hazardous chemicals located at the MDL may also include toxic liquids, such as the following:

- Ammonium fluoride
- Acetic acid
- Acetone
- Sodium hydroxide
- Nitric acid
- PRS-1000
- Hydrochloric acid
- Sulfuric acid
- PRS-3000
- Hydrofluoric acid
- Phosphoric acid
- Isopropanol
- Hydrogen peroxide

6.1 Offsite Hazards to the Public and the Environment

Possible chemical releases and nonnegligible exposure of members of the public were identified as potentially resulting from the following:

- Earthquake that exceeds design basis
- Airplane crash
- Fire in storage bays
- Hydrogen explosion

Hazards associated with the MDL that could affect the offsite environment are avoided through administrative and engineering controls.

6.2 Onsite Hazards to the Environment

Environmental hazards were not separately identified within the safety assessment for the MDL. However, release of the stored chemicals from the large tanks could obviously result in surface contamination and significant cleanup efforts. Because of the depth to groundwater and the lack of surface water, water contamination is unlikely.

6.3 Onsite Hazards to Workers

Possible chemical releases and nonnegligible exposure of workers could potentially result from the following:

- Earthquake that exceeds design basis
- Leaks from the bulk storage tanks
- Exposure to gas in north dock
- Gas exposure during clean room operation
- Fire in storage bays
- Industrial anoxia
- High-temperature equipment
- Chemical spills or splashes
- Exposure to arsine during HEPA filter changes
- Airplane crash
- Storage of incompatible materials
- Exposure to gas in gas bunkers
- Exposure to chemicals in storage bays
- Dropped gas cylinder
- High pressure
- Electrical shock
- Exposure to lasers
- Exposure to radiation

6.4 Hazard Controls

The MDL is engineered to protect workers and the public from adverse impacts of abnormal events. Table 7-2 summarizes the major protective and mitigative measures.

Table 7-2. Protective and Mitigative Measures

Location	Hazard	Accident Mitigation/Prevention
Compressed gas cylinder storage (north dock)	Compressed gas storage	Segregation, and special handling and transportation methods
Chemical storage bays (first floor, MDL)	• Flammables • Acids • Caustics • Oxidizers	• Chemical inventory control • Access control • Sloped, bermed floor • Drains to acid waste system from all but the flammable bay • Moisture sensor in oxidizer bay • Fire suppression and detection • Deluge system in the flammable bay
Bulk chemical storage tanks (outside building)	• 6,500-gal HCl tank • 6,500-gal NaOH tank • 3,000-gal oxygen tank • 6,000-gal nitrogen holding tank	• Hydrogen monitors interlocked to fail-safe shutoff • External storage • Secondary containment for the HCl and NaOH tanks with moisture sensors between plastic liner and concrete containment • Welded plug systems (double-walled with leak checks)
4,500-gal hydrogen supply tank (outside building)	Flammable gases	Hydrogen monitors interlocked to gas shutoff valves
Ventilated gas cabinets and welded pipe transfer systems (basement)	• Highly toxic gases • Pyrophoric gases • Flammable gases	Emergency Response Center controls: • Toxic gas detection analyzers control panel • Fire alarm data-gathering panel • Uninterruptible power supply (automatic transfer to diesel standby power) • Switchboard for activating automatic equipment shutdowns and autodialers on alarm detection • Excess flow detectors and alarms • Double-walled piping and leak checks for toxic gas lines
Gas bunker (basement)	• Flammable gases • Pyrophorics	• Outside MDL footprint • Blowout ceiling to mitigate effects of explosion • Access control • Separate dedicated air intake and exhaust
Source: Sandia National Laboratories, 1993		

7.0 ACCIDENT ANALYSIS SUMMARY

7.1 Selection of Accidents Analyzed in Safety Documents

Of the various accident scenarios that were developed for Microelectronics Development Laboratory (MDL) operations, 5 were natural phenomena events, 2 were external events, 17 were operational accidents, and 5 were industrial accidents.

7.2 Analysis Methods and Assumptions

The methodology for the accident analysis was essentially the "binning" methodology of AL 5481.1B in which the hazard severity categories and probability categories of the order were used as summarized in Table 7-3 (Sandia National Laboratories, 1993). The technique used for estimating the likelihood of occurrence for an event relied on the judgment of MDL staff in evaluating the effectiveness of barriers and controls as hazard prevention and mitigation measures.

Table 7-3. Risk Matrix for Accident Ranking

Hazard Severity	Probability of Occurrence			
	Incredible (D)	**Extremely Unlikely (C)**	**Unlikely (B)**	**Likely (A)**
Catastrophic (I)	Extremely low	Medium	High	High
Critical (II)	Extremely low	Low	Medium	High
Marginal (III)	Extremely low	Low	Low	Medium
Negligible (IV)	Extremely low	Extremely low	Extremely low	Extremely low

As discussed in "6.0 HAZARDS AND HAZARD CONTROLS," the risk from the MDL is primarily from the potential release of hazardous chemicals. The greatest risk is to facility workers, although some potential for exposure of the public also exists.

7.3 Summary of Accident Analysis Results

Table 7-4 summarizes the results of the accident analysis for the MDL.

Table 7-4. MDL Accident Analysis Results

Accident	Public Risk	Worker Risk
Severe earthquake	Low (IIIB)	Low (IIIB)
Aircraft crash	Medium (IIB)	High (IB)
Storage of incompatible materials	None	Low (IIC)
Leaks from bulk storage tanks (at the tank)	None	Low (IIIB)
Leaks from bulk storage tanks (in the plumbing)	None	Low (IIIB)
Exposure to gases in the north dock	None	Low (IIIB)
Exposure to gas in gas bunker	None	Low (IIIB)
Gas exposure during clean room operation	None	Low (IIIB)
Exposure to chemicals in storage bays	None	Low (IIIB)
Fire in storage bays	Low (IIIB)	Medium (IIB)
Dropped gas cylinder	None	Low (IIIB)
Anoxia	None	Low (IIC)

The highest risk is from an airplane crash, which would result in death and severe injury to personnel and possible short-term exposure of the public to hazardous chemicals in excess of "immediately dangerous to life and health" (IDLH) concentrations. Because of the location of Building 858, the offsite public is considered to be anyone located outside the perimeter fence that surrounds the building. Furthermore, the analysis assumes that the aircraft crash would cause the combustion of sufficiently hazardous materials to result in a short-term chemical concentration exceeding IDLH for anyone located in the immediate vicinity of Building 858. No dispersion modeling was performed to determine in what direction or how far a chemical plume of IDLH concentrations would travel.

The probability of such an aircraft crash was calculated in Sandia National Laboratories (1993) to be approximately 1.2×10^{-4} crashes per year. However, the number of large aircraft takeoffs and landings at Albuquerque International Sunport was estimated to be conservatively high (no credit was taken for the limited impact on Building 858 that would be anticipated from small aircraft crashes), and no credit was taken for the protection of Building 858 from skidding aircraft by adjacent structures (for example, Building 897) or for pilot action in steering a troubled aircraft toward nearby open grounds. Thus, the probability of an aircraft crash resulting in chemical releases in excess of IDLH concentrations is more likely to be less than 10^{-4} per year. The resulting risk to the offsite public would then be low (IIC).

Under the "expanded" alternative the operations of the proposed MESA Complex would combine and integrate activities from the existing MDL and CSRL. The sitewide environmental impact statement includes accident analysis for the proposed MESA Complex, including the potential for the proposed facility to concentrate larger amounts of hazardous chemicals held on hand.

(AL 5481.1B; Sandia National Laboratories, 1993)

8.0 REPORTABLE EVENTS

Table 7-5 lists the occurrence reports for the Microelectronics Development Laboratory over the past five years.

Table 7-5. Occurrence Reports for the Microelectronics Development Laboratory

Report Number	Title	Category	Description of Occurrence
ALO-KO-SNL-1000MDL-1993-0001	Electrical Shock	1F	A burn was incurred on the index finger of an employee who was troubleshooting a Varion Ion Implanter Model 100-10.
ALO-KO-SNL-1000MDL-1994-0001	Wastewater Discharge Permit Violation Building 858	2E	Due to failure of a mechanical valve, HCl was accidentally discharged from the neutralization system into the sanitary sewer, resulting in a low pH effluent.
ALO-KO-SNL-MDL1000-1994-0002	Uncontrolled Radioactive Sealed Sources	5J	Four small, unregistered sealed sources were discovered in a cabinet.
ALO-KO-SNL-NMFAC -1994-0016	Unplanned Loss of Hydrogen Supply	1H	Hydrogen supply was lost when a solenoid valve was inadvertently shut off during a maintenance operation.
ALO-KO-SNL-NMFAC-1997-0006	Chilled Water Release to the Environment Reportable to an Outside Agency	2E	Separation of a joint in a chilled water line resulted in a release of nonhazardous water to the environment.
ALO-KO-SNL-NMFAC-1997-0010	Safety Concern Relating to Violation of OSHA 1926 by Subcontractor Personnel, Working at Levels Without Fall Protection	3C	A subcontractor was performing roof repairs at a height of 15 feet without fall protection.
ALO-KO-SNL-1000-1998-0001	Spill Results in Release to the Environment	2B	A spill that resulted in a release to the environment of approximately 350 lb of sodium hydroxide, 50% NaOH solution (balance water), occurred outside of Building 858 north.

9.0 SCENARIOS FOR IMPACT ANALYSIS

In all of the scenarios for impact analysis in Section 9.0, base year values are for fiscal year (FY) 1996 unless otherwise noted.

9.1 Activity Scenarios for Development or Production of Devices, Processes, and Systems: Microelectronic Devices and Systems

9.1.1 Alternatives for Development or Production of Devices, Processes, and Systems: Microelectronic Devices and Systems

Table 7-6 shows the alternatives for development or production of microelectronic devices and systems at the Microelectronics Development Laboratory (MDL).

Table 7-6. Alternatives for Development or Production of Devices, Processes, and Systems: Microelectronic Devices and Systems

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
2,666 wafers	4,000 wafers	5,000 wafers	7,000 wafers	7,500 wafers

9.1.2 Assumptions and Actions for the "Reduced" Values

The throughput of 2,666 wafers is based on single-shift operation.

9.1.3 Assumptions and Rationale for the "No Action" Values

The present throughput of wafers in the MDL is 4,000 wafers per year, which is based on one and a quarter shifts.

The increase to 5,000 wafers in the year 2003 is based on expected increased efficiencies in processes and one and a half shifts. Year 2008 is estimated at 7,000 wafers because of breakthroughs in processing technologies, predicted Moore's law, and approximately two shifts.

9.1.4 Assumptions and Actions for the "Expanded" Values

The "expanded" alternative of 7,500 wafers throughput is a function of plant fabrication expansion technology and new methodologies coupled with increasing the work period to three shifts.

Included with expanded activities of the MDL is the development of the Microsystems and Engineering Science Applications (MESA) Complex. Major components of the MESA Complex would be constructed adjoining the MDL, with support structures (light laboratories and offices) located nearby. By sharing modernized equipment with the MDL, the MESA Complex would integrate activities of both the MDL and the Compound Semiconductor Research Laboratory (CSRL). The MESA Complex would integrate the design and simulation capabilities of microsystems with the larger system-level design and simulation capabilities to support future weapons stockpile stewardship activities. Three critical disciplines would be assembled in the MESA Complex: microsystems technology development, computational and engineering sciences and analysis, and weapon design, system integration, and certification. As the work of the CSRL is transferred tot he MESA Complex, the CSRL would be phased out and eventually decontaminated and demolished.

The efficiency of combining capacities from the MDL and CSRL into the MESA Complex would provide weapon designers and subsystem designers with the computational and rapid prototyping capabilities needed to ensure timely and accurate weapon certification. When fully operational, the MESA Complex would comprise approximately 270,000 to 320,000 gross square feet and support a heavy lab, several light labs, and administrative work space. The facility could potentially house from 550 to 650 workers.

The throughput of the MDL, integrated with the MESA Complex, would continue to be comprised of microelectronic wafers, although the composition of some wafers would include microsystems devices. These devices would be microelectronic-based chips that would embody electronics, micromachines, optoelectronics, and sensors. Microsystems devices are expected to revolutionize many technology applications during the next several decades and improve the safety and reliability of the U.S. nuclear weapon stockpile.

The combined activity of the MDL and adjoining MESA Complex would remain within the projected level of activities represented by operating the MDL at full capacity for three work shifts, an estimated 7,500 wafers annually (Beals, 1999).

9.2 Material Inventories

9.2.1 Nuclear Material Inventory Scenarios

This facility has no nuclear material inventories.

9.2.2 Radioactive Material Inventory Scenarios

This facility has no radioactive material inventories.

9.2.3 Sealed Source Inventory Scenarios

This facility has no sealed source inventory.

9.2.4 Spent Fuel Inventory Scenarios

This facility has no spent fuel inventories.

9.2.5 Chemical Inventory Scenarios

9.2.5.1 Alternatives for Chemical Inventories

The list of chemicals provided in this section does not represent the comprehensive list of chemicals that are used at this facility. After reviewing a comprehensive list of chemicals that was derived from sources of information on corporate chemical inventories (for example, the SNL/NM Chemical Information System and procurement records), DOE and the contractor responsible for preparing the sitewide environmental impact statement selected “chemicals of concern,” which are those chemicals that are most likely to affect human health and the environment.

Table 7-7 shows the alternatives for chemical inventories at the Microelectronics Development Laboratory.

Table 7-7. Chemical Inventory Scenarios

Chemical	Reduced Alternative	No Action Alternative			Expanded Alternative
		Base Year	FY2003	FY2008	
29% ammonium hydroxide	3,119.22 lb	4,680 lb	5,850 lb	8,190 lb	8,775 lb
30% diborane	25.99 ft³	39 ft³	48.75 ft³	68.25 ft³	73.12 ft³
Acetic acid, glacial	5.332 gal	8 gal	10 gal	14 gal	15 gal
Acetic acid, glacial	0.33325 l	0.5 l	0.625 l	0.875 l	0.9375 l
Acetone	14.66 l	22 l	27.5 l	38.5 l	41.25 l
Ammonia	451.887 gaseous ft³	678 gaseous ft³	847.5 gaseous ft³	1,186.5 gaseous ft³	1,271.25 gaseous ft³
Ammonium fluoride	46.655 gal	70 gal	87.5 gal	122.5 gal	131.25 gal
Ammonium fluoride	3.3325 gal	5 gal	6.25 gal	8.75 gal	9.375 gal
Arsine (15%) in 85% hydrogen	41.8562 gaseous ft³	62.8 gaseous ft³	78.5 gaseous ft³	109.9 gaseous ft³	117.75 gaseous ft³
Boron trifluoride	166.63 g	250 g	312.5 g	437.5 g	468.75 g
Bromotrifluoromethane	419.9 ft³	630 ft³	787.5 ft³	1102.5 ft³	1181.25 ft³
Chlorine	719.8 gaseous ft³	1,080 gaseous ft³	1,350 gaseous ft³	1,890 gaseous ft³	2,025 gaseous ft³
Chlorine gas	0.6665 lb	1 lb	1.25 lb	1.75 lb	1.875 lb
Diethyl silane	666.5 g	1000 g	1250 g	1750 g	1875 g
Disilane	1333 g	2000 g	2500 g	3500 g	3750 g
Fluorine (5%) in argon	25.33 gaseous ft³	38 gaseous ft³	47.5 gaseous ft³	66.5 gaseous ft³	71.25 gaseous ft³
Germanium tetradydride	6.665 gal	10 gal	12.5 gal	17.5 gal	18.75 gal
Hexanes	2.666 l	4 l	5 l	7 l	7.5 l
Hydrochloric acid	6,665 gal	10,000 gal	12,500 gal	17,500 gal	18,750 gal
Hydrochloric acid solutions, concentrates	82.646 gal	124 gal	155 gal	217 gal	232.5 gal
Hydrofluoric acid 15:1 DIL 4X1	207.948 gal	312 gal	390 gal	546 gal	585 gal
Hydrogen bromide	95.976 gaseous ft³	144 gaseous ft³	180 gaseous ft³	252 gaseous ft³	270 gaseous ft³
Hydrogen fluoride gas	115.97 lb	174 lb	217.5 lb	304.5 lb	326.25 lb
Hydrogen gas	577,008 ft³	865,729 ft³	1,082,161 ft³	1,515,026 ft³	1,623,242 ft³
Hydrogen peroxide	538.532 gal	808 gal	1,010 gal	1,414 gal	1,515 gal
Isopropanol	21.3 gal	32 gal	40 gal	56 gal	60 gal
Mercuric thiocyanate	314.588 mg	472 mg	590 mg	826 mg	885 mg
Methanol	18.662 gal	28 gal	35 gal	49 gal	52.5 gal
Methyl ethyl ketone	0.6665 l	1 l	1.25 l	1.75 l	1.875 l
Microposit S1818 photo resist	16.6625 gal	25 gal	31.25 gal	43.75 gal	46.875 gal
Microposit S1818 photo resist	11.3305 gal	17 gal	21.25 gal	29.75 gal	31.875 gal
Microposit S1818 photo resist	5.332 gal	8 gal	10 gal	14 gal	15 gal
Nitric acid	1,069.1 gal	1,604 gal	2,005 gal	2,807 gal	3,007.5 gal
Nitrogen trifluoride	39.8567 gaseous ft³	59.8 gaseous ft³	74.75 gaseous ft³	104.65 gaseous ft³	112.125 gaseous ft³

Table 7-7. Chemical Inventory Scenarios (Continued)

Chemical	Reduced Alternative	No Action Alternative			Expanded Alternative
		Base Year	FY2003	FY2008	
Phosphine	18.66 l	28 l	35 l	49 l	52.5 l
Phosphoric acid	5.332 gal	8 gal	10 gal	14 gal	15 gal
PRS-1000	117.3 l	176 l	220 l	308 l	330 l
PRS-3000	117.3 l	176 l	220 l	308 l	330 l
Silane	6,665 gal	10,000 gal	12,500 gal	17,500 gal	18,750 gal
Sodium hydroxide solutions, 40% and 50%	7,998 gal	12,000 gal	15,000 gal	21,000 gal	22,500 gal
Sulfur hexafluoride	575.19 ft³	863 ft³	1,078.75 ft³	1,510.25 ft³	1,618.12 ft³
Sulfuric acid	1.66625 l	2.5 l	3.125 l	4.375 l	4.6875 l
Sulfuric acid of low particulate grade	1,071.732 gal	1,608 gal	2,010 gal	2,814 gal	3,015 gal
Tetrabutyl ammonium hydroxide	0.6665 l	1 l	1.25 l	1.75 l	1.875 l
Tetrafluoromethane	186.62 lb	280 lb	350 lb	490 lb	525 lb
Tetrahydrofuran, anhydrous, 99.9%	0.6665 pt	1 pt	1.25 pt	1.75 pt	1.875 pt
Tetramethyl ammonium hydroxide	38 l	58 l	71.25 l	99.75 l	106.88 l
Trans 1,2-dichloroethylene	21.3 l	32 l	40 l	56 l	60 l
Triethyl borate	6.67 l	10 l	12.5 l	17.5 l	18.75 l
Vinyltrimethysilane	2.67 l	4 l	5 l	7 l	7.5 l

9.2.5.2 Operations That Require Chemical Inventories

The programs and operations that utilize these chemicals are described in detail in “3.0 DESCRIPTION,” “4.0 PROGRAM ACTIVITIES,” and “5.0 OPERATIONS AND CAPABILITIES.”

9.2.5.3 Basis for Projecting the Values in the “No Action” Columns

The values for the “no action” alternative were derived by adjusting the base year information in proportion to the changes in activity levels provided in “9.1 Activity Scenario for Development or Production of Devices, Processes, and Systems: Microelectronic Devices and Systems.” Where facility managers used process knowledge to estimate chemical use, this more specific information was used instead.

9.2.5.4 Basis for Projecting the Values in the “Reduced” Column

As for the “no action” alternative, the values for the “reduced” alternative were derived by adjusting the base year information in proportion to the changes in activity levels provided in “9.1 Activity Scenario for Development or Production of Devices, Processes, and Systems:

Microelectronic Devices and Systems." Where facility managers used process knowledge to estimate chemical applications, this more specific information was used instead.

9.2.5.5 Basis for Projecting the Values in the "Expanded" Column

Base-year values were obtained from the Sandia New Mexico Chemical Inventory System (CIS) (see Chapter 11, Section 3.0 of the *Sandia National Laboratories/New Mexico Environmental Information Document*). The values provided in the "reduced," "no action," and "expanded" column were derived by adjusting the CIS information to reflect the projections of activity levels identified in "9.1 Activity Scenario for Development and or Production of Devices, Processes, and Systems: Microelectronic Devices and Systems." Where possible, facility personnel have used process knowledge to develop these estimates.

As discussed in previous sections, a new research complex called MESA has been proposed to integrate MDL and Compound Semiconductor Research Laboratory (CSRL) operations at a centralized location. The values in the "expanded" column reflect both MDL and CSRL chemical use with the exception of the additional CSRL required chemicals and quantities noted below:

- Acetone to increase by 378.5 l annually
- Ammonia to increase by 13.37 ft^3 annually
- Isopropanol to increase by 60 gal annually
- Methanol to increase by 50 gal
- Addition of anhydrous ammonia at 140 lb annually
- Addition of 73 % hydrofluoric acid at 1 gal annually
- Addition of boron trichloride at 10 lb annually
- Addition of silicon tetrachloride at 1 lb annually
- Addition of sulfur dioxide at 100 g annually

Note: Some of the chemicals identified here also appear in Table 4-8, Compound Semiconductor Research Laboratory Hazardous Material Summary. The chemical quantities that appear above are the same quantities shown in Table 4-8, and are not intended to reflect additional amounts of these chemicals.

(Frock, 1999)

9.2.6 Explosives Inventory Scenarios

This facility has no explosives inventories.

9.2.7 Other Hazardous Material Inventory Scenarios

This 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.

9.3 Material Consumption

9.3.1 Nuclear Material Consumption Scenarios

Nuclear material is not consumed at this facility.

9.3.2 Radioactive Material Consumption Scenarios

Radioactive material is not consumed at this facility.

9.3.3 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.

9.3.4 Explosives Consumption Scenarios

Explosives are not consumed at this facility.

9.4 Waste

9.4.1 Low-Level Radioactive Waste Scenario

9.4.1.1 Alternatives for Low-Level Radioactive Waste at the Microelectronics Development Laboratory (as Part of the MESA Complex)

Table 7-8 presents the alternatives for low-level radioactive Waste at the MDL.

Table 7-8. 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	0 ft^3	<1 ft^3

9.4.1.2 Operations That Generate Low-Level Radioactive Waste

Low-level radioactive waste (LLW) is not generated as a part of routine operations at the MDL. However, under the "expanded" alternative, operations at the proposed MESA Complex could include research in radiation-hardened components that would generate small amounts of LLW. This could occur when electronic components are subjected to neutron exposure during radiation-hardness testing. Consequently, some elements contained within the components could become activated. All of the radioactivity would be fixed and non-movable in nature. Additional discussion of these activities is provided in the sections that follow.

9.4.1.3 General Nature of the Waste

Any low-level radioactive waste produced from the operations identified above at the MESA Complex would include activated electronic components. Examples of the nuclides that may be detected would include argon-100 (Ar-100), cobalt-57 and -58 (Co-57/Co-58), sodium-40 (K-40), and manganese-54 (Mn-54).

9.4.1.4 Waste Reduction Measures

Recent industry designs are trending toward the use of smaller, plastic-encapsulated devices containing less material available for activation. The continuation of this trend will reduce the amount of low-level radioactive waste generated from such operations.

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

The values provided under the "reduced" alternative for the generation of low-level radioactive waste at the MDL assume no operations of this nature would take place. The values provided under the "expanded" alternative for the generation of low-level radioactive waste at the MDL as part of the MESA Complex represent a conservative estimate based on past operations. For a period of just over three years, approximately 0.5 to 1 ft^3 of low-level radioactive waste was generated.

(Marchiondo, 1999)

9.4.2 Transuranic Waste Scenario

Transuranic waste is not produced at this facility.

9.4.3 Mixed Waste

9.4.3.1 Low-Level Mixed Waste Scenario

Low-level mixed waste is not produced at this facility.

9.4.3.2 Transuranic Mixed Waste Scenario

Transuranic mixed waste is not produced at this facility.

9.4.4 Hazardous Waste Scenario

9.4.4.1 Alternatives for Hazardous Waste at the Microelectronics Development Laboratory

Table 7-9 shows the alternatives for hazardous waste at the MDL.

Table 7-9. Alternatives for Hazardous Waste

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
1,688 kg	2,520 kg	3,150 kg	4,410 kg	8,000 kg

9.4.4.2 Operations That Generate Hazardous Waste

Hazardous waste is generated by cleanup activities.

9.4.4.3 General Nature of Waste

Hazardous waste includes items such as personal protective equipment, rags, batteries, and mercury light bulbs.

9.4.4.4 Waste Reduction Measures

Waste reduction measures include purchasing alternative materials that do not produce hazardous waste.

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

The values provided under the “reduced” alternative for the generation of hazardous waste at the MDL are generally proportional to the activity levels identified in “9.1 Activity Scenarios for Development or Production of Devices, Processes, and Systems: Microelectronic Devices and Systems.”

The values provided under the “expanded” alternative for the generation of hazardous waste at the MDL are also based on the activity levels identified in “9.1 Activity Scenarios for Development or Production of Devices, Processes, and Systems: Microelectronic Devices and Systems.” However, the number provided in the “expanded” column of Table 7-9 reflects both MDL waste and the additional hazardous waste that would be generated from CSRL-related activities as a part of the MESA Complex.

(Beals, 1999)

9.5 Emissions

9.5.1 Radioactive Air Emissions Scenarios

Radioactive air emissions are not produced at this facility.

9.5.2 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.

9.5.3 Open Burning Scenarios

This facility does not have outdoor burning operations.

9.5.4 Process Wastewater Effluent Scenario

9.5.4.1 Alternatives for Process Wastewater at the Microelectronics Development Laboratory

Table 7-10 shows the alternatives for process wastewater at the MDL.

Table 7-10. Alternatives for Process Wastewater

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
44,089,812 gal	44,089,812 gal	55,112,265 gal	77,157,171 gal	81,000,000 gal

9.5.4.2 Operations That Generate Process Wastewater

Operations at the MDL heavy laboratories generate process wastewater. Under the "expanded" alternative, the projection for process wastewater would also include that resulting from CSRL operations as part of the proposed MESA Complex.

9.5.4.3 General Nature of Effluents

Effluents include neutralized mixed minerals and acids.

9.5.4.4 Effluent Reduction Measures

Research projects are underway at the MDL that have the potential to recover or recycle approximately 90 percent of the process wastewater by the 2008 timeframe. An additional design that would become part of the MESA Complex would include an upgrade to the Reverse Osmosis Deionized Ultra Pure Water (RO/DI/UPW) system. As projected, this system would replace the mixed-bed-ion-exchangers with an electrodeionization process that would result in an estimated two million-gallon reduction in effluent. However, this anticipated reduction is not reflected in the projections provided in Table 7-10, above.

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

Wastewater effluent projections under the “reduced” alternative are generally proportional to the lowest anticipated activity level identified in “9.1 Activity Scenarios for Development or Production of Devices, Processes, and Systems: Microelectronic Devices and Systems.” Projections for wastewater effluent provided under the “expanded” alternative are based on process knowledge regarding the collective generation of wastewater effluent from MDL and CSRL operations in support of the expected level of activity as part of the MESA Complex (see “9.1 Activity Scenarios for Development or Production of Devices, Processes, and Systems: Microelectronic Devices and Systems”). These projections do not reflect upgrades that would lead to effluent reduction through recovery or recycling.

9.6 Resource Consumption

9.6.1 Process Water Consumption Scenario

9.6.1.1 Alternatives for Process Water Consumption at the Microelectronics Development Laboratory

Table 7-11 shows the alternatives for process water consumption at the Microelectronics Development Laboratory.

Table 7-11. Alternatives for Process Water Consumption

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
77 million gal	77 million gal	77 million gal	77 million gal	81 million gal

9.6.1.2 Operations That Consume Process Water

Operations at the MDL heavy laboratories consume process water. Under the “expanded” alternative, the projection for consumption of process water would also include the water requirements of CSRL operations as part of the proposed MESA Complex.

9.6.1.3 Consumption Reduction Measures

Research projects are underway at the MDL that have the potential to recover or recycle up to 90 percent of the process wastewater by the 2008 timeframe. However, this is not reflected in the projections provided in Table 7-11, above. An additional upgrade planned as part of the MESA Complex would include a newly designed Reverse Osmosis Deionized Ultra Pure Water (RO/DI/UPW) system. This would be anticipated to result in an estimated two million-gallon reduction in water consumption.

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

Water consumption projections under the “reduced” alternative are generally proportional to the lowest anticipated activity level identified in “9.1 Activity Scenarios for Development or Production of Devices, Processes, and Systems: Microelectronic Devices and Systems.” Projections for water consumption provided under the “expanded” alternative are based on process knowledge regarding the water requirements of both MDL and CSRL operations, collectively, in support of the expected level of activity (see “9.1 Activity Scenarios for Development or Production of Devices, Processes, and Systems: Microelectronic Devices and Systems.”) These projections do not reflect any potential future reduction in water consumption through recovery or recycling.

9.6.2 Process Electricity Consumption Scenario

9.6.2.1 Alternatives for Process Electricity Consumption at the Microelectronics Development Laboratory

Table 7-12 shows the alternatives for process electricity consumption at the Microelectronics Development Laboratory.

Table 7-12. Alternatives for Process Electricity Consumption

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
28,640,059 kw-hr	28,640,059 kw-hr	28,640,059 kw-hr	28,640,059 kw-hr	35,000,000 kw-hr

9.6.2.2 Operations That Consume Process Electricity

Chillers, pumps, fans, motors, elevators, lighting, instrumentation, process equipment, computers, and the nitrogen plant consume process electricity.

9.6.2.3 Consumption Reduction Measures

Most electrical savings are possible by reducing cleanroom air velocity, which results in reduced fan horsepower requirements. Electrical savings may be offset by inclusion of increased chiller load to a new facility in Building 701, the Process Environmental Technology Laboratory.

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

The basis for projection of electricity consumption is the same under both the "reduced" and "expanded" alternatives. The equipment remains on 24 hours per day, regardless of use. As such, electrical consumption would be anticipated to remain constant. However, the increase in electricity consumption projected under the "expanded" alternative reflects the additional electricity requirements of the CSRL as part of the MESA Complex.

(Beals, 1999)

9.6.3 Boiler Energy Consumption Scenario

9.6.3.1 Alternatives for Boiler Energy Consumption at the Microelectronics Development Laboratory

Table 7-13 shows the alternatives for boiler energy consumption at the Microelectronics Development Laboratory.

Table 7-13. Alternatives for Boiler Energy Consumption

Fuel	Reduced Alternative	No Action Alternative			Expanded Alternative
		Base Year	FY2003	FY2008	
Natural gas	34,346,000 ft^3	34,346,000 ft^3	34,346,000 ft^3	34,346,000 ft^3	40,500,000 ft^3

9.6.3.2 Operations That Require Boiler Use

The Steam Plant delivers steam to Building 858. Heat exchangers convert steam to hot water to be used for heating domestic water and all Building 858 heating, ventilation and air conditioning (HVAC) systems.

9.6.3.3 Consumption Reduction Measures

No consumption reduction measures for boiler energy use exist.

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

The projection provided under the "reduced" alternative reflects the rationale that natural gas usage would never drop below this level in order to maintain the facility in a state of readiness. The projection provided under the "expanded" alternative reflects the increase in natural gas usage necessary to accommodate the added floor space associated with the MESA Complex.

9.6.4 Facility Personnel Scenario

9.6.4.1 Alternatives for Facility Staffing at the Microelectronics Development Laboratory

Table 7-14 shows the alternatives for facility staffing at the MDL.

Table 7-14. Alternatives for Facility Staffing

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
105 FTEs*	126 FTEs	133 FTEs	145 FTEs	294 FTEs

9.6.4.2 Operations That Require Facility Personnel

MDL operations require employees (full-time equivalents [FTEs]) in support of administrative, scientific, technical, facility, and operational support personnel. Projections under the "no action" alternative are generally proportional to the incremental increase in shifts over time identified in "9.1 Activity Scenarios for Development or Production of Devices, Processes, and Systems: Microelectronic Devices and Systems." The projected FTEs include both SNL/NM positions and contractor support personnel.

9.6.4.3 Staffing Reduction Measures

There are currently no staffing reduction measures planned or in effect for either the MDL or the MESA Complex.

9.6.4.4. Basis for Projecting the “Reduced” and “Expanded” Values

Staffing projections under the “reduced” alternative are generally proportional to the lowest anticipated activity level identified in “9.1 Activity Scenarios for Development or Production of Devices, Processes, and Systems: Microelectronic Devices and Systems.”

Staffing projections under the “expanded” alternative reflect both the increase to three shifts identified in “9.1, Activity Scenarios for Development or Production of Devices, Processes, and Systems: Microelectronic Devices and Systems,” and the additional CSRL staff that would also be required as part of the MESA Complex. These FTEs include both SNL/NM positions and contractor support personnel.

(Jones, 1999)

9.6.5 Expenditures Scenario

9.6.5.1 Alternatives for Expenditures at the Microelectronics Development Laboratory

Table 7-15 shows the alternatives for expenditures at the MDL.

Table 7-15. Alternatives for Expenditures

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
$29M	$35M	$37M	$40M	$73M

9.6.5.2 Operations That Require Expenditures

MDL operational expenditures are based primarily on salaries and other purchases such as operational equipment and material. The base year number assumes approximately $16M in combined salaries, and $13M in other purchases. Projections under the 2003 and 2008 timeframe reflect the incremental increase in numbers of shifts over time, and are based on a similar ratio of salaries to purchases as identified for the base year projection.

9.6.5.3 Expenditure Reduction Measures

There are currently no expenditure reduction measures in place beyond the continuation of planning measures directed at achieving the highest level of efficiency in all aspects of operations.

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

Projections for expenditures under the "reduced" alternative are generally proportional to the lowest anticipated activity level identified in "9.1 Activity Scenarios for Development or Production of Devices, Processes, and Systems: Microelectronic Devices and Systems." Projections for expenditures under the "expanded" alternative reflect the funding requirements necessary to support the increase to three shifts identified in "9.1 Activity Scenarios for Development or Production of Devices, Processes, and Systems: Microelectronic Devices and Systems." These projections also reflect the additional CSRL funding that would be included as part of the MESA Complex. These projections also assume a similar ratio of salaries to purchases as identified for the base year and no action projections discussed in "9.6.5.2 Operations That Require Expenditures."

(Jones, 1999)

10.0 REFERENCES

10.1 Regulations, Orders, and Laws

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10.2 General References

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CHAPTER 8 - EXPLOSIVE COMPONENTS FACILITY SOURCE INFORMATION

LIST OF TABLES

1.0 INTRODUCTION

The Explosive Components Facility consolidates a number of ongoing activities related to explosive components, neutron generators, and battery research, testing, development, and quality control into a single structure. In operation, the Explosive Components Facility facilitates the coordination of these activities to enhance both safety and productivity.

A broad range of energetic-material research, development, and application activities are carried out at the Explosive Components Facility. Advanced diagnostic equipment is used to carry out experiments that range from 1-kg (TNT equivalent) tests to sophisticated spectroscopic studies on milligram-size samples that probe the fundamental processes of detonation. Neutron generators are assembled and tested.

Chemical laboratories typically work with small amounts of explosives of 10 g or less. These laboratories include equipment for thermal, infrared, spectroscopic, chromatographic, bomb calorimetric, chemical reactivity, scanning electron microscopy, and optical microscopy analyses. Energetic, gravimetric, and mechanical changes in material as a function of temperature or time are measured. Properties such as stability, compatibility, and aging are evaluated.

At the Battery Laboratory, batteries are subjected to destructive tests in any of six test cells. Destructive tests include overcharging, reverse polarity, and overtemperature tests. Post-test examinations are conducted in a glove box with an inert atmosphere because of the hazardous chemicals present in the batteries, specifically thionyl chloride.

2.0 PURPOSE AND NEED

SNL performs research and development on a variety of energetic components used in maintaining the nation's arsenal. The Explosive Components Facility consolidates into a single structure a number of ongoing activities relating to energetic component research, testing, development, and quality control that had been scattered over several technical areas.

The previous facilities were 30 to 40 years old. Their construction did not meet current standards and did not provide for good separation of office activities from explosives operations. The design of the previous facilities also required a large buffer zone around the explosives-testing areas to prevent detonation fragments and blast overpressures from affecting the general public. The design of Explosive Components Facility meets current standards, provides separation of office activities from explosives operations, provides extensive common areas such as conference rooms, and provides better access control to operations areas.

Hazards addressed in the design and operation of the explosive area of the facility include explosives, pyrotechnics, propellants, lasers, microwaves, radioactive materials, neutrons, x-rays, toxic chemicals, reactive chemicals, hazardous waste, and conventional industrial safety hazards.

Specific activities include:

- Shipping, receiving, and storage of explosives, pyrotechnics, and propellants.
- Physical and chemical testing of explosives, pyrotechnics, and propellants.
- Advanced development of explosive components.
- Neutron device research, development, and testing.
- Battery research, development, and testing.
- Stockpile surveillance of explosives, pyrotechnics, and propellants.

Functionally, the Explosive Components Facility supports and enhances the safety of these activities through optimization of the use of space and structural materials. The design groups similar activities into functional areas that share similar needs for blast mitigation and environmental protection. Such a design facilitates effective management controls regarding the overall safety of any given activity.

(Bonzon, Dotts, and Johnson, 1996)

3.0 DESCRIPTION

The Explosive Components Facility is a low-hazard nonnuclear facility located in Building 905. The Explosive Components Facility is a self-contained, secure site that affords maximum protection for adjacent facilities and the environment. It is located approximately 200 yards northeast of Tech Area II, 400 yards southeast of Tech Area I, approximately 1,000 yards northeast of the Simulation Technology Laboratory in Tech Area IV, and slightly more than

2 miles east of the Albuquerque International Sunport main east/west runway. The nearest offbase residential housing is located more than 1 mile northeast of the site.

The Explosive Components Facility complex includes a main building of approximately 96,500 ft^2, six explosive-service magazines, and service drives and parking areas needed to make the complex self-contained. Utilities such as water, natural gas, power, communications, and sanitary sewer extend from existing services on Kirtland Air Force Base (KAFB). Access to the complex is controlled at all times.

Design of the Explosive Components Facility provides state-of-the-art laboratory and testing space that promotes and enhances safe and efficient operation for high-consequence events. The building is divided into two wings, administrative and laboratory/testing, that are connected by a corridor. A second-story maintenance area extends over part of the administrative wing and most of the laboratory/testing wing.

The administrative wing contains a lobby, conference rooms, offices, laboratories, a lunchroom, and some maintenance areas. The lobby provides a reception area for visitors and uncleared personnel. There are two large conference rooms adjacent to the lobby that are equipped with state-of-the-art video teleconferencing and presentation equipment. Access is controlled to the rest of the building. Personnel must either have a security clearance or be escorted. The laboratories in the administrative wing are “light labs.” No work with energetic materials is done in these labs.

The laboratory/testing wing is structurally decoupled from the rest of the building to the extent that routine explosives tests will not generally be heard or felt in the administrative wing. The laboratory spaces in this wing are devoted to the routine testing of explosives and explosive devices, neutron generators, and batteries. Nine indoor firing pads and two walk-in chambers provide the capability for detonating up to 1 kg (TNT equivalent) of explosives in each location. A light-gas gun is used to conduct shock characterization, energetic-material sensitivity, and armor-penetration studies. Explosives laboratories are used for explosive and propellant preparation and component disassembly, analysis, and aging and ignition studies. The neutron generator laboratories are used for the assembly and testing of neutron generators for research manufacturing and quality assurance evaluations. Tests may include life cycle testing and environmental testing. The battery laboratory is used for evaluation and abuse testing of batteries, mostly for weapon components.

Six earth-covered explosives storage magazines that contain nonpropagating storage cabinets are south of the southwest corner of Building 905. The magazines prevent fragments and blast overpressure from accidental explosions from spreading beyond the facility's boundaries.

The design concept of the Explosive Components Facility and the small quantities of explosives that are present in the facility eliminate missile and blast pressure concerns for nearby buildings.

(Bonzon, Dotts, and Johnson, 1996)

4.0 PROGRAM ACTIVITIES

Table 8-1 shows the program activities at the Explosive Components Facility.

Table 8-1. Program Activities at the Explosive Components Facility

Program Name	Activities at the Explosive Components Facility	Category of Program	Related Section of the *SNL Institutional Plan*
Direct Stockpile Activities	Conduct research, development, application, and surveillance of energetic materials and components 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 both DOE and DoD include the reduction of operational hazards associated with energetic materials, advanced initiation and fuse development, munitions lifecycle engineering, hard target penetration, and computer simulation.	Programs for the Department of Energy	Section 6.1.1.1
System Components Science and Technology	Conduct research, development, testing, and production of energetic and neutronic components.	Programs for the Department of Energy	Section 6.1.1.1
Production Support and Capability Assurance	Test neutron generators, thermal batteries, and energetic devices. Develop and produce energetic devices (for example, detonators, neutron generator timers and drivers, and actuators).	Programs for the Department of Energy	Section 6.1.1.4

Table 8-1. Program Activities at the Explosive Components Facility (Continued)

Program Name	Activities at the Explosive Components Facility	Category of Program	Related Section of the *SNL Institutional Plan*
Sustaining Critical Progress in Model Validation	Conduct characterization studies of thermally and structurally degraded, main-charge high explosives. Support model development through validation testing of explosives in components as part of enhanced-surveillance and weapon life-extension programs.	Major Programmatic Initiatives	Section 7.1.3
Reliably Meeting Pending Production and Production Support Requirements	Test explosive neutron generators. Perform some actuator and detonator testing. Design and understand explosively formed projectiles and detonators.	Major Programmatic Initiatives	Section 7.1.4
Sustaining Momentum in Advanced Design and Production Technologies	Develop, validate, and deploy advanced product realization tools and approaches.	Major Programmatic Initiatives	Section 7.1.5
Emerging Future	Pursue high-payoff research into the advanced development of explosive components and of detonation techniques.	Laboratory-Directed Research and Development	Section 6.3.6
Technology Transfer and Education	Transfer energetic component technology to the private sector.	Programs for the Department of Energy	Section 6.1.1.3
Core Stockpile Management Programs	Examine chemistry of components in the current stockpile of nuclear weapons.	Programs for the Department of Energy	Section 6.1.1.4
Arms Control and Nonproliferation	Support the former Soviet Union staff in the development of explosive cutting techniques and the in-depth understanding of explosives technologies.	Programs for the Department of Energy	Section 6.1.3.3
Initiatives for Proliferation Prevention	Support the former Soviet Union staff in the development of explosive cutting techniques and the in-depth understanding of explosives technologies.	Programs for the Department of Energy	Section 6.1.3.5
Intelligence	Evaluate foreign technologies related to energetic materials and components.	Programs for the Department of Energy	Section 6.1.3.6
Waste Management Operations	Develop advanced explosive detection techniques.	Programs for the Department of Energy	Section 6.1.4.1

Table 8-1. Program Activities at the Explosive Components Facility (Continued)

Program Name	Activities at the Explosive Components Facility	Category of Program	Related Section of the *SNL Institutional Plan*
Environmental Technology Development	Develop the use of environmentally conscious manufacturing techniques in production programs.	Programs for the Department of Energy	Section 6.1.4.3
Department of Defense	Support a broad range of military programs, including failure analysis and special weapons development.	Work for Non-DOE Entities (Work for Others)	Section 6.2.1
National Aeronautics and Space Administration	Develop explosive components for use in NASA programs and special diagnostic equipment to evaluate NASA products.	Work for Non-DOE Entities (Work for Others)	Section 6.2.4
Environmental Protection Agency	Develop advanced explosive-detection techniques.	Work for Non-DOE Entities (Work for Others)	Section 6.2.6
Other Federal Agencies	Apply the technology base for energetic materials to security, firearms, and crowd control.	Work for Non-DOE Entities (Work for Others)	Section 6.2.7
All Other Reimbursables	Develop user facility agreements, personnel exchange agreements, and cooperative research and development agreements with a variety of commercial industry partners.	Work for Non-DOE Entities (Work for Others)	Section 6.2.8

5.0 OPERATIONS AND CAPABILITIES

The concept of the Explosive Components Facility is to consolidate into a single structure a number of ongoing activities relating to explosive component, neutron generator, and battery research, testing, development, and quality control that were previously scattered over several technical areas. In operation, the Explosive Components Facility facilitates the coordination of activities to enhance both safety and productivity.

A broad range of energetic-material research, development, and application activities are carried out at the Explosive Components Facility. Advanced diagnostic equipment is used to carry out experiments that range from 1-kg (TNT equivalent) tests to sophisticated spectroscopic studies on milligram-size samples that probe the fundamental processes of detonation. Neutron generators are assembled and tested. Batteries are subjected to abuse testing.

Major diagnostic equipment and techniques include:

- Velocity Interferometry System for Any Reflector (VISAR)
- Laser, ultraviolet/visible, and plasma spectroscopy
- Detonation timing measurements
- Detonation energy measurements
- Gas, pyrolysis gas, liquid, and ion chromatography
- Charged-coupled-device camera image analysis
- Environmental aging studies
- Microtox and mutagenic testing
- Optical and scanning-electron microscopy
- Shock and detonation chemistry
- Burn rate determination
- Material sensitivity studies
- Laser initiation testing
- Moisture analysis
- Electrical characteristics studies
- Helium leak rate determination
- Hydrostatic and volumetric density measurements
- Photometrics and high-speed photography
- Chemical reactivity testing and aging
- Adiabatic-rate and bomb calorimetry
- Particle size measurement
- Flash x-ray testing

Chemical laboratories typically work with small amounts of explosives of 10 g or less. These laboratories include capabilities for thermal, infrared, spectroscopic, chromatographic, bomb calorimetric, chemical reactivity, scanning electron microscopy, and optical microscopy analysis. Energetic, gravimetric, and mechanical changes in materials as a function of temperature or time are measured. Properties such as stability, compatibility, and aging are evaluated. Materials are analyzed in the infrared region for identification and analysis.

Neutron device activities include the assembly and testing of neutron generators for research manufacturing and quality purposes. A neutron generator is a device that, when fired, generates a pulse of less than one billion neutrons. These tests are conducted inside test chambers.

Abuse testing of batteries is done in the battery laboratory. Batteries are subjected to destructive tests in any of six test cells. Destructive tests include overcharging, reverse polarity, and overtemperature. Post-test examinations are conducted in a glove box. A glove box with an inert atmosphere is used because of the hazardous chemicals present in the batteries, specifically thionyl chloride.

A light-gas gun is used to conduct shock-characterization, energetic-material-sensitivity, and armor-penetration studies. The gun can propel a 200-g projectile at a velocity of up to 1.8 km per second down the 57-ft-long barrel. The system includes the breech, barrel, target chamber, and catch tank. The breech may be pressurized up to about 6,000 psig with either nitrogen or helium. This pressure is released rapidly to push a projectile down the barrel. The target chamber is fitted with a Velocity Interferometry System for Any Reflector (VISAR) for data collection. The catch tank catches debris and exhausts the gas to atmosphere.

Nine enclosed firing pads and two high-explosives chambers are located at the rear of the laboratory/testing wing. The firing pads and high explosives chambers are designed to protect personnel from the overpressure, hazardous fragments, and thermal effects of planned detonations of up to 1 kg (TNT equivalent). The walls, roof, and slabs-on-grade of the firing pads are designed to accommodate repeated detonations without damage to the Explosive Components Facility structure.

The high-explosives chambers are ASME-code vessels that accommodate repeated detonations without damage to the chambers or the Explosive Components Facility structure. Two blast doors provide access control and partial containment for each firing pad and chamber. The area behind the firing pads and chambers is a fenced exclusion area. This area is monitored using video cameras.

Four of the six storage magazines are used for storage of explosives. Each storage magazine contains 24 SIFCON cabinets. SIFCON is a high-strength fiber and grout mixture. It is used because of its high resistance to backspill from blast loadings and penetration by high-velocity ballistic projectiles and fragments. Each cabinet is rated at 5 lbs (approximately 2.25 kg) for nonpropagation of a detonation. Using SIFCON cabinets allows the storage magazines to contain only a 5-lb (2.25-kilogram) detonation rather than a 120-lb (54.5-kg) detonation. The other two storage magazines are currently used for bonded storage of neutron generators and long-term storage to support a neutron generator shelf-life program.

(Bonzon, Dotts, and Johnson, 1996)

6.0 HAZARDS AND HAZARD CONTROLS

Because of the design and structural integrity of the Explosive Components Facility and the relatively small amounts of explosives, toxic materials, and radioactive materials present in the facility, the Explosive Components Facility presents little opportunity for impact to the offsite environment or the public.

6.1 Hazards

Hazards addressed in the design and operation of the explosives area of the facility include the following:

- Explosives, pyrotechnics, and propellants
- Chemicals
- Electrical
- Temperature
- Radiation
- Lasers
- Pressure
- Environmental
- Other

6.1.1 Explosives, Pyrotechnics, and Propellants

Explosives offer the potential for the highest-severity accident within the Explosive Components Facility. Explosives operations, battery abuse tests, and destructive neutron generator tests all produce fragments containing considerable kinetic energy.

The main gaseous products of an explosive detonation are nitrogen, water, carbon monoxide, and carbon dioxide. The main solid product is soot, which is formed in varying amounts depending on the oxygen balance of the explosive and on whether the detonation occurred in air or under vacuum. The minor products of detonations are not known for all explosives. Propellants may produce somewhat different products; the original formulation may include some metal (typically aluminum), ammonium perchlorate, and organic polymers (for example, hydroxy-terminated polybutadiene). In general, the release of hazardous materials into the atmosphere in these experiments is small.

Another primary kinetic energy hazard is the light-gas gun operation. However, the kinetic energy projectile is completely enclosed within the system between the breech, barrel, and target chamber or catch tank. There is virtually no possibility of the projectile escaping the confines of this system. In addition, the room that contains the light-gas gun system is not manned when the launch operation is initiated with the pressurizing of the breech.

The light-gas gun accelerates projectiles that impact explosive (including propellant) and some inert materials. Helium or nitrogen is the driving gas. Up to 50 g of explosive material may be tested in the impact chamber of the light-gas gun system. The explosive may detonate, burn, or react to a lesser extent, depending on the impact conditions. Other materials that might react upon impact include epoxy (used in assembling the target) and polymethyl methacrylate (PMMA).

6.1.2 Chemicals

The chemical hazards that might be encountered in the Explosive Components Facility are varied because the materials and operations cover a wide range of activities. These include:

- Exposure to corrosive solutions of acids and bases.
- Production of flammable chemical vapors.
- Exposure to toxic, carcinogenic, or mutagenic materials.
- Exposure to potentially violent chemical reactions.

Halogen-containing gases (hydrogen chloride or fluorine) are used in the Excimer laser system. In the battery laboratory, toxic thionyl chloride is used in lithium batteries. Thionyl chloride reacts vigorously to form toxic sulfur dioxide and hydrochloric acid gas. Most laser dyes are toxic.

A few of the more common activities include use of 100-ml quantities of solvents:

- Using isopropyl alcohol, methanol, or other solvents to clean metal parts.
- Using gallon quantities of acetonitrile or methanol to chromatograph explosives.
- Testing gram quantities of plastics, metals, and inorganic salts for compatibility with explosives.
- Employing 10 ml to 100 ml of solvents for dissolving, extracting, or recrystallizing explosives and inert substances during material preparation and analysis.
- Using solvents, acids, bases, oxidizing or reducing agents, and other reactants for chemical syntheses.

In most cases, the amounts of chemicals consumed and handled in tests are low and are typically less than a pint for liquids and less than 100 g for solids. Exposures are also intermittent because a given operation is seldom carried out continuously for more than a few weeks at a time.

Flammable solvents such as methanol, ethanol, acetone, and benzene are used throughout the Explosive Components Facility, specifically in the chemistry laboratories.

Flammable solvents (for example, methanol, ethanol, ethylene glycol, and p-dioxane) and some suspected carcinogens are used in laser dye solutions.

The battery laboratory tests advanced batteries that contain lithium metal. Small quantities of combustible metals are used in spectroscopy.

6.1.3 Radiation

Flash x-ray techniques are used for taking high-speed radiographs of explosives tests. The technique involves the production of a single burst of x-ray radiation at 450 kV or less. Several x-ray tubes may be flashed sequentially to produce a time-dependent series of radiographs.

Neutron device activities include the assembly and testing of neutron generators for research manufacturing and quality purposes.

Personnel routinely use “barium bolts” (1/4 x 20 machine screws containing approximately 10 µCi of Ba-133) to calibrate neutron detectors.

Normal tests of neutron generators release minute amounts (less than 100 mCi) of gaseous tritium and airborne particulates into the test chamber. Because the particulates may contain metal tritide contamination, a potential exists for contaminating personnel and equipment when operators perform explosives tests.

Materials that are naturally radioactive, including radioactive sources or materials that have been activated by radiation-producing sources, may be hazardous to personnel.

6.1.4 Lasers

Tests involving laser ignition of explosives and other tests (primarily diagnostic) are performed utilizing continuous-wave laser, pulsed laser, and microwave radiation. Lasers are used for photographic illumination, interferometry, and spectroscopy. Microwaves are used for techniques requiring localized heating of explosive materials.

Specific applications currently identified include the use of a continuous-wave argon-ion laser (Class IV) to measure particle velocity histories at material surfaces through interferometry technique as well as various other laser-based diagnostics. Output from a Nd:YAG laser or dye laser may be used to assist in initiation of development igniter assemblies.

Principal hazards involved in these activities originate from the unique nature of the work performed, which frequently dictates that the laser beams be used in a nonenclosed system. Because these lasers are generally Class IV, there is sufficient energy for laser-induced eye and skin injuries, or, in some cases, to initiate heating or ignition among explosive materials. Applications frequently involve the use of mirrors to transmit the laser beam between adjacent rooms.

Ultraviolet (UV) reactors and ultraviolet/visible (UV/VIS) spectrophotometers utilize intense UV light. A number of laboratories use UV guns for curing epoxies.

6.1.5 Electrical

There are various high-voltage electrical energy hazards at the Explosive Components Facility; all are associated with testing operations. These hazards involve three types of hardware:

- Open setups
- Ancillary high-voltage test equipment
- Test components

An example of an open setup is the testing of electronic (nonexplosive) neutron generators. These devices usually contain a nonhazardous dielectric fluid, such as Fluorinert, to maintain high-voltage holdoff.

Operators use ancillary high-voltage test equipment to electronically produce the high voltages required to operate x-ray and neutron detectors and to fire test explosives. This type of equipment can be either high-voltage, direct current power supplies (such as for lasers) or firing sets.

Laser heads and power supplies usually contain electrical circuits that operate at high voltages. During normal use, these circuits present minimal high-voltage hazards to operating personnel because they are in a self-contained enclosure and are operated with all enclosure safety devices in place.

6.1.6 Pressure

The light-gas gun uses a high gas pressure (up to 6,000 psig) in the breech. The target chamber section of the light-gas gun system uses a modest vacuum (15 microns of Hg) in a relatively large volume.

A number of operations in the Explosive Components Facility use compressed gas from cylinders containing gas at 2,400 psig or less. The gas is transferred in hard-plumbed lines (either copper or hard plastic) to relatively small reservoirs contained within the system hardware. The Explosive Components Facility has compressed air and nitrogen lines plumbed throughout the building with drops in most laboratories. The pressures involved are the standard values of approximately 150 psig for facility gases.

Physically small vacuum systems are attached to many material characterization instruments such as electron microscopes and chromatographs.

6.1.7 Temperature

Ovens are used for the accelerated aging of explosives and components. A number of temperature chambers are also used in the neutron generator testing for conditioning components. In addition, test cubicles in the battery laboratory contain ovens for aging prototype batteries. Other ovens are used throughout the complex, mostly for curing of epoxies and temperature conditioning of components before testing. The operating temperatures of these various ovens range from 100^{o}F to 315^{o}F.

Heat associated with temperature ovens can lead to burns. However, most of these ovens operate at relatively low temperatures. The handling of energetic materials, particularly thermites and pyrotechnics, can lead to serious burns in an accident. Similarly, many chemicals (including oxidizers, acids, and bases) can produce severe burns in an accident.

A hot press for assembling exploding foil initiators has higher associated temperatures. There are high-temperature surfaces associated with analytical thermal analysis and chromatographic instrumentation.

The primary cryogenic hazard is liquid nitrogen. The main storage tank is located on the north side of the south wing, and it has a capacity of 1,500 gal. Another tank to the south of the south wing serves the neutron generator areas and has a capacity of 500 gal. Liquid nitrogen is used in smaller quantities (typically in 1-l flasks) throughout the facility, primarily in cold traps on high-vacuum systems. Although liquid nitrogen presents a potential burn hazard when contacting skin, the amounts handled are small and manageable.

6.1.8 Environmental

The primary environmental hazard for the Explosive Components Facility is the atmospheric gradient potential, including lightning. Other environmental hazards such as weather, animals, and vehicles present the same hazards as they do to any other SNL operation.

6.1.9 Other

For potential energy (gravity), the primary crane in the facility is on the breech end of the gas gun room. This crane is used to move the gun breech during servicing. Many of the chemistry laboratories and the gas gun room contain compressed-gas cylinders, which have the potential to tip over.

The primary operations that generate noise at a level that may require hearing protection are:

- Explosives operations.
- Operation of the light-gas gun, particularly at high projectile velocities (above 1 km/second).
- Testing of batteries in “abusive” environments.
- Destructive testing of neutron generators.
- Metalworking equipment in the machine shop that produces noise well above background levels.

The most serious pinch-point hazard involves the machine shop and the opening or closing of the blast doors. The reason for this hazard is the size and weight or bulk of these doors. Various metalworking machines in the machine shop have moving parts that can pinch clothing or flesh. The light-gas gun operation also has moving parts such as breeches, target-chamber door, and catch tank that can cause a significant “pinch.”

The primary location for a potential puncture incident, which includes cuts and abrasions, is the machine shop. However, many areas within the Explosive Components Facility have assembly areas where hand tools may be used.

The primary operation involving physical stress at the Explosive Components Facility involves manually opening and closing (rather than lifting) the blast doors, which are large, heavy, and bulky. The catch tank for the light-gas gun is also manually moved to and from the target chamber between light-gas gun shots. There may be some moving and lifting of heavy test apparatuses in other laboratories.

Hazards in support areas present only ordinary hazards that would be encountered in an ordinary office environment.

6.2 Hazard Controls

Functionally, the Explosive Components Facility is designed to support and enhance safety activities through the optimization of the use of space and structural materials. The design of the facility groups similar activities into functional areas that share similar needs for blast mitigation and environmental protection. Such a design facilitates effective management controls regarding the overall safety.

In addition to specific requirements listed here, personal protective equipment (PPE) is provided and used. PPE and other equipment (for example, safety glasses, gloves, aprons, shoes, and appropriate respirators) in conjunction with engineered and administrative controls are used to mitigate all hazards. Fences and gates around the perimeter of the Explosive Components Facility control access to the facility and specific operational areas. Personnel access is controlled using a computer-based keypad system to preclude access by unauthorized personnel. Specific methodologies addressing how the general mitigations are applied are contained in work-specific operating procedures.

6.2.1 Explosives, Pyrotechnics, and Propellants

The structure and integrity of the Explosive Components Facility contains blast overpressures and missiles from routine experiments and accidental detonations. The Explosive Components Facility design includes interlock systems such as door interlocks, audible and visible warning systems, and key locks on firing controls. Key-lock safe/arm switches, which must be turned to the arm position before a fireset discharge capacitor can be charged, are used. Blast doors are provided in explosives areas.

A warning system with a flashing light and siren notifies and warns occupants in the vicinity of the firing pads or high-explosives tanks.

One of the primary design intents for the Explosive Components Facility is the containment of fragments. Tests that produce fragments are performed in enclosed chambers, reinforced rooms, or firing pads.

Personnel wear approved safety glasses with side shields during all operations involving explosive materials. Safety eyewear is visually inspected prior to use.

Ground plane work areas (conductive surfaces) and grounding wrist straps are used with static-sensitive items.

Zero-potential grounding is used where explosive materials are handled. Visual inspection of grounding straps and grounding wrist straps is performed before use.

Personnel are protected by safety shields, or the operation is performed by remote control.

Some testing or analysis of materials that contain explosive materials requires special electrical instruments. For such operations, the equipment is certified by the manufacturer for use on explosives and is maintained in calibration. Bridgewire continuity testers for explosive devices are certified for use with explosives and are calibrated and inspected semiannually.

Ground fault circuit interrupts are provided and routinely tested. Conductive ground plane surfaces are tested annually for proper resistance to ground.

Energetic materials are stored in SNL-approved containers, except when the material or device must be kept in a special environment (as in a desiccator at constant humidity). These containers are kept in an explosives storage cabinet when not in use.

Surveillance cameras are used to monitor the firing area prior to and during explosives testing. Personnel-operated “shot abort” switches are located outside the firing areas. Alarms announce test shots and remain on while the shot is fired.

Electrical fireset equipment employs safe/arm locking switches. Fireset voltages and the status of equipment (for example, test chambers and firing pads) are integrated into the interlock systems. Power sources to the device under test are interlocked with the control system. Safety procedures require electrical system interlocking of all access doors to the test area, locked access gates, flashing red lights, and warning bells or horns. Chain barricades are available. The inner doors to the test firing pads are interlocked with the firing systems and must be closed for the systems to function.

6.2.2 Chemical

Fume hoods exhaust gases into the atmosphere. Firing pads and chambers are connected to an exhaust system to clear them of smoke and gas after a detonation of explosives. All air from the battery test area is water scrubbed before being exhausted into the atmosphere.

Examination of batteries is done in a nitrogen-filled glove box to minimize contact with hazardous chemicals.

The gaseous products of detonations are vented or released directly into the atmosphere with no treatment or filtering. Gaseous products are usually evacuated (pumped out) from the chamber and vented through the exhaust system into the atmosphere.

Gas cylinders that contain toxic chemicals are stored in a separate ventilated cabinet. Corrosion-resistant regulators and pressure-relief valves are used and maintained.

Dye lasers that have moderate reservoirs (greater than 1 l) are enclosed in a cabinet with an automatic fire extinguisher. Other flammable chemicals such as solvents are stored in approved flammable liquid storage cabinets. Fire extinguishers are provided at strategic locations throughout the Explosive Components Facility. An automatic sprinkler system is installed throughout the Explosive Components Facility, except in battery testing areas.

6.2.3 Radiation

Personnel working with radiation-generating devices that require a controlled area posting wear a personal dosimeter during operation of the devices. Any occupational worker operating or in close proximity of x-ray-generating devices wears a personal dosimeter during operation of the devices.

Because historical data indicates that a neutron generator blast chamber becomes contaminated after a test, operators:

- Wear rubber gloves any time they install neutron generator test assemblies or remove resultant radioactive test debris.

- Ensure that any exhaust fan or duct that has been attached to a test chamber is operational prior to conducting any explosive tests.

- Utilize approved and certified HEPA-filtered vacuum cleaners to control contaminated dust and particulates produced by the detonation.

6.2.4 Laser

Before operating a laser system, operators conduct a visual check to ensure the appropriate glasses for the wavelength are used and that the lenses and frames are undamaged.

Laser interlocks or administrative procedures control entrance into a nominal hazard zone (NHZ). Before using a laser each day, personnel verify proper functioning of the interlock system to ensure that entering the NHZ deenergizes or blocks the laser beam.

6.2.5 Electrical

Operators use key controls and interlocks to control high-voltage energy sources. For each firing set, there is a single key that is controlled by the operators who load the explosives during tests. Various interlocks are located on access doors and test chambers that control and restrict the respective high-voltage electrical circuits during explosives component or electronic neutron generator testing. The interlocks short out or deenergize the respective high-voltage circuits any time an operator enters the control area or tries to access a controlled device such as an open setup. Screens, guards, or enclosures on high-voltage electrical equipment prevent contact with the operator and test devices.

6.2.6 Pressure

The light-gas gun system has high-pressure plumbing, control valves, and pressure indicators to handle the high-pressure gases in the breech section. Pressure-relief valves are used to prevent overpressurization. The vacuum system on the target section also has indicators and valve controls. An interlock system automatically controls the release of gas pressure and vacuum if the controlled area is entered.

Compressed-gas bottles have proper transportation carts and storage racks to prevent them from falling. Gas lines for air, nitrogen, and the natural gas system are installed to “building code” specifications.

6.2.7 Temperature

Furnaces and ovens are protected by mechanical and electrical temperature over-shoot protection devices. If necessary, signs that indicate "Hot" are used on the equipment. Insulating gloves are used when appropriate.

Thermos bottles are used to transport small quantities of liquid nitrogen to vacuum pump traps. Insulated gloves and face shields are worn during these operations.

6.2.8 Environmental

The Explosive Components Facility has a lightning early warning system (LEWS) that continuously measures the atmospheric gradient potential. The LEWS provides indication of the gradient at multiple locations throughout SNL. A video-based gradient map is provided to all firing pads, the high-explosives chambers, and the explosives receiving area. There are also 26 LEWS light stacks in explosives labs and the corridors in the south wing.

There is an extensive lightning collection and diversion system that uses a mast and cable system to discharge lightning strikes on site.

6.2.9 Other

The primary sites for possible puncture hazards, which include the machine shop and other assembly locations that use hand tools, have protective shields and guards on equipment. Eye protection is used at all posted sites.

The following chemicals have been used in the past and may be used in the future at the Explosive Components Facility. However, these chemicals are not presently being used and are not being held in inventory:

- Thionyl chloride
- Fluorine
- Ethanol
- Ethylene glycol
- Hydrogen chloride
- Isopropyl alcohol
- Benzene
- P-dioxane

(Bonzon, Dotts, and Johnson, 1996; U.S. Department of Energy, 1992)

7.0 ACCIDENT ANALYSIS SUMMARY

This section summarizes the accident assessment included in the safety assessment for the Explosive Components Facility. The safety assessment discusses the range of potential accidents, including those resulting from natural phenomena, external energy sources, and operational mishaps. Potential accidents are rated in terms of accident severity and qualitative probability. From this information, a determination of the relative risk was performed for the various accident scenarios.

7.1 Failure Modes and Accident Analysis

Accident prevention and mitigation and risk management were addressed at every stage of the Explosive Components Facility's life cycle beginning with the design concept. The structural integrity of the building provides the first level of protection in that the building is designed to contain accidental detonations, control missiles, and control hazardous air contaminants. Personnel and environmental safety are also major considerations in experiment design. Each experiment design is reviewed to assure that all hazards are adequately addressed. Finally, administrative controls are coupled with the facility engineering controls and the experimental design to further minimize risks.

7.2 Failure Events

Typical industrial and laboratory hazards are present in all areas within the facility. Naturally occurring energy sources likewise present a common hazard to all facility activities. In addressing these common hazards, credible failure modes and accidents from operations have been combined into generic descriptions for further analysis. A credible failure mode or accident is defined as one in which the annual probability of the event occurring is 10^{-6} per year or greater.

Accident scenarios identified and discussed in the safety assessment include the following:

- Detonation of up to 1,000 g of high explosives in the shipping and receiving area.
- Traditional industrial accidents involving falls, cuts, fractures, and related physical injuries.
- Detonation of up to 500 g of high explosives during transportation through the corridors to different laboratories.
- Detonation of up to 5.0 lb of high explosives in the magazine area from handling mishaps and external energy sources.
- Detonation of up to 500 g of high explosives during physical testing activities involving explosives and explosives components.
- Detonation of up to 1,000 g of high explosives during test firing.
- Neutron exposure during testing of neutron generators and zetatrons.

- Tritium exposure from testing of neutron generators and handling the residue.
- Detonation of up to 1,000 g of high explosives during temperature aging studies.
- Deflagration of up to 1,500 g of propellant during blending, aging, or testing operations.
- Detonation of up to 10 g of high explosives during machining of components.
- Detonation of up to 1 g of high explosives during electrical testing of detonators and other explosive components.
- Uncontrolled or uncontained projectile from gas gun activities.
- Detonation of up to 50 g of explosives associated with gas gun targets or projectiles.
- Violent rupture of a lithium cell or battery in the battery abuse area during testing.
- Lithium metal fire in the battery abuse area.
- Fire of unspecified origin anywhere within the facility.
- Damage initiated by external and natural phenomena such as earthquake, tornado, flood, extreme winds, lightning, and aircraft crash.
- Exposure to thionyl chloride during battery-abuse testing.
- Exposure to nonionizing radiation (laser light) that causes serious injury.

7.3 Severity and Consequences

Accident severity (and the resulting consequences) for each accident scenario are addressed in terms of impact on the public, the environment, the facility, programs, and operating personnel. Upon considering the impact of a failure mode and the resulting accident, the severity of each event is rated as catastrophic, critical, marginal, or negligible.

In evaluation of the severity of a given accident, the worst-case situation was used. The resulting severity analysis is therefore conservative with respect to normal operations. The results of this evaluation indicate that all of the accident scenarios have negligible impact on the public and the environment. Impacts on the facility, programs, and operating personnel range from negligible to catastrophic. Generally, unplanned detonations are the accident scenarios with catastrophic impacts.

7.4 Qualitative Accident Probabilities

To adequately assess the risk associated with a given activity or facility design, there must be an assessment of the probability that any of the events might occur. A set of experience-based probabilities has been established that is consistent with AL 5481.1B.

The probabilities were derived from “best engineering” judgment, which takes into account the barriers. These barriers include the mechanical safeguards such as construction of the facility, electrical and mechanical interlocks on all firing systems, specific operational procedures for each operation that will be performed, experience of the personnel, personnel training, and management oversight of the operation. Additional data was drawn from the DOE databases on accidents and from SNL operational experience over the past 40 years.

A “likely” accident is one that is assumed to happen several times during the life of the facility based on the fact that similar accidents have occurred in the DOE system or elsewhere. For an accident to be considered “unlikely,” the accident could occur during the life of the facility but the probability is low. For an accident to be considered “extremely unlikely,” it is assumed that there is a very low probability it will occur during the life of the facility.

The “likely” accident scenarios include industrial accidents (for example, falls), exposure to nonionizing radiation (laser light), and high winds. The “unlikely” accident scenarios include neutron exposure, tritium exposure, unplanned detonation of 10 g of explosive during machining operations, unplanned detonation of 1 g of explosive during electrical testing, an uncontrolled projectile from gas gun operations, a violent rupture of a lithium battery cell, tornado, earthquake, and an aircraft crash. The “extremely unlikely” accident scenarios include unplanned detonations of larger quantities of explosives or propellants (10 g or greater), a lithium fire, a major facility fire, and lightning.

By both intent and design, the Explosive Components Facility complies with all existing and applicable DOE, Air Force, industry consensus, state, federal, and local codes, standards, criteria, statutes and regulations. Compliance is ensured through multiple layers of design and procedure review by both SNL and DOE.

(Bonzon, Dotts, and Johnson, 1996; U.S. Department of Energy, 1992)

8.0 REPORTABLE EVENTS

Table 8-2 lists the occurrence reports for the Explosive Components Facility over the past five years.

Table 8-2. Occurrence Reports for the Explosive Components Facility

Report Number	Title	Category	Description of Occurrence
ALO-KO-SNL-NMFAC-1995-0005	Duct Work Fire	1B	A small fire occurred when a contractor attempted to cut an access door in the duct work with a plasma cutter.
ALO-KO-SNL-2000-1995-0003	Research Lab Operations Limited Due to Acetonitrile Chemical Spill	1C	A four-liter bottle of acetonitrile was placed on the floor and knocked over.
ALO-KO-SNL-14000-1996-0004	Electrical Shock Incident in Building 905 Due to Violation of Procedures	1F	A technician placed his hand too close to the fully charged Pulse Forming Network and received a minor shock.
ALO-KO-SNL-1000-1997-0004	Potential Item of Concern Relating to Facility Condition from Overpressurization of Return Air Plenum from Actuation of the Light Gun	1F and 10B	Some suspended ceiling tiles were dislodged when the return air plenum was overpressurized.

9.0 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.

9.1 Activity Scenarios

9.1.1 Scenario for Test Activities: Neutron Generator Tests

9.1.1.1 Alternatives for Test Activities: Neutron Generator Tests

Table 8-3 shows the alternatives for neutron generator tests at the Explosive Components Facility.

Table 8-3. Alternatives for Test Activities: Neutron Generator Tests

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
500 tests	200 tests	500 tests	500 tests	500 tests

9.1.1.2 Assumptions and Actions for the "Reduced" Values

The operating level projected for the reduced alternative is consistent with the maintenance of mission requirements.

9.1.1.3 Assumptions and Rationale for the "No Action" Values

The base year for neutron generator tests is FY98. The operating levels are sufficient to do product acceptance tests of units produced at the Neutron Generator Facility and to do development testing. Staffing levels increase from four to six.

9.1.1.4 Assumptions and Actions for the "Expanded" Values

The operating levels are sufficient to do product acceptance tests of units produced at the Neutron Generator Facility and to do development testing for the maximum level of production.

9.1.2 Scenario for Test Activities: Explosive Testing

9.1.2.1 Alternatives for Test Activities: Explosive Testing

Table 8-4 shows the alternatives for explosive testing at the Explosive Components Facility.

Table 8-4. Alternatives for Test Activities: Explosive Testing

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
300 tests	600 tests	750 tests	850 tests	900 tests

9.1.2.2 Assumptions and Actions for the "Reduced" Values

The operating level for the reduced value is sufficient only to maintain capabilities to provide support for nuclear weapon stockpile activities. There is little success in Work For Others and Laboratory-Directed Research and Development initiatives. Staffing levels decrease to about 35. All laboratory areas are available but not staffed.

9.1.2.3 Assumptions and Rationale for the "No Action" Values

The base year for explosive tests is FY97. Explosive tests include detonations and deflagrations, regardless of the amount and type (for example, UNO 1.1) of energetic material expended. The operating level for "no action" values assumes only minimal increases in activity from inflation and only minimum additional success in Work For Others and Laboratory-Directed Research and Development initiatives. There are no major additions to the Explosive Components Facility. Staffing levels to support explosive testing increase from about 65 to 70 as all laboratory areas used for detonating explosives are fully utilized.

9.1.2.4 Assumptions and Actions for the "Expanded" Values

The operating level for the expanded value assumes all labs used for detonating explosives are operating at full potential because of excellent success in Work For Others and Laboratory-Directed Research and Development initiatives. Staffing levels increase to about 75. A major addition to the facility is completed in FY2003 as part of the expansion of neutron generator production capabilities.

9.1.3 Scenario for Test Activities: Chemical Analysis

9.1.3.1 Alternatives for Test Activities: Chemical Analysis

Table 8-5 shows the alternatives for chemical analysis at the Explosive Components Facility.

Table 8-5. Alternatives for Test Activities: Chemical Analysis

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
500 analyses	900 analyses	950 analyses	1,000 analyses	1,250 analyses

9.1.3.2 Assumptions and Actions for the "Reduced" Values

The operating level for the "reduced" value is sufficient only to maintain capabilities to provide support for nuclear weapon stockpile activities. There is little success in Work For Others and Laboratory-Directed Research and Development initiatives. Staffing levels decrease from about ten to six. All laboratory areas are available, but not staffed full time.

9.1.3.3 Assumptions and Rationale for the "No Action" Values

The base year for chemical analysis is FY97. Chemical analysis includes techniques such as spectroscopy, chromatography, calorimetry, and morphology. The operating level for "no action" values assumes only minimal increases in activity from inflation and only minimum additional success in Work For Others and Laboratory-Directed Research and Development initiatives. There are no major additions to the Explosive Components Facility. Staffing levels to support chemical analysis increase from about 10 to 15 as all chemistry laboratories are utilized.

9.1.3.4 Assumptions and Actions for the "Expanded" Values

The operating level for the expanded value assumes all labs used for chemical analysis are operating at full potential because of excellent success in Work For Others and Laboratory-Directed Research and Development initiatives. Staffing levels increase to about 15.

9.1.4 Scenario for Test Activities: Battery Tests

9.1.4.1 Alternatives for Test Activities: Battery Tests

Table 8-6 shows the alternatives for battery tests at the Explosive Components Facility.

Table 8-6. Alternatives for Test Activities: Battery Tests

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
10 tests	50 tests	60 tests	60 tests	100 tests

9.1.4.2 Assumptions and Actions for the "Reduced" Values

The operating level for the reduced value is sufficient only to maintain capabilities to provide support for nuclear weapon stockpile activities. There is little success in Work For Others and Laboratory-Directed Research and Development initiatives. Staffing levels decrease to one.

9.1.4.3 Assumptions and Rationale for the "No Action" Values

The base year for battery tests is FY97. The operating level for "no action" values assumes only minimal increases in activity from inflation and only minimum additional success in Work For Others and Laboratory-Directed Research and Development initiatives. Staffing levels to support battery testing increase from two to three.

9.1.4.4 Assumptions and Actions for the "Expanded" Values

The operating level for the expanded value assumes the battery lab is operating at full potential because of excellent success in Work For Others and Laboratory-Directed Research and Development initiatives. Staffing levels increase to four.

9.2 Material Inventories

9.2.1 Nuclear Material Inventory Scenario for Tritium

9.2.1.1 Alternatives for Tritium Nuclear Material Inventory

Table 8-7 shows the alternatives for the tritium inventory at the Explosive Components Facility.

Table 8-7. Alternatives for Tritium Nuclear Material Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
49 Ci	49 Ci	49 Ci	49 Ci	49 Ci

9.2.1.2 Operations That Require Tritium

Neutron generators that contain tritium are used at the Explosive Components Facility as a metal hydride in tritium-loaded occluder films, which are also called targets. The targets are an integral part of a neutron generator.

Neutron generators that contain tritium are also stored at the Explosive Components Facility as part of an ongoing shelf-life evaluation program. These are the major contributors to the inventory. The neutron generators are monitored to determine the shelf life of the tritium and neutron generator.

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

The average annual inventory remains essentially constant because the major contributors to inventory are the neutron generators stored at the Explosive Components Facility as part of an ongoing shelf-life evaluation program. Up to 200 neutron generators, each of which has less than 200 mCi of activity, will be stored. In addition, three controlatrons, each of which has 3 Ci of activity, will be stored.

9.2.2 Radioactive Material Inventory Scenarios

This facility has no radioactive material inventories.

9.2.3 Sealed Source Inventory Scenarios

9.2.3.1 Sealed Source Inventory Scenario for Ba-133

9.2.3.1.1 Alternatives for Ba-133 Sealed Source Inventory

Table 8-8 shows the alternatives for the Ba-133 sealed source inventory at the Explosive Components Facility.

Table 8-8. Alternatives for Ba-133 Sealed Source Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
42.8 µCi	42.8 µCi	42.8 µCi	42.8 µCi	42.8 µCi

9.2.3.1.2 Operations That Require Ba-133

Ba-133 is used in analytical instruments.

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

The inventory of Ba-133 remains essentially a constant because all chemical analysis laboratories are already outfitted with instruments. The "reduced" and "expanded" scenarios affect only the utilization of these areas, not the analysis capabilities available. Barium bolts are used with the controlatrons for calibration of neutron generators. Each bolt has approximately 10 µCi of barium.

9.2.3.2 Sealed Source Inventory Scenario for Ni-63

9.2.3.2.1 Alternatives for Ni-63 Sealed Source Inventory

Table 8-9 shows the alternatives for the Ni-63 sealed source inventory at the Explosive Components Facility.

Table 8-9. Alternatives for Ni-63 Sealed Source Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
1.020×10^5 µCi	1.020×10^5 µCi	1.020×10^5 µCi	1.020×10^5 µCi	1.020×10^5 µCi

9.2.3.2.2 Operations That Require Ni-63

Ni-63 is used in analytical instruments in the chemistry laboratories.

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

The inventory of Ni-63 remains essentially a constant because all chemical analysis laboratories are already outfitted with instruments. The "reduced" and "expanded" alternatives affect only the utilization of these areas, not the analysis capabilities available.

9.2.4 Spent Fuel Inventory Scenarios

This facility has no spent fuel inventories.

9.2.5 Chemical Inventory Scenarios

9.2.5.1 Alternatives for Chemical Inventories

Table 8-10 shows the alternatives for the chemical inventories at the Explosive Components Facility.

Table 8-10. Alternatives for Chemical Inventories

Chemical	Reduced Alternative	No Action Alternative			Expanded Alternative
		Base Year	FY2003	FY2008	
Acetone	1.2 l	6 l	9 l	12 l	12 l
Acetone	0.2 gal	1 gal	1.5 gal	2 gal	2 gal
Acetone	1.6 l	8 l	12 l	16 l	16 l
Acetonitrile	3.2 l	16 l	24 l	32 l	32 l
Acetonitrile	1.2 l	6 l	9 l	12 l	12 l
D5605	320 mg	1,600 mg	2,400 mg	3,200 mg	3,200 mg
Magnesium oxide	140 g	700 g	1,050 g	1,400 g	1,400 g
Magnesium oxide	20 g	100 g	150 g	200 g	200 g
Methyl alcohol	1.2 l	6 l	9 l	12 l	12 l
Methylene chloride	3 l	15 l	22.5 l	30 l	30 l
Propanol, 2-	0.8 l	4 l	6 l	8 l	8 l
Propanol, 2-	0.2 gal	1 gal	1.5 gal	2 gal	2 gal
Reagent alcohol	1.6 l	8 l	12 l	16 l	16 l
Tetrahydrofuran	0.2 gal	1 gal	1.5 gal	2 gal	2 gal

9.2.5.2 Operations That Require Chemical Inventories

The programs and operations that utilize these chemicals are described in detail in “3.0 DESCRIPTION,” “4.0 PROGRAM ACTIVITIES,” and “5.0 OPERATIONS AND CAPABILITIES.”

9.2.5.3 Basis for Projecting the Values in the “No Action” Columns

Baseline values for the chemicals listed in Table 8-10 were obtained from the SNL Chemical Information System. In most cases, the values for the “no action,” “reduced,” and “expanded” alternatives were derived by adjusting the base year information in proportion to the changes in activity levels provided in “9.1 Activity Scenarios.” However, where facility managers used process knowledge to estimate chemical applications, this more specific information was used instead.

Projections for highly toxic chemicals or those used in large quantity may have deviated from this methodology and used estimated values if deemed appropriate by the facility representatives.

9.2.5.4 Basis for Projecting the Values in the “Reduced” Column

Baseline values for the chemicals listed in Table 8-10 were obtained from the SNL Chemical Information System. In most cases, the values for the “no action,” “reduced,” and “expanded” alternatives were derived by adjusting the base year information in proportion to the changes in activity levels provided in “9.1 Activity Scenarios.” However, where facility managers used process knowledge to estimate chemical applications, this more specific information was used instead.

Projections for highly toxic chemicals or those used in large quantity may have deviated from this methodology and used estimated values if deemed appropriate by the facility representatives.

9.2.5.5 Basis for Projecting the Values in the “Expanded” Column

Baseline values for the chemicals listed in Table 8-10 were obtained from the SNL Chemical Information System. In most cases, the values for the no action, reduced, and expanded alternatives were derived by adjusting the base year information in proportion to the changes in activity levels provided in “9.1 Activity Scenarios.” However, where facility managers used process knowledge to estimate chemical applications, this more specific information was used instead.

Projections for highly toxic chemicals or those used in large quantity may have deviated from this methodology and used estimated values if deemed appropriate by the facility representatives.

9.2.6 Explosives Inventory Scenarios

9.2.6.1 Explosives Inventory Scenario for Bare UNO 1.1

9.2.6.1.1 Alternatives for Bare UNO 1.1 Explosives Inventory

Table 8-11 shows the alternatives for the bare UNO 1.1 explosives inventory at the Explosive Components Facility.

Table 8-11. Alternatives for Bare UNO 1.1 Explosives Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
100 kg	130 kg	150 kg	150 kg	150 kg

9.2.6.1.2 Operations That Require Bare UNO 1.1

The base year is FY97. Test firing in the firing pads, high-explosive chambers, small indoor firing chambers, and the gas gun use explosives.

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

The projected values for inventory are related to the number of explosive tests conducted. The change in inventory levels is not directly proportional because the inventory is maintained as low as reasonably achievable and because physical space limits are reached before the maximum allowable net equivalent weight limits.

9.2.6.2 Explosives Inventory Scenario for Bare UNO 1.2

9.2.6.2.1 Alternatives for Bare UNO 1.2 Explosives Inventory

Table 8-12 shows the alternatives for the bare UNO 1.2 explosives inventory at the Explosive Components Facility.

Table 8-12. Alternatives for Bare UNO 1.2 Explosives Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
15 kg	20 kg	30 kg	30 kg	30 kg

9.2.6.2.2 Operations That Require Bare UNO 1.2

See “9.2.6.1.2 Operations That Require Bare UNO 1.1.”

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

See “ 9.2.6.1.3 Basis for Projecting the 'Reduced' and 'Expanded' Values.”

9.2.6.3 Explosives Inventory Scenario for Bare UNO 1.3

9.2.6.3.1 Alternatives for Bare UNO 1.3 Explosives Inventory

Table 8-13 shows the alternatives for the bare UNO 1.3 explosives inventory at the Explosive Components Facility.

Table 8-13. Alternatives for Bare UNO 1.3 Explosives Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
20 kg	23 kg	30 kg	30 kg	30 kg

9.2.6.3.2 Operations That Require Bare UNO 1.3

See “9.2.6.1.2 Operations That Require Bare UNO 1.1.”

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

See “9.2.6.1.3 Basis for Projecting the ‘Reduced’ and ‘Expanded’ Values.”

9.2.6.4 Explosives Inventory Scenario for Bare UNO 1.4

9.2.6.4.1 Alternatives for Bare UNO 1.4 Explosives Inventory

Table 8-14 shows the alternatives for the bare UNO 1.4 explosives inventory at the Explosive Components Facility.

Table 8-14. Alternatives for Bare UNO 1.4 Explosives Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
1 kg	2 kg	3 kg	3 kg	3 kg

9.2.6.4.2 Operations That Require Bare UNO 1.4

See "9.2.6.1.2 Operations That Require Bare UNO 1.1."

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

See "9.2.6.1.3 Basis for Projecting the 'Reduced' and 'Expanded' Values."

9.2.7 Other Hazardous Material Inventory Scenarios

This 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.

9.3 Material Consumption

9.3.1 Nuclear Material Consumption Scenarios

Nuclear material is not consumed at this facility.

9.3.2 Radioactive Material Consumption Scenarios

Radioactive material is not consumed at this facility.

9.3.3 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.

9.3.4 Explosives Consumption Scenarios

9.3.4.1 Explosives Consumption Scenario for Bare UNO 1.1 Explosives

9.3.4.1.1 Alternatives for Bare UNO 1.1 Explosives Consumption

Table 8-15 shows the alternatives for bare UNO 1.1 explosives consumption at the Explosive Components Facility.

Table 8-15. Alternatives for Bare UNO 1.1 Explosives Consumption

Reduced Alternative		**No Action Alternative**						**Expanded Alternative**	
		Base Year		**FY2003**		**FY2008**			
NA pkgs	10 kg	NA pkgs	15 kg	NA pkgs	18 kg	NA pkgs	18 kg	NA pkgs	18 kg

9.3.4.1.2 Operations That Require Bare UNO 1.1 Explosives

Explosive Components Facility operations that require the use of explosives include test firing in the firing pads, high-explosive chamber operations, small indoor firing chamber operations, and gas gun use of explosives. The use of explosives at the Explosive Components Facility is the same irrespective of category of explosives (the same for UNO 1.1, UNO 1.2, UNO 1.3, and UNO 1.4).

Similarly, any explosives test may include the use of one or every category of explosive. (There is no set number of UNO 1.1 tests or UNO 1.4 tests from which one can project consumption or use of any one category of explosive over another.)

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

Consumption and inventory are not directly proportional. Even though inventory is maintained as low as reasonably achievable, inventory can exceed consumption by as much as an order of magnitude.

The basis for the number provided for the “reduced” and “expanded” alternatives are related to the numbers of tests projected in “9.1 Activity Scenarios.” However, the quantity of any category of explosives used in a single test or series of tests was derived through a historical understanding of the annual use of explosives (the amount of any category of explosives in a test is a function of the objectives of the user-client).

9.3.4.2 Explosives Consumption Scenario for Bare UNO 1.2 Explosives

9.3.4.2.1 Alternatives for Bare UNO 1.2 Explosives Consumption

Table 8-16 shows the alternatives for bare UNO 1.2 explosives consumption at the Explosive Components Facility.

Table 8-16. Alternatives for Bare UNO 1.2 Explosives Consumption

Reduced Alternative		No Action Alternative						Expanded Alternative	
		Base Year		FY2003		FY2008			
NA pkgs	0.5 kg	NA pkgs	2 kg	NA pkgs	4 kg	NA pkgs	4 kg	NA pkgs	4 kg

9.3.4.2.2 Operations That Require Bare UNO 1.2 Explosives

Explosive Components Facility operations that require the use of explosives include test firing in the firing pads, high-explosive chamber operations, small indoor firing chamber operations, and gas gun use of explosives. The use of explosives at the Explosive Components Facility is the same irrespective of category of explosives (the same for UNO 1.1, UNO 1.2, UNO 1.3, and UNO 1.4).

Similarly, any explosives test may include the use of one or every category of explosive. (There is no set number of UNO 1.1 tests or UNO 1.4 tests from which one can project consumption or use of any one category of explosive over another.)

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

Consumption and inventory are not directly proportional. Even though inventory is maintained as low as reasonably achievable, inventory can exceed consumption by as much as an order of magnitude.

The basis for the number provided for the “reduced” and “expanded” alternatives are related to the numbers of tests projected in “9.1 Activity Scenarios.” However, the quantity of any category of explosives used in a single test or series of tests was derived through a historical understanding of the annual use of explosives. (The amount of any category of explosives in a test is a function of the objectives of the user-client.)

9.3.4.3 Explosives Consumption Scenario for Bare UNO 1.3 Explosives

9.3.4.3.1 Alternatives for Bare UNO 1.3 Explosives Consumption

Table 8-17 shows the alternatives for bare UNO 1.3 explosives consumption at the Explosive Components Facility.

Table 8-17. Alternatives for Bare UNO 1.3 Explosives Consumption

Reduced Alternative		No Action Alternative						Expanded Alternative	
		Base Year		FY2003		FY2008			
NA pkgs	1 kg	NA pkgs	3 kg	NA pkgs	5 kg	NA pkgs	5 kg	NA pkgs	5 kg

9.3.4.3.2 Operations That Require Bare UNO 1.3 Explosives

Explosive Components Facility operations that require the use of explosives include test firing in the firing pads, high-explosive chamber operations, small indoor firing chamber operations, and gas gun use of explosives. The use of explosives at the Explosive Components Facility is the same irrespective of category of explosives (the same for UNO 1.1, UNO 1.2, UNO 1.3, and UNO 1.4).

Similarly, any explosives test may include the use of one or every category of explosive. (There is no set number of UNO 1.1 tests or UNO 1.4 tests from which one can project consumption or use of any one category of explosive over another.)

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

Consumption and inventory are not directly proportional. Even though inventory is maintained as low as reasonably achievable, inventory can exceed consumption by as much as an order of magnitude.

The basis for the number provided for the “reduced” and “expanded” alternatives are related to the numbers of tests projected in “9.1 Activity Scenarios.” However, the quantity of any category of explosives used in a single test or series of tests was derived through a historical understanding of the annual use of explosives. (The amount of any category of explosives in a test is a function of the objectives of the user-client.)

9.3.4.4 Explosives Consumption Scenario for Bare UNO 1.4 Explosives

9.3.4.4.1 Alternatives for Bare UNO 1.4 Explosives Consumption

Table 8-18 shows the alternatives for bare UNO 1.4 explosives consumption at the Explosive Components Facility.

Table 8-18. Alternatives for Bare UNO 1.4 Explosives Consumption

Reduced Alternative		No Action Alternative						Expanded Alternative	
		Base Year		FY2003		FY2008			
NA pkgs	2 kg	NA pkgs	10 kg	NA pkgs	14 kg	NA pkgs	14 kg	NA pkgs	14 kg

9.3.4.4.2 Operations That Require Bare UNO 1.4 Explosives

Explosive Components Facility operations that require the use of explosives include test firing in the firing pads, high-explosive chamber operations, small indoor firing chamber operations, and gas gun use of explosives. The use of explosives at the Explosive Components Facility is the same irrespective of category of explosives (the same for UNO 1.1, UNO 1.2, UNO 1.3, and UNO 1.4).

Similarly, any explosives test may include the use of one or every category of explosive. (There is no set number of UNO 1.1 tests or UNO 1.4 tests from which one can project consumption or use of any one category of explosive over another.)

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

Consumption and inventory are not directly proportional. Even though inventory is maintained as low as reasonably achievable, inventory can exceed consumption by as much as an order of magnitude.

The basis for the number provided for the “reduced” and “expanded” alternatives are related to the numbers of tests projected in “9.1 Activity Scenarios.” However, the quantity of any category of explosives used in a single test or series of tests was derived through a historical understanding of the annual use of explosives. (The amount of any category of explosives in a test is a function of the objectives of the user-client.)

9.4 Waste

9.4.1 Low-Level Radioactive Waste Scenario

9.4.1.1 Alternatives for Low-Level Radioactive Waste at the Explosive Components Facility

Table 8-19 shows the alternatives for low-level radioactive waste at the Explosive Components Facility.

Table 8-19. Alternatives for Low-Level Radioactive Waste

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
190 ft^3	95 ft^3	190 ft^3	190 ft^3	190 ft^3

9.4.1.2 Operations That Generate Low-Level Radioactive Waste

Testing operations in the neutron generator areas generate low-level radioactive waste.

Note: Currently this waste is being disposed of as low-level mixed waste. However, approval has been requested to dispose of it as low-level radioactive waste.

9.4.1.3 General Nature of Waste

Almost all of this waste is contaminated personnel protective equipment (PPE), such as gloves and coveralls. A minimal additional amount of waste would also include expended neutron generators that have undergone some test function.

9.4.1.4 Waste Reduction Measures

No additional waste reduction measures are planned; waste is already at a minimum consistent with required operations. As-low-as-reasonable-achievable practices maintain inventory at a minimum.

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

The values track the operating levels projected for the Neutron Generator Facility. Also refer to “9.1.1 Scenario for Test Activities: Neutron Generator Tests.”

9.4.2 Transuranic Waste Scenario

Transuranic waste is not produced at this facility.

9.4.3 Mixed Waste

9.4.3.1 Low-Level Mixed Waste Scenario

9.4.3.1.1 Alternatives for Low-Level Mixed Waste at the Explosive Components Facility

Table 8-20 shows the alternatives for low-level mixed waste at the Explosive Components Facility.

Table 8-20. Alternatives for Low-Level Mixed Waste

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

9.4.3.1.2 Operations That Generate Low-Level Mixed Waste

Operations that generate low-level mixed waste include those that involve neutron generators.

9.4.3.1.3 General Nature of Waste

The waste consists of HEPA filters with lead dust, neutron generator debris from destructive tests, ferro-electric neutron generators with lead dust, and electronic neutron generators with printed circuit boards and lead.

9.4.3.1.4 Waste Reduction Measures

No waste reduction measures exist.

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

The values do not vary across the alternatives.

9.4.3.2 Transuranic Mixed Waste Scenario

Transuranic mixed waste is not produced at this facility.

9.4.4 Hazardous Waste Scenario

9.4.4.1 Alternatives for Hazardous Waste at the Explosive Components Facility

Table 8-21 shows the alternatives for hazardous waste at the Explosive Components Facility.

Table 8-21. Alternatives for Hazardous Waste

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
200 kg	360 kg	400 kg	500 kg	500 kg

9.4.4.2 Operations That Generate Hazardous Waste

Most of the hazardous waste is generated from operations in the chemical laboratories. There is essentially no explosive waste generated.

9.4.4.3 General Nature of Waste

Residuals include empty chemical containers, wipes, glassware, and water contaminated with acetone. Most of the hazardous waste is liquid (water that has been contaminated with acetone after being used in analysis instruments).

9.4.4.4 Waste Reduction Measures

No additional waste reduction measures are planned; waste is already at a minimum consistent with required operations. The ALARA principle is practiced to maintain inventory at a minimum and to ensure chemicals are used before their shelf life expires.

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

The projected values track the number of analyses done in the chemical laboratories.

9.5 Emissions

9.5.1 Radioactive Air Emissions Scenario for H-3

9.5.1.1 Alternatives for H-3 Emissions at the Explosive Components Facility

Table 8-22 shows the alternatives for H-3 emissions at the Explosive Components Facility.

Table 8-22. Alternatives for H-3 Emissions

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
2×10^{-3} Ci	1×10^{-3} Ci	2×10^{-3} Ci	2×10^{-3} Ci	2×10^{-3} Ci

9.5.1.2 Operations That Generate H-3 Air Emissions

Except under accident scenarios, there are no expected emissions of metallic tritium. Approximately 5 µCi of tritium as gas are assumed to be released per test. For the purposes of this exercise, all H-3 emissions resulting from testing are assumed to be released.

9.5.1.3 General Nature of Emissions

The emission is tritium gas released during testing of neutron generators.

9.5.1.4 Emission Reduction Measures

Tritium attached to particulates is filtered through HEPA filters.

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

The H-3 numbers provided are only related to potential emissions during the period when a neutron generator is being “functioned,” or tested. The base year number provided above is related to the 200 neutron generator tests identified for the base year in “9.1 Activity Scenarios.”

The projections for the “reduced” and “expanded” alternatives are also tied to the numbers of tests projected in “9.1.1 Scenario for Test Activities: Neutron Generator Tests.” The projections above assume an increase of 0.5×10^{-3} Ci of H-3 emission per each 100 additional neutron generators tested.

Note: While other neutron generators are stored as part of Explosive Components Facility operations, these are only maintained as a part of a monitoring program. The H-3 that is found in the monitoring program for neutron generators is not included in the base year number that is provided above.

9.5.2 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.

9.5.3 Open Burning Scenarios

This facility does not have outdoor burning operations.

9.5.4 Process Wastewater Effluent Scenario

9.5.4.1 Alternatives for Process Wastewater at the Explosive Components Facility

Table 8-23 shows the alternatives for process wastewater at the Explosive Components Facility.

Table 8-23. Alternatives for Process Wastewater

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
3,200,000 gal	4,800,000 gal	5,000,000 gal	5,000,000 gal	6,400,000 gal

9.5.4.2 Operations That Generate Process Wastewater

Process water is used for cooling systems, potable water, and nonpotable water. Cooling water is expended in the primary loop of the building utility systems, in evaporative coolers, in the potable water system, and in the nonpotable water system. Changes in levels of testing do not result in directly proportional changes in wastewater generated.

9.5.4.3 General Nature of Effluents

The wastewater is from onsite wells and from evaporation of cooling water, and is returned to the sanitary sewer system.

9.5.4.4 Effluent Reduction Measures

The facilities organizations and the Operations Management Team are continually looking for ways to reduce consumption of resources, including gas, water, electricity, and chemicals. Since the initial occupancy, several improvements have been made. For example, controllers have been installed in many rooms to turn off the lights automatically if the room is not occupied.

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

The projected values for the "reduced" and "expanded" alternatives track loosely with the number of tests and the number of analyses performed. However, the facility is base loaded so that decreases or increases in operations do not result in directly proportional changes in consumption.

9.6 Resource Consumption

9.6.1 Process Water Consumption Scenario

9.6.1.1 Alternatives for Process Water Consumption at the Explosive Components Facility

Table 8-24 shows the alternatives for process water consumption at the Explosive Components Facility.

Table 8-24. Alternatives for Process Water Consumption

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
4,000,000 gal	6,000,000 gal	6,500,000 gal	6,500,000 gal	7,000,000 gal

9.6.1.2 Operations That Consume Process Water

Process water is used for cooling systems, potable water, and nonpotable water. Cooling water is expended in the primary loop of the building utility systems, in evaporative coolers, in the potable water system, and in the non-potable water system. Changes in levels of testing do not result in directly proportional changes in water requirements. About 80 percent of the water used is returned to the sanitary sewer. Also refer to "9.5.4 Process Wastewater Effluent Scenario."

9.6.1.3 Consumption Reduction Measures

The facilities organizations and the Operations Management Team are continually looking for ways to reduce consumption of resources, including gas, water, electricity, and chemicals. Since initial occupancy, several improvements have been made. For example, controllers have been installed in many rooms to turn off the lights automatically if the room is not occupied.

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

The projected values for “reduced” and “expanded” alternatives track loosely with the number of tests and the number of analyses performed. However, the facility is base loaded so that decreases or increases in operations do not result in directly proportional changes in consumption.

9.6.2 Process Electricity Consumption Scenario

9.6.2.1 Alternatives for Process Electricity Consumption at the Explosive Components Facility

Table 8-25 shows the alternatives for process electricity consumption at the Explosive Components Facility.

Table 8-25. Alternatives for Process Electricity Consumption

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
2,500,000 kw-hr	2,875,000 kw-hr	3,100,000 kw-hr	3,100,000 kw-hr	3,400,000 kw-hr

9.6.2.2 Operations That Consume Process Electricity

Electricity is consumed by lighting, rotating equipment (for example, pumps and fans), instruments for analysis and data acquisition, and controls.

9.6.2.3 Consumption Reduction Measures

See “9.6.1 Process Water Consumption Scenario.”

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

See “9.6.1 Process Water Consumption Scenario.”

9.6.3 Boiler Energy Consumption Scenario

9.6.3.1 Alternatives for Boiler Energy Consumption at the Explosive Components Facility

Table 8-26 shows the alternatives for boiler energy consumption for the Explosive Components Facility.

Table 8-26. Alternatives for Boiler Energy Consumption

Fuel	Reduced Alternative	No Action Alternative			Expanded Alternative
		Base Year	FY2003	FY2008	
Natural gas	16 million ft^3	24 million ft^3	27 million ft^3	27 million ft^3	29 million ft^3

9.6.3.2 Operations That Require Boiler Use

The natural gas-fired boiler supplies heating water for the entire building. Natural gas is also used for heating the domestic hot water.

9.6.3.3 Consumption Reduction Measures

The hot water heating pumps have been fitted with variable-frequency drives to adjust system flow based on demand for heat. Also see "9.6.1 Process Water Consumption Scenario."

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

See "9.6.1 Process Water Consumption Scenario."

9.6.4 Facility Personnel Scenario

9.6.4.1 Alternatives for Facility Staffing at the Explosive Components Facility

Table 8-27 shows the alternatives for facility staffing at the Explosive Components Facility.

Table 8-27. Alternatives for Facility Staffing

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
94 FTEs	81 FTEs	94 FTEs	94 FTEs	102 FTEs

9.6.4.2 Operations That Require Facility Personnel

All operations require facility personnel. These include engineers, scientists, and technicians to propose, design, and implement experiments and tests and support personnel for maintenance and project and facility management.

9.6.4.3 Staffing Reduction Measures

There are no current or planned staffing reduction measures.

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

The rationale for the relative increase or decrease in FTEs projected for either of these alternatives is derived directly from the activity scenarios found in "9.1 Activity Scenarios."

9.6.5 Expenditures Scenario

9.6.5.1 Alternatives for Expenditures at the Explosive Components Facility

Table 8-28 shows the alternatives for expenditures at the Explosive Components Facility.

Table 8-28. Alternatives for Expenditures

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
$2,100,000	$1,700,000	$2,100,000	$2,100,000	$2,500,000

9.6.5.2 Operations That Require Expenditures

With the exception of employee salaries, Explosive Components Facility expenditures are primarily for space and operations. Space charges include the cost of maintenance on facilities-owned structures, systems, and components. Operations charges include the cost of maintenance of line-owned systems and components, consumables for operations, and projects to maintain or enhance capabilities.

9.6.5.3 Expenditure Reduction Measures

As stated in "9.6.1 Process Water Consumption Scenario," the facilities organizations and the Operations Management Team are continually looking for ways to reduce consumption of resources, including gas, water, electricity, and chemicals. Since initial occupancy, several improvements have been made. For example, controllers have been installed in many rooms to turn off the lights automatically if the room is not occupied. There are no current or planned employee or salary reduction measures.

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

The numbers that are provided for these alternatives reflect facility operations only; salaries are not included. Salaries can be estimated at a rate of approximately $200,000 per employee, although category and function of any individual employee would likely result in some variance. However, if the $200,000 per employee multiplier is used, the following “additional” expenditures could be added to numbers currently provided in the table above:

- Reduced: An additional $18.8 million
- 2003 and 2008: An additional $18.8 million
- Base Year: An additional $16.2 million
- Expanded: An additional $20.4 million

10.0 REFERENCES

10.1 Regulations, Orders, and Laws

AL 5481.1B, *Safety Analysis and Review System*, January 27, 1988.

10.2 General References

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U.S. Department of Defense, 1997, *DOD Ammunition and Explosives Safety Standards*, DOD 6055.9-STD, U.S. Department of Defense, Washington, D.C.

U.S. Department of Energy, 1992, *Environmental Assessment, Explosive Components Facility at Sandia National Laboratories, Albuquerque, New Mexico*, DOE/EA-0576, U. S. Department of Energy, Washington D.C.

CHAPTER 9 - ADVANCED MANUFACTURING PROCESSES LABORATORY SOURCE INFORMATION

LIST OF TABLES

1.0 INTRODUCTION

The Manufacturing Technologies Center and specifically the Advanced Manufacturing Processes Laboratory can prototype and do limited manufacture for many of the specialized components of nuclear weapons. Advanced manufacturing technology development in the Advanced Manufacturing Processes Laboratory is focused on enhancing SNL/NM's capability in four broad areas:

- Manufacture of engineering hardware
- Design and fabrication of unique production equipment
- Emergency and specialized production of weapon hardware
- Development of robust manufacturing processes

The activities conducted in the Advanced Manufacturing Processes Laboratory are typically laboratory and small-scale operations involving material and process research performed by SNL/NM and subcontractor personnel. Operations include but are not limited to development of processes that utilize the following:

- Plastics/organics
- Nonexplosive powders
- Adhesives
- Potting compounds
- Ceramics
- Laminates
- Microcircuits
- Lasers
- Machine shop equipment
- Electronic fabrication
- Multichip modules
- Thin film brazing and deposition
- Plating
- Glass technology

The equipment used is commercial or custom-built small-scale or laboratory instrumentation. Operations range from standard wet chemistry to high-tech chemical techniques.

2.0 PURPOSE AND NEED

The Advanced Manufacturing Processes Laboratory develops and applies advanced manufacturing technology for realization of products to fulfill SNL's national security mission. The advanced manufacturing technologies developed in the Advanced Manufacturing Processes Laboratory support this mission, but experience has shown that it is broadly applicable to the needs of other federal agencies and industry. Advanced Manufacturing Processes Laboratory has partnered with other federal agencies, industry, and universities to leverage these activities (Sandia National Laboratories, 1998a; 1998b; U.S. Department of Energy, 1998; Wood, 1994).

3.0 DESCRIPTION

The Advanced Manufacturing Processes Laboratory is a one-story structure that covers more than two acres, or approximately 8,500 m^2. The key laboratory functions occupy more than 6,500 m^2, and the remaining space is primarily office areas. The Advanced Manufacturing Processes Laboratory is a mechanically intensive building. Two 790-m^2 rooftop equipment rooms provide enclosure for heating, cooling, and ventilating equipment. Exhaust fans and stacks are also located on the roof but are not enclosed. A 1,020-m^2 basement accommodates equipment for assorted building and environmental services and provides storage for some hazardous materials. The Advanced Manufacturing Processes Laboratory is divided into 12 zones (Sandia National Laboratories, 1998a; U.S. Department of Energy, 1998).

4.0 PROGRAM ACTIVITIES

Table 9-1 shows the program activities at the Advanced Manufacturing Processes Laboratory.

Table 9-1. Program Activities at the Advanced Manufacturing Processes Laboratory

Program Name	Activities at the Advanced Manufacturing Processes Laboratory	Category of Program	Related Section of the *SNL Institutional Plan*
Direct Stockpile Activities	Develop and apply advanced manufacturing processes for nuclear weapon applications.	Programs for the Department of Energy	Section 6.1.1.1
System Components Science and Technology	Support materials processing needs of Defense Programs (metals, polymers, ceramics, and glasses). Develop manufacturing processes for systems and subsystems.	Programs for the Department of Energy	Section 6.1.1.1

Table 9-1. Program Activities at the Advanced Manufacturing Processes Laboratory (Continued)

Program Name	Activities at the Advanced Manufacturing Processes Laboratory	Category of Program	Related Section of the *SNL Institutional Plan*
Technology Transfer and Education	Develop advanced manufacturing processes in concert with industrial partners.	Programs for the Department of Energy	Section 6.1.1.3
Production Support and Capability Assurance	Develop and produce active ceramic components for neutron generators. Support neutron generator development.	Programs for the Department of Energy	Section 6.1.1.4
Advanced Manufacturing, Design, and Production Technologies	Develop and improve manufacturing processes for weapon production.	Programs for the Department of Energy	Section 6.1.1.4
Catalysis and Separations Science and Engineering	Research and Develop material processes for catalytic materials.	Programs for the Department of Energy	Section 6.1.5.6
Reliably Meeting Pending Production and Production Support Requirements	Fabricate hardware and testers to support neutron generator production and development.	Major Programmatic Initiatives	Section 7.1.4
Sustaining Momentum in Advanced Design and Production Technologies	Develop and characterize advanced manufacturing systems. Characterize manufacturing equipment and processes. Develop advanced materials and processes.	Major Programmatic Initiatives	Section 7.1.5
All Other Reimbursables	Work for Others (WFO) support includes the development of advanced manufacturing techniques and processes, electronics, materials, and systems for other federal agencies, private corporations, and institutions. In addition, operational strategies include the coordination of user facility agreements and cooperative research and development agreements with a variety of commercial industry partners.	Work for Non-DOE Entities (WFO)	Section 6.2.8

5.0 OPERATIONS AND CAPABILITIES

The Advanced Manufacturing Processes Laboratory can prototype and do limited manufacturing for many of the specialized components of nuclear weapons. The advanced manufacturing technology development in the Advanced Manufacturing Processes Laboratory is focused on enhancing its capability in four broad areas:

- Manufacture of engineering hardware
- Emergency and specialized production of weapon hardware
- Development of robust manufacturing processes
- Design and fabrication of unique production equipment

Advanced Manufacturing Processes Laboratory technology areas are listed below:

- Ceramics and glass processing
- Electronic fabrication
- Machining
- Information management technologies
- Laser-engineered net shaping
- Manufacturing processing
- Materials characterization
- Mechanical measurement and calibration
- Mechanical engineering
- MCM processing
- Plating
- Polymer prototyping and production
- Rapid prototyping
- Thin film, vacuum, and packaging
- Virtual manufacturing applications system

The activities conducted in the Advanced Manufacturing Processes Laboratory are typically laboratory and small-scale operations involving materials and process research performed by SNL and subcontractor personnel. Operations include but are not limited to development of processes utilizing plastics and organics, nonexplosive powders, adhesives, potting compounds, ceramics, laminates, microcircuits, lasers, machine shop equipment, electronic fabrication, multichip modules, thin film brazing and deposition, plating, and glass technology. The equipment used is commercial or custom-built laboratory or small-scale instrumentation. Operations range from standard wet chemistry to high-tech chemical techniques.

5.1 Ceramics and Glass Processing Department

The Ceramics and Glass Processing Department provides a wide range of processing options for many types and compositions of prototype ceramic, glass, and glass-ceramic components. More specifically, they:

- Formulate and fabricate tailored polycrystalline ceramic compositions (for example, alumina, lead zirconate titanate, barium titanate, zinc oxide varistor, and superconducting ceramics) by conventional mixed oxide or by advanced chemical preparation technology.
- Formulate and fabricate glass and glass-ceramic products that function in extreme environments such as corrosion, heat, pressure, and impact.
- Produce a variety of prototype electronic and structural ceramic components.
- Produce highly complex electronic components by sealing glass to metals such as titanium, aluminum, and Inconel for unique applications.

The Ceramics and Glass Processing Department can:

- Interface with designers and vendors to ensure that the most appropriate materials are selected to meet specifications.
- Perform process development needed to scale up laboratory research processes.
- Develop new chemical preparation processes for ceramic powder production.
- Formulate and produce glass compositions by conventional high-temperature melting or low-temperature chemical polymerization (sol-gel techniques).
- Deposit thin films with controlled porosity using sol-gel processing.
- Produce quality melts of specialized glass compositions, including tellurium and tungsten-based glasses, aluminum sealing glasses based on phosphorus and germanium, and a variety of non-silicate glasses.
- Provide a full range of glass-forming techniques, including casting and pressing.

- Chemically strengthen glass to customer specifications.
- Establish key processing time-temperature schedules for glass annealing, sealing, and crystallization.
- Provide production capability and quality processing for ferroelectric ceramics.
- Prepare ZnO varistors from powder synthesized by solution precipitation.
- Fabricate prototype electronic and specialty components that incorporate glass or glass-ceramic to metal seals.
- Fabricate prototype alumina structural or insulating components with rapid turnaround time.
- Develop multilayer ceramic-metal devices based on the tape casting of thin (0.001 in. to 0.080 in.) flexible ceramic layers and associated thick-film technology.
- Develop glass and glass-ceramic headers for components such as actuators, batteries, miniature connectors, detonators, fiber-optic devices, sensors, and X-ray tubes that are used in severe environments.
- Employ powder consolidation methods such as uniaxial and cold isostatic pressing to form ceramic parts.
- Machine ultra-low density glass foams (aerogels) prepared by sol-gel processing.
- Measure physical properties of glasses such as coefficient of thermal expansion, density, and viscosity.
- Modify manufacturing operations to eliminate process-induced failures.
- Produce and test neutron generators.

Resources at the Ceramics and Glass Processing Department include the following:

- Four laboratories supplied with HEPA-filtered air containing class 100 down-flow hoods
- Multilayer ceramic processing facility for developing advanced electronic ceramic components
- Pilot scale ferroelectric component processing facility
- Microprocessor-controlled batch and moving belt furnaces with controlled atmospheres for glass sealing
- Precision testing equipment
- Powder consolidation equipment, sintering furnaces, prototype ceramic machining, and component assembly equipment

5.2 Ceramic Powder Processing Laboratory

The Ceramic Powder Processing Laboratory processes ceramic powders into monolithic ceramic components. Processes at the laboratory include:

- Powder sieving
- Blending
- Uniaxial and isostatic compaction
- Sintering
- Component characterization

5.3 Mechanical Engineering Department

Processes of the Mechanical Engineering Department include the following:

- Kinematic and dynamic analysis
- Full-dimensional metrology lab, including automated inspection software
- Reverse engineering using three-dimensional laser digitizing system

- Extensive design and manufacturing expertise for conventional and unique electromechanical products
- State-of-the-art winding technology to fabricate and assemble prototype high-energy capacitors using fully automated winding machines
- Rapid prototyping processes for complex three-dimensional models, functional parts, and patterns for use in casting and RTV molding

Capabilities of the Mechanical Engineering Department include the following:

- Manufacturing of prototype models from CAD solid models
- Reverse engineering
- Proprietary and classified SL parts
- RTV molds for urethane, epoxy, and RTV parts
- Tooling for wax or foam parts
- Mandrels for composite structures
- Three-dimensional topographic maps from either Synthetic Aperture Radar or U.S. Geological Survey data
- Special coatings for RP parts such as copper, Kirksite, nickel, and paints

Resources of the Mechanical Engineering Department include the following:

- Open architecture controller for computer numerical control (CNC) machines
- Non-orthogonal multi-axis high-speed milling machine (hexapod)
- Complete machine shop, including a three-axis CNC milling machine and lathe, and milling machines

- Class 1,000 and 100,000 clean rooms equipped with capacitor winding machines, Faxitron X-ray machine, resistance welder, mechanical tester, and microscopes for microphotography that allow assembly and testing of miniature components and electromechanical devices

- Engineering laboratory equipped with ultrasonic welder and cleaner, leak detectors, and plasma oven

- On-machine acceptance program that allows in-process and final inspection by real-time comparison of x-, y-, and z-point data to the designer's solid model

- Predictive maintenance program for maintaining machine reliability

- CAD solid modeling

- Selective laser sintering machine

- Three stereolithography machines

- Inspection facility including a coordinate measuring machine, a video measuring system, and a noncontact surface analyzer

- Three-dimensional laser digitizing system

- Manufacturing-related engineering development, fabrication, and calibration services for components and systems for other organizations throughout SNL/NM. These services include the following:

  - Design
  - Manufacturing
  - Precision machining
  - Prototyping
  - Engineering analysis
  - Stereolithography
  - Assembly
  - Fixturing
  - Mechanical measurement
  - Mechanical testing
  - Selective laser sintering
  - LENS and wire feed laser systems

5.4 Polymer Materials and Materials Analysis Department

The Polymer Materials and Materials Analysis Department provides materials and processing expertise and prototype fabrication capabilities for a wide variety of polymer applications. Associated activities include application of thermosetting, thermoplastic, and composite materials to join, package, and provide structural members to satisfy demanding electrical, mechanical, and environmental design requirements.

5.5 Materials Characterization Laboratory

The Materials Characterization Laboratory provides expertise and capabilities for a broad range of material characterization techniques.

Capabilities of the Materials Characterization Laboratory include the following:

- Thermal analysis
- Mechanical testing
- Infrared spectroscopy
- Imaging
- Qualification of new materials for use in components, subsystems, and systems
- Interfacial property analysis
- Rheological testing
- Microhardness testing
- Work of adhesion
- Optical and electron microscopy
- Elemental microvolume and surface analysis

Resources of the Materials Characterization Laboratory for thermal analysis include the following:

- Differential scanning calorimeter
- Thermal mechanical analyzer
- Dynamic mechanical analyzer
- Thermal gravimetric analyzer
- Volume dilatometer

5.6 Polymer Prototyping and Production Laboratory

The Polymer Prototyping and Production Laboratory of the Advanced Manufacturing Processes Laboratory is a resource for those seeking innovative prototype fabrication; full-service, small-lot production; and materials technology and processing expertise. The laboratory's focus is in joining, packaging, and providing structural support using thermosetting, thermoplastic, and composite materials. The laboratory supports demanding applications such as the following:

- Packaging and encapsulation of high-voltage components
- Formulation of materials for demanding environments
- Development of adhesive joining techniques for difficult materials
- Microelectronics packaging
- Unique applications of stereolithography to manufacture molds for polymer processing

The Polymer Prototyping and Production Laboratory has developed a variety of mechanical testing techniques to evaluate adhesive bonds of various kinds. Additionally, the laboratory has formulated new materials that reduce or eliminate the environmental, safety, and health hazards associated with certain polymer processes.

Resources of the Polymer Prototyping and Production Laboratory include the following:

- Abrasive blasters
- Autoclaves up to 4 ft diameter by 8 ft long
- UV curing
- Dry wall (walk-in hood)
- Thermoformer
- Plasma cleaner
- Vacuum laminator
- Transfer and compression molding presses
- Filament winder, five-axis, computer controlled
- Microprocessor-controlled ovens
- Three-roll mill
- Walk-in oven
- Vacuum casting equipment
- Rubber mill
- Terpene-based cleaning system
- Class 100 clean bench
- Gradient cure apparatus
- Environmental temperature cycling with optional humidity control

Capabilities of the Polymer Prototyping and Production Laboratory include:

- **Encapsulation** - Foams, elastomers, and rigid resins (epoxies, silicones, and polyurethanes) are used to protect electrical devices from shock and vibration. These encapsulants provide rugged protection and help to ensure a long service life for the component.

- **Bonding** - Bonding operations employ anaerobic, aerobic, and ultra-violet curing methods on many different geometries.

- **Materials Selection** - The Polymer Prototyping and Production Laboratory works with customers to select alternative materials to replace traditional processes that involve ozone-depleting, toxic, or carcinogenic materials. The laboratory evaluates alternative materials and processes regarding both long- and short-term compatibility issues. The Polymer Prototyping and Production Laboratory also does custom resin formulation.

- **Cleaning/Surface Preparation** - The Polymer Prototyping and Production Laboratory uses a variety of surface preparation techniques such as solvent cleaning (both traditional and alternative), plasma cleaning, sandblasting, chemical etching, and priming.

- **Large-Scale Foaming** - The Polymer Prototyping and Production Laboratory has experience in foaming oversized objects, often in complicated geometries.

- **Composite Fabrication** - The Polymers, Adhesives and Composites Lab also fabricates polymer composites using hand lay-up, filament winding, and vacuum bagging techniques. These materials are composed of fibers in an organic matrix that can be useful in applications requiring a high strength-to-weight ratio.

- **Coating** - Conformal coatings protect printed circuit boards from dirt, moisture, and other contaminants. Coating options, including epoxies, urethanes, and silicones, can be applied using spray, brush, or dipping techniques.

- **Milling** - The rubber mill allows for custom compounding of all types of elastomers.

- **Compression and Transfer Molding** - Compression and transfer molding is used to fabricate housings, brackets, bobbins, and other complex parts from thermosetting resins (epoxies, silicones, phenolics, and polyimides).

- **Thermoforming** - The laboratory processes thermoplastics such as polycarbonate, polymethyl methacrylate, polypropylene, and polystyrene.

- **Tooling and Fixture Design** - The Polymer Prototyping and Production Laboratory can design and develop metallic or elastomeric molds and fixtures for a wide variety of product geometries and sizes. Some of the products that the laboratory has developed tooling for include elastomeric seals, adhesive assemblies, foam structures, and other intricate encapsulated components.

- Encapsulation of neutron generator tubes.

These processes require routine handling and storage of chemicals.

5.7 Thin Film, Vacuum, & Packaging Technologies Department

The Thin Film, Vacuum, & Packaging Technologies Department of the Advanced Manufacturing Processes Laboratory offers expertise in a variety of materials processes. Their mission is to work with partners who require thin-film engineering, vacuum system design and fabrication, brazing, and electronic module manufacturing and packaging technologies. They provide extensive experience with coating processes, including sputter deposition, electron beam evaporation, and electroplating. They routinely deposit over 25 elements as well as numerous compounds. In addition, they have expertise in vacuum system design and manufacturing. This includes engineering new and existing vacuum systems, instrumentation, and processing tools. Parts can also be prepared (cleaned) for use in vacuum. The brazing and joining team can advance electronics and other manufacturing processes by performing special bonding operations.

The electronic microcircuit and packaging effort provides an important resource for engineering multi-chip modules (MCMs). From layout to fabrication of prototype samples, they offer opportunities for concurrent development and testing of MCMs and precision microwave networks. An important aspect of these efforts is assisting partners in selecting an appropriate manufacturing technology.

Thin-film deposition and analysis includes the following:

- Deposition of numerous materials as mechanical, optical, and pyrolytic coatings

- Fabrication of multi-element electrical contacts on semiconductors

- Analysis of thin-film microstructure, residual stress, and adhesion
- Application of electrochemical and conversion coatings

Multi-chip modules and packaging includes the following:

- Fabrication of precision microwave modules
- Low-temperature co-fired ceramic MCMs
- Plating process development
- High reliability thin- and thick-film electronic modules
- Laser-based materials processing

Vacuum system design and fabrication includes the following:

- Computer-aided engineering of systems, including three-dimensional solid modeling and gas flow simulation
- Measurement of outgassing rates of materials and components

Brazing and joining involves joining metals and ceramics by brazing, soldering, and diffusion bonding in vacuum, hydrogen, or inert atmospheres.

Resources of the Thin Film, Vacuum, & Packaging Technologies Department include the following:

- Multiple evaporative deposition systems with electron beam and resistively heated sources
- RF, DC, and ion beam sputter deposition systems with surface modification
- Multi-size vacuum, hydrogen, and inert gas processing furnaces accommodating 2,000°C with hot zones up to 16 ft^3
- Vacuum or inert atmosphere low-temperature diffusion bonding system

- Over 3,000 ft^2 of class 1,000 (or better) cleanroom for assembly and thin-film deposition
- High and ultrahigh vacuum outgassing analysis system
- Workstations for three-dimensional modeling and performance simulations of vacuum systems
- Lasers (CO_2 and YAG) for marking and machining various materials
- Plasma processing and electrochemical facility for surface modifications
- Surface-mount, hermetic sealing, and integrated circuit packaging equipment
- Complete facilities for design and prototyping of LTCC, precision microwave, thick-film and thin-film MCMs
- Large area (18 x 24 $in.^2$) extrusion coater capable of submicron-thick coatings with ± 3 percent uniformity

Personnel in the MCM Hybrid Microcircuits Lab develop processes for and fabricate, assemble, and test hybrid circuits. Personnel use a wide variety of hand tools, power tools, and equipment, including direct laser imagers, FAS extrusion coater, developers, strippers, etchers, and lab-size cleaning and plating lines.

Processes in the lab include:

- Establishing design practices
- Determining performance characteristics
- Developing processes compatible with environmentally conscious manufacturing

Personnel in the Thin Film, Vacuum, and Brazing Laboratory develop processes and prototype hardware for production support as well as research and development organizations at SNL/NM and external customers.

Primary activities include:

- Development of thin-film processes.
- Development of high-vacuum and brazing or joining technologies.
- Implementation of these technologies into hardware fabrication.

Laboratory processes include the following:

- Thin film deposition by physical or chemical vapor processes
- Vacuum and atmospheric brazing
- Surface processes
- Material characterization
- Equipment development
- Manufacturing process engineering
- Soldering
- Etching
- Plating

These activities require routine chemical handling.

Processes associated with the Hydrogen Trailer Storage Facility include the exchange of hydrogen trailers and purging of trailer regulators, delivery lines, and delivery manifold with argon.

5.8 Electronic Fabrication

The Electronic Fabrication group of the Advanced Manufacturing Processes Laboratory offers a variety of electrical hardware needs for unique applications. Their expertise resides in electro-mechanical prototype fabrication and packaging of single units to complete systems, working one-on-one with design engineers with information ranging from verbal instructions to complete drawing packages.

Typical activities include:

- Electronic system design
- Testing and data acquisition
- Electrical inspection
- Magnetic device fabrication
- Electrical systems preventative maintenance

Electronic fabrication capabilities include the following:

- Technicians' skills that support concurrent engineering in packaging and manufacturing specifications for new designs
- Complete inspection services for electronic packaging per SNL specifications and industry standards
- Review of electronic drawings for packaging design, fabrication, and inspection requirements
- Manufacturing and packaging of unique electrical designs
- Customer assistance with complete systems assembly, installation, and final product testing
- CAD file generation or translation for use with computer engraving and silkscreening

Electronic fabrication resources include:

- Computer-controlled engravers capable of receiving electronic files over the Internet and producing engraved panels.

- SE3262 Cable Tester utilized for 100 percent electrical inspection of complex cables. The system can measure inter-conductor isolation up to 500 V DC, identify conductor size of internal wires, and scan unknown cable configurations and print out a point-to-point path of complex cable assemblies.

- Self-contained machine shop for mechanical fabrication of electronic packages.

5.9 Virtual Manufacturing Applications System (VMAS)

The Virtual Manufacturing Applications System (VMAS) located in the Advanced Manufacturing Processes Laboratory provides for the practical application and advanced development of modern virtual reality (VR) techniques for integrated analysis, prototyping, and manufacturing. VMAS is applying SNL-developed software in a manufacturing systems development environment to provide a new dimension in human-machine interaction.

At the core of this effort is the enhancement of the human-computer interface. The VMAS application environment is designed for interaction on human perception levels. Data is represented in a multi-dimensional geometric universe that can be easily and naturally navigated much as one moves about the real world. The control mechanisms, while easily modifiable according to the needs of a particular application or device, are intended to operate via speech interaction and physical manipulation rather than command syntax or hierarchical menu control systems. The concept of computer interaction is important for dealing with modern information resources and for realizing agile manufacturing goals:

- VMAS takes advantage of the human mind's inherent and unmatched capabilities for pattern recognition, anomaly detection, and spatial navigation by representing data in a geometric universe. Data that may take weeks to generate and represent with charts or graphs often takes only seconds to comprehend in the graphic geometry of VR.

- Agile rapid manufacturing hinges on realizing radical change in the design-through-manufacturing cycle by requiring that more design, analysis, simulation, and validation prototyping be done in computational space with virtual resources rather than with conventional manufacturing resources. The system can actively link to in-house rapid manufacturing technologies, including stereolithography, selective laser sintering, and laser engineered net shaping systems.

VMAS is based on software developed by researchers in SNL's Computer Architectures Department. The multi-dimensional, user-oriented synthetic environment (MUSE) is the application code and associated libraries that provide the basic customizable shell environment. Enhancement and evolution of the software continues in collaboration with the developer group.

Primary customers for VMAS are SNL designers and analysts. Data preprocessor procedures have been developed for SNL design formats. Data can be quickly imported from Pro/Engineer CAD models and any EXODUS II-compliant finite-element analysis source. From these data types, VMAS can initially build a data set into the VR environment in minutes. Other data formats may require modification of an existing preprocessor tool or the creation of an entirely new tool, with the initial application build taking one or two days.

Data may be represented in a number of ways and be experienced and operated on using speech and physical interaction.

Major resources of VMAS include the following:

- **Staff** - Personnel include systems analysts, software specialists and manufacturing product engineers. Other SNL resources in human-computer interaction, finite-element analysis, CAD/CAM solid modeling, high-speed networking, communications, supercomputing, and computer architectures are available for consultation.

- **Facility** - The VMAS is easily accessed. It resides within the Manufacturing Technologies User Facility, allowing interaction with industry and nonprofit entities. The computer lab is connected to the Internet for easy electronic access.

- **Equipment** - The VR environment is primarily supported by Silicon Graphics Inc. (SGI) Onyx-class multi-pipeline graphics computers. Additional resources include SGI and SUN workstations, PCs, and a variety of commercial and research devices for exploring and manipulating the VMAS environment.

- **Software** - The software structures created by SNL researchers are the basic elements of the VMAS. The MUSE is designed to be device-independent so that core structures can remain fundamentally unchanged as platform and devices evolve around it.

(Sandia National Laboratories, 1998a; U.S. Department of Energy, 1998)

6.0 HAZARDS AND HAZARD CONTROLS

The activities involve the use of a wide variety of chemicals (including corrosives, solvents, organics, inorganics, and gases) in relatively small amounts. Some of the laboratories meet the definition of the OSHA Laboratory Standard (29 CFR 1910.1450) while others are chemical laboratories. All activities are performed in well-ventilated areas or fume hoods to prevent employee exposure. Therefore, potential environmental impacts are generally restricted to building exhaust systems. Some SNL internal permits allow discharge of rinse water from cleaning lab ware. This discharge contains only trace solvent or chemical content. The ceramics processing area discharges lead particulate-containing wastewater into a lead settling tank located in the basement of the Advanced Manufacturing Processes Laboratory. Exhaust hoods used for lead processing are routed through a filtration system also located in the basement of the Advanced Manufacturing Processes Laboratory. All other liquid and solid wastes will be disposed of through the SNL Chemical Waste Disposal Department, and no chemical waste is allowed into the ground or the sanitary sewer. Most of the waste generated in these activities is spent solvents and corrosives, and inert purge gases (for example, N_2 and He).

Table 9-2 summarizes the hazardous material at the Advanced Manufacturing Processes Laboratory.

Table 9-2. Hazardous Material at the Advanced Manufacturing Processes Laboratory

Chemical	Maximum Quantity	Location
Cyanomethane	2 gal	Organic Materials
Methylene chloride	32 l	

Fluorine gas is used in the operation of an Excimer laser. The room has several alarm systems within it and in the ventilation system. Controls are in place that allow isolation in the event of a leak and purging of the room. The feed valve to the fluorine is a restricted orifice that only permits very slow delivery rates.

Gold plating solution contains a small amount of cyanide to keep the gold in solution. Because this powder or liquid solution contains a precious metal, it is stored in a locked safe except during actual use. Secondary containment is provided in both storage and usage areas.

A proposed activity already located at SNL is the fabrication of solar cell prototyping. The current facility is scheduled for demolition in the next year. It is proposed that the activity will be relocated to the Advanced Manufacturing Processes Laboratory. If the operation moves to the

Advanced Manufacturing Processes Laboratory, adequate monitoring systems, flow monitoring alarms, and gas storage cabinets will be utilized.

MDA (4,4'-methylenedianiline) is used in encapsulation processes in the Organic Materials Processing Laboratory. Although the material is a carcinogen, there is not an alternative substitute. The material is used in highly controlled processes and stored utilizing access control and secondary containment.

All of the above “maximums” are based on the “expanded” alternative. With the exception of the hydrogen, the “reduced” alternative would also be the current volumes, equal to half of those listed.

A small amount of radioactive material (less than 0.1 Ci tritium in the form of metal titrites) is used in a sealed tube in each neutron generator. The anticipated maximum quantity of radioactive material in the Advanced Manufacturing Processes Laboratory is less than 2.5 Ci at one time. Because of the low quantity of radioactive material, the radioactive hazard at the facility is minimal.

The following are hazard controls by material listed in Table 9-2:

- Cyanomethane is stored in 1-gal glass bottles at ambient temperature and pressure.

- Methylene chloride is stored in various locations and in various quantities within flammable material storage cabinets. The maximum laboratory quantity of the material is 4 l, and the largest quantity delivered to the Advanced Manufacturing Processes Laboratory dock is 16 l.

The following are other hazard controls at the Advanced Manufacturing Processes Laboratory:

- All chemicals that enter the facility are delivered to one of two spill containment units on the loading dock.

- The Ceramics Hot Pressing and Machining Methods Laboratory has the following safety features:

- Water-cooled pressing chambers that provide protection from heat and flying debris
- Electrical interlocks
- Ram travel limit switches
- Gas pressure relief valves
- Gas valve lockouts

- Radiological control personnel perform external swipe analyses of neutron tubes before those tubes are delivered to the Advanced Manufacturing Processes Laboratory. Tubes with outside contamination of greater than 200 disintegrations per minute are not accepted at the facility.

- An engineered control associated with the Hydrogen Trailer Storage Facility is the hydrogen dryer, which removes oxygen and water from the source hydrogen. Two pressure relief valves that are vented above the building roof protect the dryer from overpressurization, a hydrogen gas sensor detects hydrogen that leaks from the dryer, and a second sensor detects leaks at the outer cylinder of the hydrogen line that connects the hydrogen supply with the dryer.

In addition to those identified above, the facility also maintains the following other materials. The quantities identified below represent both capacity and total maximum amount on-hand at any one time.

- Liquid nitrogen (6,000 gal)
- Nitrogen gas (11,000 gal)
- Hydrogen gas (43,000 ft^3)
- Argon (900 gal)

(Sandia National Laboratories, 1998b; Wood *et al*., 1994)

7.0 ACCIDENT ANALYSIS SUMMARY

The Advanced Manufacturing Processes Laboratory is a low-hazard nonnuclear facility and does not require accident analysis (Wood *et al*., 1994).

8.0 REPORTABLE EVENTS

Table 9-3 lists the occurrence reports for the Advanced Manufacturing Processes Laboratory over the past five years.

Table 9-3. Occurrence Reports for the Advanced Manufacturing Processes Laboratory

Report Number	Title	Category	Description of Occurrence
ALO-KO-SNL-2000-1993-0008	Violation of City Waste Water Discharge Permit	2E	Copper was accidentally released into the sanitary sewer.
ALO-KO-SNL-2000-1993-0009	Hydropress Falls Off Casters Causing Damage	7A and 10B	The castor on a large hydropress went into a depression on the floor during a move operation, causing it to fall against a door jam.
ALO-KO-SNL-NMFAC-1994-0004	Partial Electrical Power Outage	1H	A failure of a building transformer caused a power outage.
ALO-KO-SNL-NMFAC-1994-0006	Unplanned Evacuation	1H	A leak detection alarm was activated by atmospheric humidity in a chemical storage building.
ALO-KO-SNL-2000-1995-0001	Violation of City Waste Water Discharge Permit	2E	Lead standards were exceeded in the sanitary sewer effluent.
ALO-KO-SNL-1000-1996-0006	Air Filter Fire in Glove Box During Maintenance Activity Disrupts Normal Facility Operations	1B	A small fire occurred when an employee used a vacuum cleaner to remove stainless steel powder from a glove box.
ALO-KO-SNL-1000-1996-0008	Violation of City Waste Water Discharge Permit #2069H-3	2E	The pH of the sanitary sewer effluent dropped below permit limits.
ALO-KO-SNL-1000-1997-0001	Non-Compliance Resulting From Violation of City of Albuquerque Waste Water Discharge Permit	2E	The pH of the sanitary sewer effluent dropped below permit limits.
ALO-KO-SNL-12000-1997-0002	Suspect Counterfeit Bolts, Building 878 Piping Supports	7B	Suspect counterfeit bolts were discovered in basement piping structures.

9.0 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.

9.1 Activity Scenario for Development or Production of Devices, Processes, and Systems: Materials, Ceramics/Glass, Electronics, Processes, and Systems

9.1.1 Alternatives for Development or Production of Devices, Processes, and Systems: Materials, Ceramics/Glass, Electronics, Processes, and Systems

Table 9-4 shows the alternatives for development of materials, ceramics/glass, electronics, processes, and systems.

Table 9-4. Alternatives for Development or Production of Devices, Processes, and Systems: Materials, Ceramics/Glass, Electronics, Processes, and Systems

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
248,000 operational hours	248,000 operational hours	310,000 operational hours	310,000 operational hours	347,000 operational hours

9.1.2 Assumptions and Actions for the "Reduced" Values

The characteristics of Advanced Manufacturing Processes Laboratory operations include numerous and diverse laboratories and capabilities as well as frequent change in clients, production schedules, products, and processes. As a result, more preferable or traditional throughput parameters such as the numbers of tests or units produced were not useful for projecting Advanced Manufacturing Processes Laboratory facility activities over a multiple-year timeframe. As such, annual operational hours have been used to project facility throughput or activity. The following provides the basis for the assumptions used to derive the initial base year number of operational hours from which other projections were derived.

The 1996-1997 average annual number of Advanced Manufacturing Processes Laboratory personnel is estimated at 150, and they fall into the following broad categories:

- Administrative (10 percent)
- Scientific and technical (60 percent)
- Facility and operational (30 percent)

Because administrative personnel provide a generally consistent level of support over a broad range of program activity, their level of effort is considered to be steady state throughout all of the alternatives. The change in activity scenarios for the various alternatives depends more on the change in the level of effort of scientific, technical, and facility personnel. As a result, the administrative personnel were subtracted from the total number of base year personnel. This resulted in a reduction in numbers of personnel by 10 percent, or from 150 to a new adjusted total of 135 base year personnel.

The Advanced Manufacturing Processes Laboratory operational work year is 46 weeks. The 52-week calendar year has been reduced to an adjusted operational work year of 46 weeks by subtracting the following:

- Four weeks of personnel leave
- One week of travel
- One week of holidays

To determine Advanced Manufacturing Processes Laboratory operational activity levels, the 46-week work year was multiplied by a 40-hour workweek to derive the total number of work hours per year for one employee:

46 weeks/year x 40 hours/week = 1,840 hours/year

The product was multiplied by the average number of scientific, technical, and facility personnel:

1,840 hours/year x 135 employees = 248,000 hours per year that the Advanced Manufacturing Processes Laboratory facility is in full operational mode within the combined labs

The results provide an estimated baseline of Advanced Manufacturing Processes Laboratory activity for 1996-1997.

The level of effort projected for the “reduced” alternative is identical to the base year number of 248,000 operating hours because the facility is currently operating at the minimum number of personnel (minus administrative staff) required to maintain operational capability in each of the various areas of expertise. In addition, any lower level of effort would not provide the minimum support necessary to keep the facility responsive to the needs of DOE and other customers.

See "5.0 OPERATIONS AND CAPABILITIES," for additional description of facility operations and capabilities at the Advanced Manufacturing Processes Laboratory. See "4.0 PROGRAM ACTIVITIES," for additional information on programs.

9.1.3 Assumptions and Rationale for the "No Action" Values

The base year number for operational hours of the Advanced Manufacturing Processes Laboratory was derived by multiplying the number of weeks in the operational work year by the number of hours worked by one employee during a five-day, eight-hour-per-day work week and multiplying the product by the number of operational employees:

46 weeks/year x 40 hours/week = 1,840 hours/year

1,840 hours/year x 135 employees = 248,000 hours per year that the Advanced Manufacturing Processes Laboratory facility is in operational mode

See the narrative above for additional background on this calculation.

The projections for 2003 and 2008 assume an increase in Work for Others and other program activity sufficient to require an estimated 34 additional employees or an increase of just over 25 percent in the total number of employees:

135 employees x 1.25 = 168 total employees or an increase of approximately 34 employees

This would also result in an increase in facility operational hours of approximately 62,000 annually for a projected total of 310,000 annually:

248,000 annual operational hours x 1.25 = 310,000 annual operational hours

9.1.4 Assumptions and Actions for the "Expanded" Values

The projections under the "expanded" alternative assume an increase in Work for Others and other program activity sufficient to require an estimated 54 additional employees or an increase of approximately 40 percent in the total number of employees:

135 employees x 1.40 = 189 total employees or an increase of approximately 54 employees

The addition of these extra personnel would require the facility to begin operating more than one shift per day.

This would also result in an increase in facility operational hours of approximately 99,000 annually for a projected total of 347,000 annual operating hours:

248,000 annual operational hours x 1.4 = 347,000 annual operational hours

9.2 Material Inventories

9.2.1 Nuclear Material Inventory Scenarios

This facility has no nuclear material inventories.

9.2.2 Radioactive Material Inventory Scenarios

This facility has no radioactive material inventories.

9.2.3 Sealed Source Inventory Scenario for H-3

9.2.3.1 Alternatives for H-3 Sealed Source Inventory

Table 9-5 shows the alternatives for the H-3 sealed source inventory at the Advanced Manufacturing Processes Laboratory.

Table 9-5. Alternatives for H-3 Sealed Source Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
2.594 x 10^6 µCi	2.594 x 10^6 µCi	2.594 x 10^6 µCi	2.594 x 10^6 µCi	2.594 x 10^6 µCi

9.2.3.2 Operations That Require H-3

Information on operations that require H-3 is not currently available.

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

This information is not currently available.

9.2.4 Spent Fuel Inventory Scenarios

This facility has no spent fuel inventories.

9.2.5 Chemical Inventory Scenarios

9.2.5.1 Alternatives for Chemical Inventory Scenarios

The list of chemicals provided in this section does not represent the comprehensive list of chemicals that are used at this facility. After reviewing a comprehensive list of chemicals that was derived from sources of information on corporate chemical inventories (for example, the SNL/NM Chemical Information System and procurement records), DOE and the contractor responsible for preparing the sitewide environmental impact statement selected “chemicals of concern,” which are those chemicals that are most likely to affect human health and the environment.

Table 9-6 shows the chemical inventory scenarios at the Advanced Manufacturing Processes Laboratory.

Table 9-6. Chemical Inventory Scenarios

Chemical	Reduced Alternative	No Action Alternative			Expanded Alternative
		Base Year	FY2003	FY2008	
(3-glycidoxypropyl) trimethoxysilane	200 ml	200 ml	300 ml	300 ml	400 ml
109 thinner	5 gal	5 gal	7.5 gal	7.5 gal	10 gal
1-butanol	4 l	4 l	6 l	6 l	8 l
201 protective cream	4 oz	4 oz	6 oz	6 oz	8 oz
2-ethoxyethyl acetate	4 l	4 l	6 l	6 l	8 l
2X988-B silicone lubricant	10 oz	10 oz	15 oz	15 oz	20 oz
3,4,5,6-tetrabromophenolsulfonephthalein	10 ml	10 ml	15 ml	15 ml	20 ml
3M 76 High Tack Adhesive (1PA)	16 oz	16 oz	24 oz	24 oz	32 oz
3M 90 High Strength Adhesive	32 oz	32 oz	48 oz	48 oz	64 oz
3M Super 74 Foam Fast Adhesive (PB/PC)	17 oz	17 oz	25.5 oz	25.5 oz	34 oz
49 Perma Seal Sanding Sealer	33.25 fl oz	33.25 fl oz	49.87 fl oz	49.87 fl oz	66.5 fl oz
5063D	100 g	100 g	150 g	150 g	200 g
5087	50 g	50 g	75 g	75 g	100 g
5725 conductor composition	200 g	200 g	300 g	300 g	400 g
670 Ceramabond	1 kg	1 kg	1.5 kg	1.5 kg	2 kg
69-3080 Fibrmet Extender	6 fl oz	6 fl oz	9 fl oz	9 fl oz	12 fl oz
8001 cleaner for static control mats	160 fl oz	160 fl oz	240 fl oz	240 fl oz	320 fl oz
984	500 ml	500 ml	750 ml	750 ml	1,000 ml
984-LVF	2,000 ml	2,000 ml	3,000 ml	3,000 ml	4,000 ml
A-2000 aerosol lacquer series	24 oz	24 oz	36 oz	36 oz	48 oz
Ablebond 8175	110 ml	110 ml	165 ml	165 ml	220 ml
Ablebond 8175A	4 ml	4 ml	6 ml	6 ml	8 ml
Ablebond 967-1	60 ml	60 ml	90 ml	90 ml	120 ml
Ablebond 967-3	2 ml	2 ml	3 ml	3 ml	4 ml

Table 9-6. Chemical Inventory Scenarios (Continued)

Chemical	Reduced Alternative	No Action Alternative			Expanded Alternative
		Base Year	FY2003	FY2008	
Ablefilm 5025E	25 g	25 g	37.5 g	37.5 g	50 g
Ablefilm ECF 550	25 g	25 g	37.5 g	37.5 g	50 g
Accubrade-50	3,653 lb	3,653 lb	5,481 lb	5,481 lb	7,308 lbs
Acetic acid	3,505 ml	3,505 ml	5,257.5 ml	5,257.5 ml	7,010 ml
Acetone	481 l	481 l	721 l	721 l	962 l
Acetylene, dissolved	220 ft^3	220 ft^3	330 ft^3	330 ft^3	440 ft^3
Acid copper plating solution	55 gal	55 gal	82.5 gal	82.5 gal	110 gal
Acid spill kit	22 kg	22 kg	33 kg	33 kg	44 kg
Adiprene L-100	45 lb	45 lb	67.5 lb	67.5 lb	90 lb
Aerosol lacquer series paint	12 oz	12 oz	18 oz	18 oz	24 oz
Aerosol spray paints - (Dunn Edwards Series) Cot.	12 oz	12 oz	18 oz	18 oz	24 oz
Aerosol spray paints, All-Pro Sprays	24 oz	24 oz	36 oz	36 oz	48 oz
Alcohol, anhydrous	25 gal	25 gal	37.5 gal	37.5 gal	50 gal
All established steel grades	5 lb	5 lb	7.5 lb	7.5 lb	10 lb
Alumina	500 g	500 g	750 g	750 g	1,000 g
Alumina paste	1,000 cm^3	1,000 cm^3	1,500 cm^3	1,500 cm^3	2,000 cm^3
Aluminum	672.2 g	672.2 g	1,014.3g	1,014.3 g	1,352.4 g
Aluminum oxide	51 kg	51 kg	76.5 kg	76.55 kg	102 kg
Aluminum, pellets, 3-8 mesh	0.5 kg	0.5 kg	0.75 kg	0.75 kg	1 kg
Ammonium hydroxide	330 gal	330 gal	495 gal	495 gal	660 gal
Ammonium hydroxide, Diazo developer	55.5 l	55.5 l	83.25 l	83.25 l	111 l
Amyl acetate	500 ml	500 ml	750 ml	750 ml	1,000 ml
Amyl acetate, N-	500 ml	500 ml	750 ml	750 ml	1,000 ml
Ancamine 2049 curing agent	505 ml	505 ml	757.5 ml	757.5 ml	1,010 ml
A-Plus	54 oz	54 oz	81 oz	81 oz	108 oz
AZ 400K developer	4 gal	4 gal	6 gal	6 gal	8 gal
AZ 400K developer diluted 1:4	4 gal	4 gal	6 gal	6 gal	8 gal
AZ 4330 photoresist	1 qt	1 qt	1.5 qt	1.5 qt	2 qt
AZ 4330-RS liquid positive photoresist	3 gal	3 gal	4.5 gal	4.5 gal	6 gal
AZ P4620 photoresist	1 qt	1 qt	1.5 qt	1.5 qt	2 qt
Benzyl alcohol	12 l	12 l	18 l	18 l	24 l
Best Test paper cement	1 pt	1 pt	1.5 pt	1.5 pt	2 pt
Bethlehem Instrument mercury	60 lb	60 lb	90 lb	90 lb	120 lb
BKC 1271 prepolymer, BKC 44402 series, component	1 gal	1 gal	1.5 gal	1.5 gal	2 gal
Blue glass	1 qt	1 qt	1.5 qt	1.5 qt	2 qt
Blue Wellborn spray lacquer	11 oz	11 oz	16.5 oz	16.5 oz	22 oz
Buffer solution PH 7.0 (color-coded yellow)	500 ml	500 ml	750 ml	750 ml	1000 ml
Butanol, 1-	4 l	4 l	6 l	6 l	8 l
Butyl acetate, N-	1 qt	1 qt	1.5 qt	1.5 qt	2 qt

Table 9-6. Chemical Inventory Scenarios (Continued)

Chemical	Reduced Alternative	No Action Alternative			Expanded Alternative
		Base Year	FY2003	FY2008	
Calthane 1800 & 1900 MDI A & NF 1500 A	10 oz	10 oz	15 oz	15 oz	20 oz
Cataposit 44 catalyst	3 gal	3 gal	4.5 gal	4.5 gal	6 gal
Cataposit 449 replenisher	4 gal	4 gal	6 gal	6 gal	8 gal
Cathane 1900B	2 pt	2 pt	3 pt	3 pt	4 pt
Cee Bee A-202	10 gal	10 gal	15 gal	15 gal	20 gal
Ceramabind 542	2 kg	2 kg	3 kg	3 kg	4 kg
Ceramabind 644	2 kg	2 kg	3 kg	3 kg	4 kg
CF 7570	5 lb	5 lb	7.5 lb	7.5 lb	10 lb
Choline hydroxide, 50%	200 ml	200 ml	300 ml	300 ml	400 ml
Cho-Shield 598, Part A	1 pt	1 pt	1.5 pt	1.5 pt	2 pt
Cho-Shield 598, Part B	1 pt	1 pt	1.5 pt	1.5 pt	2 pt
Chromium	5 lb	5 lb	7.5 lb	7.5 lb	10 lb
Chromium, chips	14.2 g	14.2 g	21.3 g	21.3 g	28.4 g
Cibatool SL 5170	47.6 kg	47.6 kg	71.4 kg	71.4 kg	95.2 kg
Circuposit MLB conditioner 211	20 gal	20 gal	30 gal	30 gal	40 gal
CIS-1, 2-cyclohexane dicarboxylic acid	1,000 g	1,000 g	750 g	750 g	2,000 g
Clean up solvent for instant adhesives	1 oz	1 oz	1.5 oz	1.5 oz	2 oz
Cleaners and disinfectants	38 oz	38 oz	57 oz	57 oz	76 oz
Clearview glass cleaner	1 qt	1 qt	1.5 qt	1.5 qt	2 qt
Combat boron nitride aerosol	16 oz	16 oz	24 oz	24 oz	32 oz
Conathane EN-4, part A	8 gal	8 gal	12 gal	12 gal	16 gal
Conathane EN-7 part A	1 qt	1 qt	1.5 qt	1.5 qt	2 qt
Conathane TU-4010 part B curative	1 gal	1 gal	1.5 gal	1.5 gal	2 gal
Copper metal	6.1 lbs	6.1 lbs	9.2 lbs	9.2 lbs	12.2 lbs
Crodafos N3 acid	25 ml	25 ml	37.5 ml	37.5 ml	50 ml
CS 3100 type II class 2 (Part A)	18 qt	18 qt	27 qt	27 qt	36 qt
Cuposit 328C copper mix concentrate	49 gal	49 gal	73.5.5 gal	73.5 gal	98 gal
Cuposit cleaner-conditioner 1175A	5 gal	5 gal	7.5 gal	7.5 gal	10 gal
Cuposit Z	10 gal	10 gal	15 gal	15 gal	20 gal
Curimid-CN	200 g	200 g	300 g	300 g	400 g
Cyanomethane	2 gal	2 gal	3 gal	3 gal	4 gal
DAG 154	100 ml	100 ml	150 ml	150 ml	200 ml
Decane	500 ml	500 ml	750 ml	750 ml	1,000 ml
Delcrome 316/JK513	15 lb	15 lb	22.5 lb	22.5 lb	30 lb
Denatured alcohol	16 l	16 l	24 l	24 l	32 l
Diazo developer	24 l	24 l	36 l	36 l	48 l
Diethanolamine	5,500 ml	5,500 ml	8,250 ml	8,250 ml	11,000 ml
Dimethyl sulfoxide	4 l	4 l	6 l	6 l	8 l
DMP-10	1 gal	1 gal	1.5 gal	1.5 gal	2 gal
Double Bubble purple/beige A85, Part A	2 g	2 g	3 g	3 g	4 g

Table 9-6. Chemical Inventory Scenarios (Continued)

Chemical	Reduced Alternative	No Action Alternative			Expanded Alternative
		Base Year	FY2003	FY2008	
Dow Corning 1204 prime coat	14 fl oz	14 fl oz	21 fl oz	21 fl oz	28 fl oz
Dow Corning 3145 RTV adhesive/sealant-clear	6 fl oz	6 fl oz	9 fl oz	9 fl oz	12 fl oz
Dow Corning 732 multi-purpose sealant, clear	1,443 ml	1,443 ml	2,164.5 ml	2,164.5 ml	2,886 ml
Dow Corning high vacuum grease	18.3 oz	18.3 oz	30.45 oz	30.45 oz	40.6 oz
Dow Corning HS II, 10:1, colored catalyst	8 lb	8 lb	12 lb	12 lb	16 lb
Dyclean II	1 gal	1 gal	1.5 gal	1.5 gal	2 gal
ECC440 part A	1 pt	1 pt	1.5 pt	1.5 pt	2 pt
Eccobond 104, part A black	3 oz	3 oz	4.5 oz	4.5 oz	6 oz
Emphos PS-21A	200 ml	200 ml	300 ml	300 ml	400 ml
EPK 660 Part B varian - torrseal	118 g	118 g	177 g	177 g	236 g
Epo cleaner for dry erase surfaces	8 fl oz	8 fl oz	12 fl oz	12 fl oz	16 fl oz
EPO TEK H37-MP	6 ml	6 ml	9 ml	9 ml	12 ml
Epon resin 815	2 gal	2 gal	3 gal	3 gal	4 gal
Ethanol denaturated with 5% methanol	2 gal	2 gal	3 gal	3 gal	4 gal
Ethyl acetate	500 ml	500 ml	750 ml	750 ml	1,000 ml
Ethyl alcohol	12 l	12 l	18 l	18 l	24 l
Ethylene	114 lb	114 lb	171 lb	171 lb	228 lb
Ethylene glycol	2 pt	2 pt	3 pt	3 pt	4 pt
EU-2 sealing glass	2 lb	2 lb	3 lb	3 lb	4 lb
Facsimile curing liquid	122 ml	122 ml	183 ml	183 ml	244 ml
Facsimile separator	4 oz	4 oz	6 oz	6 oz	8 oz
FH-3150-A	75 g	75 g	112.5 g	112.5 g	150 g
Five-minute epoxy hardener	12 qt	12 qt	18 qt	18 qt	24 qt
Fluohydric acid	1 lb	1 lb	1.5 lb	1.5 lb	2 lb
Formaldehyde	2 qt	2 qt	3 qt	3 qt	4 qt
Frekote 700-NC	192 oz	192 oz	288 oz	288 oz	384 oz
General purpose solvent thinner #6997, #6999	4 l	4 l	6 l	6 l	8 l
Grade C-13	4 lb	4 lb	6 lb	6 lb	8 lb
Houghto-Safe 620	54 gal	54 gal	81 gal	81 gal	108 gal
Hydrochloric acid	503.5 ml	503.5 ml	755.25 ml	755.25 ml	1,007 ml
Hydrochloric acid solutions, concentrates	2.5 l	2.5 l	3.75 l	3.75 l	5 l
Hydrofluoric acid	15 kg	15 kg	22.5 kg	22.5 kg	30 kg
Hydrofluoric acid emergency cleanup kit	5 lb	5 lb	7.5 lb	7.5 lb	10 lb
Hydrogen peroxide 30%	569 ml	569 ml	853.5 ml	853.5 ml	1,138 ml
Hydrogenated methylene diisocyanate prepolymer	3 lb	3 lb	4.5 lb	4.5 lb	6 lb
Hyprez diamond slurry S-4889	11,200 g	11,200 g	16,800 g	16,800 g	22,400 g
Hysol DH3475	3 qt	3 qt	4.5 qt	4.5 qt	6 qt

Table 9-6. Chemical Inventory Scenarios (Continued)

Chemical	Reduced Alternative	No Action Alternative			Expanded Alternative
		Base Year	FY2003	FY2008	
Hysol EA 9394 QT system, part A	162 g	162 g	243 g	243g	324 g
Hysol K8-4238	10 lb	10 lb	15 lb	15 lb	20 lb
Indium	100 g	100 g	150 g	150 g	200 g
Ink for disposable pen for film	0.75 oz	0.75 oz	1.125 oz	1.125 oz	1.5 oz
Iodine	700 g	700 g	1,050 g	1,050 g	1,400 g
Iodine solutions, 0.1N, 0.02N	4 l	4 l	6 l	6 l	8 l
Isocut fluid	2 qt	2 qt	3 qt	3 qt	4 qt
Isopropyl alcohol	12 l	12 l	18 l	18 l	24 l
Ken-React NZ 38	8 oz	8 oz	12 oz	12 oz	16 oz
Kodak HRP developer	8 l	8 l	12 l	12 l	16 l
Kodak RA 2000 developer and replenisher	75 gal	75 gal	112.5 gal	112.5 gal	150 gal
Kodak rapid fixer - Part A	65.72 l	65.72 l	98.58 l	98.58 l	131.44 l
Kyzen Aquanox SSA	1 gal	1 gal	1.5 gal	1.5 gal	2 gal
Laminar X500 gloss clear	1 qt	1 qt	1.5 qt	1.5 qt	2 qt
Laminar X500 hardener	1 pt	1 pt	1.5 pt	1.5 pt	2 pt
Liquid Bright Gold	100 g	100 g	150 g	150 g	200 g
Liquid Bright Platinum	650 g	650 g	975 g	975 g	1,300 g
Locquic primer N aerosol 764-56	6 oz	6 oz	9 oz	9 oz	12 oz
Locquic primer T (aerosol)	6 oz	6 oz	9 oz	9 oz	12 oz
Macco CA-80	1 pt	1 pt	1.5 pt	1.5 pt	2 pt
Magnesium oxide	1 kg	1 kg	1.5 kg	1.5 kg	2 kg
M-Bond 600 adhesive	10 oz	10 oz	15 oz	15 oz	20 oz
M-Bond curing agent for 600/610 adhesive	11 oz	11 oz	16.5 oz	16.5 oz	22 oz
M-Coat C RTV silicone rubber	4 oz	4 oz	6 oz	6 oz	8 oz
Metadi fluid 40-6004 6014 6016 6032	7 qt	7 qt	10.5 qt	10.5 qt	14 qt
Metallo organic platinum Ink	105 g	105 g	157.5 g	157.5 g	210 g
Methyl alcohol	69 l	69 l	103.5 l	103.5 l	138 l
Methyl ethyl ketone	4 l	4 l	6 l	6 l	8 l
Methyl-2-pyrrolidinone, 1-	36 l	36 l	54 l	54 l	72 l
Methyl-5-norbornene-2, 3-dicarboxylic anhyride	8 kg	8 kg	12 kg	12 kg	16 kg
Methylene chloride	50 l	50 l	75 l	75 l	100 l
Mold release 226	17 gal	17 gal	25.5 gal	25.5 gal	34 gal
Molybdenum metal	300.6 g	300.6 g	450.9 g	450.9 g	601.2 g
M-Prep conditioner A	2 pt	2 pt	3 pt	3 pt	4 pt
M-Prep ceutralizer 5	503 ml	503 ml	754.5 ml	754.5 ml	1006 ml
MS-122N/CO2 release agent/dry lubricant	479 g	479 g	718.5 g	718.5 g	953 g
Mullite-Paste	1,000 cm^3	1,000 cm^3	1,500 cm^3	1,500 cm^3	2,000 cm^3
Neutra-Clean 68	3 gal	3 gal	4.5 gal	4.5 gal	6 gal
Nickel	125 g	125 g	187.5 g	187.5 g	250 g
Nicrobraz L.C. rod	1 lb	1 lb	1.5 lb	1.5 lb	2 lb

Table 9-6. Chemical Inventory Scenarios (Continued)

Chemical	Reduced Alternative	No Action Alternative			Expanded Alternative
		Base Year	FY2003	FY2008	
Nistelle 718	15 lb	15 lb	22.5 lb	22.5 lb	30 lb
Nitric Acid	17 gal	17 gal	25.5 gal	25.5 gal	34 gal
Nu-Sheen	1 qt	1 qt	1.5 qt	1.5 qt	2 qt
Oakite Inpro-Clean 3800	1 gal	1 gal	1.5 gal	1.5 gal	2 gal
O-phosphoric acid	502 ml	502 ml	753 ml	753ml	1,004 ml
Opotow EBA cement powders	28 g	28 g	42 g	42 g	56 g
Pan indicator solution 0.3%	100 ml	100 ml	150 ml	150 ml	200 ml
PB-1	125 cm^3	125 cm^3	187.5 cm^3	187.5 cm^3	250 cm^3
PB-3 paste base	125 cm^3	125 cm^3	187.5 cm^3	187.5 cm^3	250 cm^3
PB-4	125 cm^3	125 cm^3	187.5 cm^3	187.5 cm^3	250 cm^3
Peldri II	250 g	250 g	375 g	375 g	500 g
Photoposit 303A developer	5 gal	5 gal	7.5 gal	7.5 gal	10 gal
Phthalate-phosphate reagent	12 g	12 g	18 g	18 g	24 g
Platinum	2,031 g	2,031 g	3,046.5 g	3,046.5 g	4,062 g
Platinum on carbon black	500 g	500 g	750 g	750 g	1,000 g
Ply #2 protective skin cream	5.5 oz	5.5 oz	8.25 oz	8.25 oz	11 oz
Polycaprolactone triol	8 qt	8 qt	12 qt	12 qt	16 qt
Polymer latex suspensions	200 ml	200 ml	300 ml	300 ml	400 ml
Positec photosystems Brand Repro 2200 remover	5 gal	5 gal	7.5 gal	7.5 gal	10 gal
Potassium hydroxide (dry solid, flake, bead)	3,300 g	3,300 g	4,950 g	4,950 g	6,600 g
Preposit etch 746	10 gal	10 gal	15 gal	15 gal	20 gal
Primer for conductive caulk 2-00151/152	2 oz	2 oz	3 oz	3 oz	4 oz
Promyristyl PM3	20 ml	20 ml	30 ml	30 ml	40 ml
Propanol, 1-	5 l	5 l	7.5 l	7.5 l	10 l
Propanol, 2-	240 l	240 l	360 l	360 l	481 l
Pyridine	200 ml	200 ml	300 ml	300 ml	400 ml
Pyrolidine	2 l	2 l	3 l	3 l	4 l
Quick Dry background enamel	32 fl oz	32 fl oz	48 fl oz	48 fl oz	64 fl oz
Reagent alcohol	8 l	8 l	12 l	12 l	16 l
Redi RS90-005 San Tan	36 oz	36 oz	54 oz	54 oz	72 oz
Reference electrode filling solution	2 oz	2 oz	3 oz	3 oz	4 oz
Rely-Imide P-86A hybrid encapsulant	5 ml	5 ml	7.5 ml	7.5 ml	10 ml
Residual insect spray	16 oz	16 oz	24 oz	24 oz	32 oz
Resin defoamer No. 1	12 oz	12 oz	18 oz	18 oz	24 oz
Rigidizer	2 gal	2 gal	3 gal	3 gal	4 gal
Rosin flux cored solder wire	1 lb	1 lb	1.5 lb	1.5 lb	2 lb
RTV 630A	28.3 pt	28.3 pt	42.45 pt	42.45 pt	56.6 pt
RTV630B	826 g	826 g	1,239 g	1,239 g	1,652 g
SC paste	125 cm^3	125 cm^3	187.5 cm^3	187.5 cm^3	250 cm^3
SC3400HT	300 g	300 g	450 g	450 g	600 g
SC4401HTP	500 g	500 g	750 g	750 g	1,000 g

Table 9-6. Chemical Inventory Scenarios (Continued)

Chemical	Reduced Alternative	No Action Alternative			Expanded Alternative
		Base Year	FY2003	FY2008	
Scotchcast Brand resin primer	14 fl oz	14 fl oz	21 fl oz	21 fl oz	28 fl oz
SFR	4 l	4 l	6 l	6 l	8 l
Silastic 732 RTV adhesive sealant, clear	72 oz	72 oz	108 oz	108 oz	144 oz
Silicon dioxide granules patinal	1,001g	1,001 g	1,501.5 g	1,501.5 g	2,002 g
Silvaloy A-56T (355)	2 oz	2 oz	3 oz	3 oz	4 oz
Silver-plated copper-filled silicone caulk	5 oz	5 oz	7.5 oz	7.5 oz	10 oz
Silver/copper-filled adhesive	5 oz	5 oz	7.5 oz	7.5 oz	10 oz
Simichrome polish	75 g	75 g	112.5 g	112.5 g	150 g
SN 60 solder	2 lb	2 lb	3 lb	3 lb	4 lb
SN paste	125 cm^3	125 cm^3	187.5 cm^3	187.5 cm^3	250 cm^3
SN60 (SN60PB40) 2000	2 lb	2 lb	3 lb	3 lb	4 lb
SN63 X32 no residue cored solder 1.0%	1 lb	1 lb	1.5 lb	1.5 lb	2 lb
Sodium (DI) ethylenediamine tetraacetate solution	3 l	3 l	4.5 l	4.5 l	6 l
Sodium bisulfite	500 g	500 g	750 g	750 g	1,000 g
Sodium borate decahydrate	10 kg	10 kg	15 kg	15 kg	20 kg
Sodium hydroxide solution 0.02 N to 1 N	500 ml	500 ml	750 ml	750 ml	1,000 ml
Sodium hydroxide solutions	1 l	1 l	1.5 l	1.5 l	2 l
Sodium metabisulfite (anhydrous sodium)	100 lb	100 lb	150 lb	150 lb	200 lb
Solder	0.5 lb	0.5 lb	0.75 lb	0.75 lb	1 lb
Solder 63/37	11 lb	11 lb	16.5 lb	16.5 lb	22 lb
Solder alloys containing lead	1 lb	1 lb	1.5 lb	1.5 lb	2 lb
Solder alloys of lead, tin, silver, bismuth, antim	1 lb	1 lb	1.5 lb	1.5 lb	2 lb
Solder brightener 215	5 gal	5 gal	7.5 gal	7.5 gal	10 gal
Spinel paste	1,000 cm^3	1,000 cm^3	1,500 cm^3	1,500 cm^3	2,000 cm^3
Spray-A-Way	323oz	323 oz	484.5 oz	484.5 oz	646oz
SS4004	500 ml	500 ml	750 ml	750 ml	1,000 ml
SS4155	500 ml	500 ml	750 ml	750 ml	1,000 ml
Sta-Brite NC	54 oz	54 oz	81 oz	81 oz	108 oz
Staticide	64 fl oz	64 fl oz	96 fl oz	96 fl oz	128 fl oz
Stelcar 6189	20 lb	20 lb	30 lb	30 lb	40 lb
Stelcar 967	10 lb	10 lb	15 lb	15 lb	20 lb
Sulfuric acid	177 gal	177 gal	265.1 gal	265.1 gal	353.6 gal
Superclear lens cleaner aerosol	48 fl oz	48 fl oz	72 fl oz	72 fl oz	96 fl oz
Sylgard prime coat	1 pt	1 pt	1.5 pt	1.5 pt	2 pt
Tantalum(v) ethoxide	10 g	10 g	15 g	15 g	20 g
Tantalum, foil, 0.025MM thick, 99.9+%	1,040.8 g	1,040.8 g	1,561.2 g	1,561.2 g	2,081.6 g
Tetra-Etch etchant	1,000 ml	1,000 ml	1,500 ml	1,500 ml	2,000 ml

Table 9-6. Chemical Inventory Scenarios (Continued)

Chemical	Reduced Alternative	No Action Alternative			Expanded Alternative
		Base Year	FY2003	FY2008	
Thiokol MC-520 accelerator	8 qt	8 qt	12 qt	12 qt	16 qt
Thiokol MC-521 type II class 2 base part B	50 g	50 g	75 g	75 g	100 g
Tin(IV) tert-amyloxide	100 ml	100 ml	150 ml	150 ml	200 ml
Tinposit LT-34	30 gal	30 gal	45 gal	45 gal	60 gal
Titanium disopropoxide bis(2,4-pentane-dionate)	100 ml	100 ml	150 ml	150 ml	200 ml
Toluene	6 l	6 l	9 l	9 l	12 l
Tra-Bond 2122 hardener	10 oz	10 oz	15 oz	15 oz	20 oz
Tra-Bond 2122 resin	10 oz	10 oz	15 oz	15 oz	20 oz
Tra-Cast 3103 hardener	30 oz	30 oz	45 oz	45 oz	60 oz
Tra-Cast 3103 resin	18oz	18 oz	27 oz	27 oz	36 oz
Trichloroethane-1,1,1	60 l	60 l	90 l	90 l	120 l
Trichloroethylene	198 gal	198 gal	297 gal	297 gal	396 gal
Trubble Bubble	6 fl oz	6 fl oz	9 fl oz	9 fl oz	12 fl oz
Tube coating No. 360 powder	5.5 lb	5.5 lb	8.25 lb	8.25 lb	11 lb
Tungsten	35 lb	35 lb	52.5 lb	52.5 lb	70 lb
Type Zo-Mod-Black	1 pt	1 pt	1.5 pt	1.5 pt	2 pt
Type Z-Paste	125 cm^3	125 cm^3	187.5 cm^3	187.5 cm^3	250 cm^3
Ultra Etch make-up solution	110 gal	110 gal	165 gal	165 gal	220 gal
Vanadium	165.3 g	165.3 g	247.95 g	247.95 g	330.6 g
Waterproof solution 741	1 oz	1 oz	1.5 oz	1.5 oz	2 oz
Weber Costello marker board cleaner	16 oz	16 oz	24 oz	24 oz	32 oz
Wesgo metal products and alloys	11.87 lb	11.87 lb	17.8 lb	17.8 lb	63.3 lb
Xylenes	4 l	4 l	6 l	6 l	8 l
Y-9492	8 oz	8 oz	12 oz	12 oz	16 oz
Yttrium methoxyethoxide	100 g	100 g	150 g	150 g	200 g
Zinc oxide	100 g	100 g	150 g	150 g	200 g
Zirconium (IV) butoxide, 80 Wt. % solution, butano	300 ml	300 ml	450 ml	450 ml	600 ml
Zirconium acetate solution	800 g	800 g	1200 g	1200 g	1600 g
Zirconium(IV) propoxide	100 ml	100 ml	150 ml	150 ml	200 ml
Zirconyl nitrate, CA. 35 Wt. % solution in dilute	1,500 ml	1,500 ml	2,250 ml	2,250 ml	3,000 ml

9.2.5.2 Operations That Require Chemical Inventories

The programs and operations that utilize these chemicals are described in detail in "3.0 DESCRIPTION," "4.0 PROGRAM ACTIVITIES," and "5.0 OPERATIONS AND CAPABILITIES."

9.2.5.3 Basis for Projecting the Values in the "No Action" Columns

Baseline values for the chemicals listed in Table 9-6 were obtained from the SNL Chemical Information System. In most cases, the values for the "no action," "reduced," and "expanded" alternatives were derived by adjusting the base year information in proportion to the changes in activity levels provided in "9.1 Activity Scenario for the Development or Production of Devices, Processes, and Systems: Materials, Ceramics/Glass, Electronics, Processes, and Systems" of this chapter. However, where facility managers used process knowledge to estimate chemical applications, this more specific information was used instead.

Projections for highly toxic chemicals or those used in large quantity may have deviated from this methodology and used estimated values if deemed appropriate by the facility representatives.

9.2.5.4 Basis for Projecting the Values in the "Reduced" Column

Baseline values for the chemicals listed in Table 9-6 were obtained from the SNL Chemical Information System. In most cases, the values for the "no action," "reduced," and "expanded" alternatives were derived by adjusting the base year information in proportion to the changes in activity levels provided in "9.1 Activity Scenario for the Development or Production of Devices, Processes, and Systems: Materials, Ceramics/Glass, Electronics, Processes, and Systems." However, where facility managers used process knowledge to estimate chemical applications, this more specific information was used instead.

Projections for highly toxic chemicals or those used in large quantity may have deviated from this methodology and used estimated values if deemed appropriate by the facility representatives.

9.2.5.5 Basis for Projecting the Values in the "Expanded" Column

Baseline values for the chemicals listed in Table 9-6 were obtained from the SNL Chemical Information System. In most cases, the values for the "no action," "reduced," and "expanded" alternatives were derived by adjusting the base year information in proportion to the changes in activity levels provided in "9.1 Activity Scenario for the Development or Production of Devices, Processes, and Systems: Materials, Ceramics/Glass, Electronics, Processes, and Systems." However, where facility managers used process knowledge to estimate chemical applications, this more specific information was used instead.

Projections for highly toxic chemicals, or those used in large quantity, may have deviated from this methodology and used estimated values, if deemed appropriate by the facility representatives.

9.2.6 Explosives Inventory Scenarios

This facility has no explosives inventories.

9.2.7 Other Hazardous Material Inventory Scenarios

This 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.

9.3 Material Consumption

9.3.1 Nuclear Material Consumption Scenarios

Nuclear material is not consumed at this facility.

9.3.2 Radioactive Material Consumption Scenarios

Radioactive material is not consumed at this facility.

9.3.3 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.

9.3.4 Explosives Consumption Scenarios

Explosives are not consumed at this facility.

9.4 Waste

9.4.1 Low-Level Radioactive Waste Scenario

Low-level radioactive waste is not produced at this facility.

9.4.2 Transuranic Waste Scenario

Transuranic waste is not produced at this facility.

9.4.3 Mixed Waste

9.4.3.1 Low-Level Mixed Waste Scenario

Low-level mixed waste is not produced at this facility.

9.4.3.2 Transuranic Mixed Waste Scenario

Transuranic mixed waste is not produced at this facility.

9.4.4 Hazardous Waste Scenario

9.4.4.1 Alternatives for Hazardous Waste at the Advanced Manufacturing Processes Laboratory

Table 9-7 shows the alternatives for hazardous waste at the Advanced Manufacturing Processes Laboratory.

Table 9-7. Alternatives for Hazardous Waste

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
4,732 kg	4,732 kg	5,915 kg	5,915 kg	6,625 kg

9.4.4.2 Operations That Generate Hazardous Waste

The majority of all Advanced Manufacturing Processes Laboratory operations individually generate small amounts of hazardous waste. Collectively, Advanced Manufacturing Processes Laboratory operations generated approximately 1,183 kg of hazardous waste in the first quarter of 1998. This value was obtained from the *Center 1400 Quarterly Waste Generation and Waste Minimization Fee Report FY98*. The base year projected number was then derived by multiplying the quarterly amount times four (4,732 kg).

Initially, a 10,000-kg quantity had been provided as the Advanced Manufacturing Processes Laboratory base year number for 1996. This number was the result of a one-time decommissioning of one of the laboratory operations and as such is not viewed as representative of actual annual amounts of hazardous waste generated by Advanced Manufacturing Processes Laboratory operations.

Assumptions under the 2003 and 2008 alternatives are consistent with the logic presented in "9.1 Activity Scenario for Development or Production of Devices, Processes, and Systems: Materials Ceramics/Glass, Electronics, Processes, and Systems," for the 2003 and 2008 timeframes. These values show an increase by a factor of 1.25 in operations:

The annual amount of base year waste (4,732 kg) x 1.25 = 5,915 kg generated under the 2003 and 2008 projections

9.4.4.3 General Nature of Waste

The general nature of the residuals would include solvent-, adhesive-, and resin-contaminated rags, wipes, and other paper products, paper filters, drilling oils, metal turnings, ceramic and glass cuttings, photographic film, plastics, rubber millings, and acid-etching and photoresist solutions.

9.4.4.4 Waste Reduction Measures

Waste reduction measures currently include conservation of materials, use of environmentally safe products, and the use of recycled paper products.

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

The projections provided under the "reduced" alternative are the same as the base year number of 4,732 kg annually. This number is consistent with assumptions presented in "9.1 Activity Scenario for Development or Production of Devices, Processes, and Systems: Materials Ceramics/Glass, Electronics, Processes, and Systems," in which Advanced Manufacturing Processes Laboratory operations are anticipated to remain relatively static between the base year and the "reduced" scenario. (The facility would need to maintain the current level of activity to maintain the minimum level of operational capability in all areas.)

Projections under the "expanded" alternative assume an increase by a factor of 1.4, or an increase in hazardous wastes of approximately 1,893 kg annually. This would represent an increase in wastes proportional to the level of activity generated by operating the facility approximately 347,000 hours annually. This assumption is also consistent with the logic presented in "9.1 Activity Scenario for Development or Production of Devices, Processes, and Systems: Materials Ceramics/Glass, Electronics, Processes, and Systems," for the "expanded" alternative of an increase by a factor of 1.4 in operations:

Annual amount of base year waste (4,732 kg) x 1.4 = 6,624 kg generated under the “expanded” alternative

9.5 Emissions

9.5.1 Radioactive Air Emissions Scenarios

Radioactive air emissions are not produced at this facility.

9.5.2 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.

9.5.3 Open Burning Scenarios

This facility does not have outdoor burning operations.

9.5.4 Process Wastewater Effluent Scenario

This facility does not generate process wastewater.

9.6 Resource Consumption

9.6.1 Process Water Consumption Scenario

This facility does not consume process water.

9.6.2 Process Electricity Consumption Scenario

This facility does not consume process electricity.

9.6.3 Boiler Energy Consumption Scenario

This facility does not consume energy for boilers.

9.6.4 Facility Personnel Scenario

9.6.4.1 Alternatives for Facility Staffing at the Advanced Manufacturing Processes Laboratory

Table 9-8 shows the alternatives for facility staffing at the Advanced Manufacturing Processes Laboratory.

Table 9-8. Alternatives for Facility Staffing

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
150 FTEs	150 FTEs	184 FTEs	184 FTEs	204 FTEs

9.6.4.2 Operations That Require Facility Personnel

Advanced Manufacturing Processes Laboratory operations require administrative, scientific, technical, facility, and operational support personnel.

In “9.1 Activity Scenario for Development or Production of Devices, Processes, and Systems: Materials Ceramics/Glass, Electronics, Processes, and Systems,” administrative personnel were not included in the equation used to calculate operational activity for the Advanced Manufacturing Processes Laboratory facility. This was primarily because multipliers were being derived for use in estimating other related operational values (for example, waste generated). However, for the purpose of this section, administrative personnel are included in the numbers provided under each alternative scenario.

The base year value was obtained from the known average of 1996-1997 Advanced Manufacturing Processes Laboratory employees, including administrative personnel.

The numbers provided for 2003 and 2008 are based on the 1996-1997 known average, including administrative personnel (150), in combination with the estimated number of additional employees (34) projected for that scenario.

9.6.4.3 Staffing Reduction Measures

There are currently no staff reductions measures planned or in effect.

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

The number provided for the "reduced" alternative is identical to that of the base year. This is because the "reduced" alternative in "9.1 Activity Scenario for Development or Production of Devices, Processes, and Systems: Materials Ceramics/Glass, Electronics, Processes, and Systems," also assumed that a same or similar level of effort as that of the base year would be required to maintain operational capability in all areas needed to respond to DOE and other customer needs. Section "9.1 Activity Scenario for Development or Production of Devices, Processes, and Systems: Materials Ceramics/Glass, Electronics, Processes, and Systems," did not, however, include administrative personnel.

The number provided for the "expanded" alternative is based on the 1996-1997 known average, including administrative personnel (150), in combination with the estimated number of additional employees (54) projected for that scenario.

9.6.5 Expenditures Scenario

9.6.5.1 Alternatives for Expenditures at the Advanced Manufacturing Processes Laboratory

Table 9-9 shows the alternatives for expenditures at the Advanced Manufacturing Processes Laboratory.

Table 9-9. Alternatives for Expenditures

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
$32 million	$32 million	$40 million	$40 million	$45 million

9.6.5.2 Operations That Require Expenditures

Advanced Manufacturing Processes Laboratory operations require expenditures in the following representative categories:

- Salaries
- Consumables
- Capital improvements

The base year number is the known budget for 1996. This number is based on approximately $30 million in salary for combined personnel, including administrative personnel, and an additional $2 million for consumables, capital improvements, and other expenditures.

The number provided for the 2003 and 2008 timeframes of the "no action" alternative is based on an increase in expenditures by a factor of 1.25 ($32 million x 1.25 = $40 million). The 1.25 multiplier was derived through equations provided in "9.1 Activity Scenario for Development or Production of Devices, Processes, and Systems: Materials Ceramics/Glass, Electronics, Processes, and Systems."

9.6.5.3 Expenditure Reduction Measures

There are currently no expenditure reduction measures in place beyond the continuation of measures directed at achieving the highest level of efficiency in all aspects of operations.

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

The number provided for the "reduced" alternative is based maintaining the same level of operations and expenditures as that of the base year.

The number provided for the expanded alternative is based on an increase in expenditures by a factor of 1.4 ($32 million x 1.4 = $44.8 million or $45 million). The 1.4 multiplier was derived through equations provided in "9.1 Activity Scenario for Development or Production of Devices, Processes, and Systems: Materials Ceramics/Glass, Electronics, Processes, and Systems."

10.0 REFERENCES

10.1 Regulations, Orders, and Laws

29 CFR 1910.1450, *Occupational Exposure to Hazardous Chemicals in Laboratories*.

10.2 General References

Sandia National Laboratories, 1997a, database report for the Program Information Manager, Sandia National Laboratories, Integrated Risk Management Department, Albuquerque, New Mexico.

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Wood, C. L., *et al*., 1994, *Advanced Manufacturing Processes Laboratory Building 878 Hazards Assessment Document*, SAND94-1520, Sandia National Laboratories, Albuquerque, New Mexico.

Wood. C. L., 1994, *Hydrogen Trailer Storage Facility (Building 878) Consequence Analysis,* SAND94-3178, Sandia National Laboratories, Albuquerque, New Mexico.

CHAPTER 10 - INTEGRATED MATERIALS RESEARCH LABORATORY SOURCE INFORMATION

LIST OF TABLES

1.0 INTRODUCTION

The Integrated Materials Research Laboratory enables SNL/NM to develop new and superior material that meets government and industrial needs. This 140,000-ft^2 building houses most of the advanced material research and development functions at SNL/NM.

The research activities at the Integrated Materials Research Laboratory include lab studies in chemistry, physics, and alternative energy technologies. Material that is studied includes ceramics, organic polymers, alloys, and electronic components. The facility integrates research from the atomic scale through the development of electronic devices to full-scale mechanical components. The experimental work is augmented by advanced computer modeling and simulation techniques, which is another area of SNL/NM expertise.

A wide variety of materials are investigated, including the following:

- Advanced metallic alloys
- Semiconductors for electronic and photonic applications, such as high temperature superconductors and ceramics
- Metals with properties tailored for improved resistance to friction, wear, corrosion and erosion
- Laser, optical, and dielectric material

2.0 PURPOSE AND NEED

The Integrated Materials Research Laboratory provides offices and laboratory space for conducting materials and advanced components research.

Materials research enables the ideas of scientists to meet the needs of engineers. Studies into the relationships between the atomic structure of materials and their physical and mechanical properties, both in the U.S. and elsewhere, are leading to new alloys and other structures that can be designed to exhibit a wide range of useful properties.

For this reason, a number of federal agencies, including the Department of Energy, Department of Defense, Department of Commerce, and advisory bodies such as the Office of Science and

Technology Policy and the National Research Council have identified materials as a critical technology area vital to our nation's national security and economic competitiveness.

The Integrated Materials Research Laboratory enables SNL to develop new and superior materials that meet government and industrial needs. This 140,000-ft^2 building houses most of the advanced materials research and development functions at SNL. The facility integrates research from the atomic scale through the development of electronic devices to full-scale mechanical components. The experimental work is augmented by advanced computer modeling and simulation techniques, which is another area of SNL's expertise.

A wide variety of types of materials are investigated, including the following:

- Advanced metallic alloys
- Semiconductors for electronic and photonic applications
- High-temperature superconductors
- Ceramics
- Metals with properties tailored for improved resistance to friction, wear, corrosion, and erosion
- Laser, optical, and dielectric materials

The Integrated Materials Research Laboratory was built outside SNL's secure area to facilitate technical cooperation with researchers from industry and universities. The new four-story building has permitted SNL to bring together some 250 materials researchers previously scattered about the campus. It also includes space for postdoctoral researchers and guests from other organizations, facilitating the collaborative generation of new ideas and the subsequent transfer of novel, precompetitive technologies to practice.

The Integrated Materials Research Laboratory is strategically located near the Microelectronics Development Laboratory, the Compound Semiconductor Research Laboratory, and the Robotics Manufacturing Science & Engineering Laboratory. This drives the integration of materials research with advanced microelectronic component development, creating the nucleus of an integrated microsystems technology park.

(Sandia National Laboratories, 1998)

3.0 DESCRIPTION

The Integrated Materials Research Laboratory, located in Building 897, has approximately 42,000 ft^2 of office space and approximately 98,000 ft^2 of laboratory space for a total of approximately 140,000 ft^2 of net floor space. The building is constructed of structural concrete with stucco exterior walls and a flat, built-up roof. Building 897 has four stories, a full basement, and a mechanical penthouse. The penthouse and roof contain local exhaust ventilation systems that are used to vent chemical vapors from the labs to the outside of the building (Swihart, 1996).

4.0 PROGRAM ACTIVITIES

Table 10-1 shows the program activities at the Integrated Materials Research Laboratory.

Table 10-1. Program Activities at the Integrated Materials Research Laboratory

Program Name	Activities at the Integrated Materials Research Laboratory	Category of Program	Related Section of the *SNL Institutional Plan*
Advanced Industrial Materials Research	Conduct materials research and development.	Programs for the Department of Energy	Section 6.1.5.6
Catalysis and Separations Science and Engineering	Chemistry and materials research and development.	Programs for the Department of Energy	Section 6.1.5.6
Materials Processing by Design	Conduct materials research and development.	Programs for the Department of Energy	Section 6.1.5.6
Materials Sciences	Use advanced characterization instrumentation to understand the relationships between materials properties and structure and to understand how to tailor materials to have new and favorable properties through advanced synthesis and nanoscale structuring of materials.	Programs for the Department of Energy	Section 6.1.9.3
Sustaining Momentum in Advanced Design and Production Technologies	Develop and characterize advanced materials and processes.	Major Programmatic Initiatives	Section 7.1.5
Direct Stockpile Activities	Conduct research and development of engineered materials for nuclear weapon applications.	Programs for the Department of Energy	Section 6.1.1.1

Table 10-1. Program Activities at the Integrated Materials Research Laboratory (Continued)

Program Name	Activities at the Integrated Materials Research Laboratory	Category of Program	Related Section of the *SNL Institutional Plan*
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 both 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
Chemistry and Materials Science and Technology	Conduct research and development in materials processing, materials characterization, advanced materials development, and materials aging and compatibility for Defense Programs applications.	Programs for the Department of Energy	Section 6.1.1.1
Technology Transfer and Education	Conduct materials development and testing in conjunction with industry partners technology development.	Programs for the Department of Energy	Section 6.1.1.3
Advanced Manufacturing, Design, and Production Technologies	Develop new processes and build prototypes.	Programs for the Department of Energy	Section 6.1.1.4

5.0 OPERATIONS AND CAPABILITIES

The research activities at the Integrated Materials Research Laboratory include laboratory studies in chemistry, physics, and alternative energy technologies. The activities in the building include but are not limited to material-related research programs. Materials that are studied include ceramics, organic polymers, and electronic components. For detailed information on activities at the Integrated Materials Research Laboratory, see Swihart (1996).

6.0 HAZARDS AND HAZARD CONTROLS

Table 10-2 summarizes the hazardous material at the Integrated Materials Research Laboratory.

Table 10-2. Summary for Integrated Materials Research Laboratory Hazardous Material

Chemical	Quantity	Location
Ammonia	6.6 kg	Rooms 1207, 1094, B236, 3085
Bromine	1.1 kg	Rooms 1094, 1207
Chlorine	1.3 kg	Rooms 4207, 4301, 4480
Fluorine (5%)	0.8 kg (F only)	Rooms 1094, 3300
Furan	1.3 kg	Rooms 1094, 1207
Hydrobromic acid (50%)	1.3 kg	Rooms 1094, 1207
Hydrofluoric acid (50%)	18.5 kg	Rooms 1094, 1085, 1207, 2025, 2301, 2420, 3300, 3480, 3484, 4085
Methylamine (40%)	3.1 kg	Rooms 4207, 4301, 4480
Nitric acid (70%)	27.4 kg	Rooms B205G, B232, 1085, 1094, 1280, 1460, 2025, 2085, 2420, 3206, 3444, 3480, 4085, 4301
Nitric oxide	0.1 kg	Room 1094
Thionyl chloride	1 kg	Room 1094

Hazard controls at the Integrated Materials Research Laboratory include the following:

- Worker training
- Fume hoods
- Storage of all flammable and pyrophoric chemicals in approved cabinets
- Spill pillows for chemical spills
- Operating procedures, environment, safety and health (ES&H) standard operating procedures (SOPs), and other instructions for use of the equipment and for use and disposal of chemicals
- Emergency showers
- Personal protective equipment (PPE)
- Material safety data sheets for reference information
- Eye wash stations
- Hazardous waste receptacles for both solid and liquid waste disposal

(Swihart, 1996)

7.0 ACCIDENT ANALYSIS SUMMARY

The Integrated Materials Research Laboratory is a low-hazard nonnuclear facility and does not require accident analysis (Swihart, 1996).

8.0 REPORTABLE EVENTS

Table 10-3 lists the occurrence reports for the Integrated Materials Research Lab over the past five years.

Table 10-3. Occurrence Reports for the Integrated Materials Research Lab

Report Number	Title	Category	Description of Occurrence
ALO-KO-SNL-1000-1995-0005	Property Damage in Excess of $10,000 to Electrical System Caused by a Broken Inline Filter Housing	7A	Equipment was damaged when an inline water filter housing broke.
ALO-KO-SNL-1000-1995-0003	Violation of Procedures During Startup of Radiation Generating Devices (RGDs)	1F	Two radiological control technicians discovered that several RGDs were operating in violation of SNL's ES&H Manual, Chapter 6.
ALO-KO-SNL-1000-1996-0005	Violation of Authority Basis - Failure to Modify Hazard Assessment Documentation when Operations were Modified	1C	Workers were using titanium powder not identified in the preliminary hazard assessment, and the powder from a glovebox generated a small amount of smoke.

9.0 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.

9.1 Activity Scenario for Research and Development of Materials

9.1.1 Alternatives for Research and Development of Materials

Table 10-4 shows the alternatives for research and development of materials at the Integrated Materials Research Laboratory.

Table 10-4. Alternatives for Research and Development of Materials

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
363,817 operational hours	395,454 operational hours	395,454 operational hours	395,454 operational hours	395,454 operational hours

9.1.2 Assumptions and Actions for the "Reduced" Values

The characteristics of Integrated Materials Research Laboratory operations include numerous and diverse laboratories and capabilities, as well as frequent changes in clients, production schedules, products, and processes. As a result, more preferable or traditional throughput parameters such as the numbers of tests or units produced were not useful for projecting Integrated Materials Research Laboratory facility activities over an extended period of time. As an alternative approach, annual operational hours have been used to project facility throughput or activity. The following provides the basis for the assumptions used to derive the initial base year number of operational hours from which other projections were derived.

The 1996 and 1997 average annual number of Integrated Materials Research Laboratory personnel is estimated at 250. The broad categories of personnel include the following:

- Administrative (10 percent)
- Scientific and technical (86 percent)
- Facility and operational (4 percent)

Because administrative personnel generally support a broad range of program activities, their level of effort is considered to be steady throughout all the alternatives. The change in activity scenarios for the various alternatives depends more on changes in the level of effort of scientific, technical, and facility personnel. For that reason, the administrative personnel were subtracted from the total number of base year personnel. This resulted in a reduction in numbers of personnel by 10 percent or from 250 to a new adjusted total of 227 base year personnel.

The level of activity in the Integrated Materials Research Laboratory is expected to be constant through the next ten years. However, there may be a slight reduction in the number of personnel due to budget constraints. Therefore, the level of effort projected for the "reduced" alternative is slightly lower than the base year number. However, this reduction would only involve postdoctoral workers. Any reduction in the Integrated Materials Research Laboratory's core staff would imply a reduction in capabilities.

The Integrated Materials Research Laboratory operational work consists of 1,740 hours per year.

9.1.3 Assumptions and Rationale for the "No Action" Values

The base year number for operational hours was derived by multiplying the number of workers in the Integrated Materials Research Laboratory by the number of hours worked by one employee during a year (1,740 hours/employee/year x 227 employees = 395,454 hours/year). See "9.1.2 Assumptions and Actions for the 'Reduced' Values," for additional background on this calculation.

The projections under the 2003 and 2008 timeframes of the "no action" alternative assume no change in level of operations because no reductions are anticipated and because the facility is already operating at its maximum capability.

It is not realistic to consider multiple shifts because laboratory space is limited. When a scientist sets up an experiment, the space cannot be used for other purposes simultaneously. Portions of experiments are automated, with data collection performed on a continuous basis over certain periods of time. Typically in a research and development setting, equipment is used for a single purpose 24 hours per day. This eliminates the option of considering multiple shifts.

9.1.4 Assumptions and Actions for the "Expanded" Values

The level of activity in the Integrated Materials Research Laboratory is expected to be constant through the next ten years. Because the facility is currently working at its maximum capacity, no increase is anticipated.

It is not realistic to consider multiple shifts in a research and development setting because a laboratory that is set up for a particular experiment can't be used for multiple purposes simultaneously.

9.2 Material Inventories

9.2.1 Nuclear Material Inventory Scenario for Depleted Uranium

9.2.1.1 Alternatives for Depleted Uranium Nuclear Material Inventory

Table 10-5 shows the alternatives for the depleted uranium inventory at the Integrated Materials Research Laboratory.

Table 10-5. Alternatives for Depleted Uranium Nuclear Material Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 mCi	0.93 mCi	1.0 mCi	1.0 mCi	1.0 mCi

9.2.1.2 Operations That Require Depleted Uranium

Depleted uranium is used in remote sensing and calibration of uranium-using lasers. The depleted uranium consists of samples used for reference standards. The material is stored in Building 897, Room 3240.

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

If the project is reduced, there will be no depleted uranium in the Integrated Materials Research Laboratory. If the project is expanded, there is not a requirement for increased amounts of depleted uranium.

9.2.2 Radioactive Material Inventory Scenario for C-14

9.2.2.1 Alternatives for C-14 Radioactive Material Inventory

Table 10-6 shows the alternatives for the C-14 radioactive material inventory at the Integrated Materials Research Laboratory.

Table 10-6. Alternatives for C-14 Radioactive Material Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
220 µCi	220 µCi	220 µCi	220 µCi	220 µCi

9.2.2.2 Operations That Require C-14

This material is used in a microorganic residue analyzer that is used to determine the level of organic contamination on the surfaces of materials. This material is used in Building 897, Room 1280.

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

The users do not plan to increase or decrease the amount of C-14 used in the lab.

9.2.3 Sealed Source Inventory Scenarios

9.2.3.1 Sealed Source Inventory Scenario for Th-230

9.2.3.1.1 Alternatives for Th-230 Sealed Source Inventory

Table 10-7 shows the alternatives for the Th-230 sealed source inventory at the Integrated Materials Research Laboratory.

Table 10-7. Alternatives for Th-230 Sealed Source Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 µCi	1.0 µCi	1.0 µCi	1.0 µCi	1.0 µCi

9.2.3.1.2 Operations That Require Th-230

The material is used to calibrate an electron microprobe instrument.

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

A reduced scenario would be to eliminate the sealed source. The expanded scenario would not increase the number of sources.

9.2.3.2 Sealed Source Inventory Scenario for U-238

9.2.3.2.1 Alternatives for U-238 Sealed Source Inventory

Table 10-8 shows the alternatives for the U-238 sealed source inventory at the Integrated Materials Research and Development Laboratory.

Table 10-8. Alternatives for U-238 Sealed Source Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 µCi	4.6 µCi	4.6 µCi	4.6 µCi	4.6 µCi

9.2.3.2.2 Operations That Require U-238

The material is used to calibrate an electron microprobe instrument.

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

A reduced scenario would be to eliminate the sealed source. The expanded scenario would not increase the number of sources.

9.2.3.3 Sealed Source Inventory Scenario for Fe-55

9.2.3.3.1 Alternatives for Fe-55 Sealed Source Inventory

Table 10-9 shows the alternatives for the Fe-55 sealed source inventory at the Integrated Materials Research Laboratory.

Table 10-9. Alternatives for Fe-55 Sealed Source Inventory

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
0 µCi	102.75 µCi	102.75 µCi	102.75 µCi	102.75 µCi

9.2.3.3.2 Operations That Require Fe-55

The sealed sources are used for calibration of x-ray diffraction instruments in Building 897, Room 2206 and Building 897, Room 2300.

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

A reduced scenario would be to eliminate the sealed sources. The expanded scenario would not increase the number of sources.

9.2.4 Spent Fuel Inventory Scenarios

This facility has no spent fuel inventories.

9.2.5 Chemical Inventory Scenarios

9.2.5.1 Alternatives for Chemical Inventories

The list of chemicals provided in this section does not represent the comprehensive list of chemicals that are used at this facility. After reviewing a comprehensive list of chemicals that was derived from sources of information on corporate chemical inventories (for example, the SNL/NM Chemical Information System and procurement records), DOE and the contractor responsible for preparing the sitewide environmental impact statement selected “chemicals of concern,” which are those chemicals that are most likely to affect human health and the environment.

Table 10-10 shows the alternatives for chemical inventories at the Integrated Materials Research Laboratory.

Table 10-10. Alternatives for Chemical Inventories

Chemical	Reduced Alternative	No Action Alternative			Expanded Alternative
		Base Year	FY2003	FY2008	
1,1,1-trichloroethane	8.28 l	9 l	9 l	9 l	9 l
1,5-hexadiyne, 50 Wt. % solution in pentane	138 ml	150 ml	150 ml	150 ml	150 ml
10,000 ppm of hafnium in 5% hydrochloric acid	460 ml	500 ml	500 ml	500 ml	500 ml
1-allylimidazole	368 g	400 g	400 g	400 g	400 g
3-chloroprophyltriethoxysilane	23 g	25 g	25 g	25 g	25 g
4-vinylanisole	9.2 g	10 g	10 g	10 g	10 g
7-OCT--1-enyltrichlorosilane	92 g	100 g	100 g	100 g	100 g
Acetic acid, glacial	8,740 ml	9,500 ml	9,500 ml	9,500 ml	9,500 ml
Acetone	7907 l	86.6 l	36.6 l	86.6 l	86.6 l
Acetonitrile	7.36 l	8 l	8 l	8 l	8 l
Acetonitrile, anhydrous	368 ml	400 ml	400 ml	400 ml	400 ml
Acetyl chloride	.92 kg	1 kg	1 kg	1 kg	1 kg
Acrylonitrile	92 ml	100 ml	100 ml	100 ml	100 ml
Allyl bromide	460 g	500 g	500 g	500 g	500 g
Alumina	920 g	1,000 g	1,000 g	1,000 g	1,000 g
Ammonia	6.07 kg	6.6 kg	6.6 kg	6.6 kg	6.6 kg
Aniline	460 ml	500 ml	500 ml	500 ml	500 ml
BBN, 0.5M solution in tetrahydrofuran	736 ml	800 ml	800 ml	800 ml	800 ml
Benzene	46 ml	50 ml	50 ml	50 ml	50 ml
Benzene-D6	9.89 ml	10.75 ml	10.75 ml	10.75 ml	10.75 ml
Benzyl alcohol	460 ml	500 ml	500 ml	500 ml	500 ml
Bromine	1.01 kg	1.1 kg	1.1 kg	1.1 kg	1.1 kg
Bromoform	46 g	50 g	50 g	50 g	50 g
Buffer solutions Ph 9.0 to 11.0	23,000 ml	25,000 ml	25,000 ml	25,000 ml	25,000 ml
Buffered oxide ethc 7:1 FC93 KTI	1.84 gal	2gal	2 gal	2 gal	2 gal
Cesium trichlorogermanate	119.6 g	130 g	130 g	130 g	130 g
Chlorine	1.19 kg	1.3 kg	1.3 kg	1.3 kg	1.3 kg
Chlorodimethylvinylsilane	23 ml	25 ml	25 ml	25 ml	25 ml
Chloroform	9.2 l	10 l	10 l	10 l	10 l
Contrad 70	4.6 l	5 l	5 l	5 l	5 l
Custom Plasma Standard, lead in HNO3, PLPB	460 ml	500 ml	500 ml	500 ml	500 ml

Table 10-10. Alternatives for Chemical Inventories (Continued)

Chemical	Reduced Alternative	No Action Alternative			Expanded Alternative
		Base Year	FY2003	FY2008	
Custom Plasma Standard, magnesium in HNO	92 ml	100 ml	100 ml	100 ml	100 ml
Cyanamide	23 g	25 g	25 g	25 g	25 g
Cyclohexane-D12	2.76 g	3 g	3 g	3 g	3 g
Dibutyl phosphate	230 ml	250 ml	250 ml	250 ml	250 ml
Dichloromethylsilane	460 g	500 g	500 g	500 g	500 g
Dimethyl sulfoxide	920 ml	1,000 ml	1,000 ml	1,000 ml	1,000 ml
Dimethylamine	368 g	400 g	400 g	400 g	400 g
Diphenyldimethoxysilane	230 g	250 g	250 g	250 g	250 g
Di-tert-butyl-4-methylphenol, 2,6-	92 g	100 g	100 g	100 g	100 g
EPK 615 resin	54.464 oz	59.2 oz	59.2 oz	59.2 oz	59.2 oz
Ethanol denaturated with 5% methanol	4.6 gal	5 gal	5 gal	5 gal	5 gal
Ether, anhydrous, 99+%	0.92 l	1 l	1 l	1 l	1 l
Ethyl acetate	18.2 l	19.8 l	19.8 l	19.8 l	19.8 l
Ethyl acetate 99%	0.92 gal	1 gal	1 gal	1 gal	1 gal
Ethyl alcohol	3.68 l	4 l	4 l	4 l	4 l
Ethyl ether	25.76 l	28 l	28 l	28 l	28 l
Ethylene glycol	1.84 l	2 l	2 l	2 l	2 l
Fluorine	291 ft^3	317 ft^3	317 ft^3	317 ft^3	317 ft^3
Furan	1.2 kg	1.3 kg	1.3 kg	1.3 kg	1.3 kg
Heptane, 99%	7.36 l	8 l	8 l	8 l	8 l
Hexafluorobenzene	460 g	500 g	500 g	500 g	500 g
Hexanes	37.12 l	40.35 l	40.35 l	40.35 l	40.35 l
Hydrobromic acid	1.2 kg	1.3 kg	1.3 kg	1.3 kg	1.3 kg
Hydrochloric acid	1,380 ml	1,500 ml	1,500 ml	1,500 ml	1,500 ml
Hydrochloric acid	0.92 gal	1 gal	1 gal	1 gal	1 gal
Hydrochloric acid solutions, concentrates	460 ml	500 ml	500 ml	500 ml	500 ml
Hydrofluoric acid 15:1 DIL 4X1	0.92 gal	1 gal	1 gal	1 gal	1 gal
Hydrofluoric acid solutions	460 ml	500 ml	500 ml	500 ml	500 ml
Hydrogen chloride (gas)	1.7388 lb	1.89 lb	1.89 lb	1.89 lb	1.89 lb
Hydrogen chloride, 4.0M solution in 1	92 ml	100 ml	100 ml	100 ml	100 ml
Hydrogen peroxide	0.92 gal	1 gal	1 gal	1 gal	1 gal
Hydrogen peroxide 30%	460 ml	500 ml	500 ml	500 ml	500 ml
Hydroxymethyltriethoxysilane	23 g	25 g	25 g	25 g	25 g
Isopropanol	7.2 l	7.8 l	7.8 l	7.8 l	7.8 l
Kerosene	0.92 gal	1 gal	1 gal	1 gal	1 gal
Kodak D-19 developer	12,590.2 g	13,685 g	13,685 g	13,685 g	13,685 g
Kodak indicator stop bath	7 gal	11.7 gal	11.7 gal	11.7 gal	11.7 gal
Kodak rapid fixer - part A	34 gal	37 gal	37 gal	37 gal	37 gal
Kodak Royalprint activator	18.3 gal	20.5 gal	20.5 gal	20.5 gal	20.5 gal

Table 10-10. Alternatives for Chemical Inventories (Continued)

Chemical	Reduced Alternative	No Action Alternative			Expanded Alternative
		Base Year	FY2003	FY2008	
Kodak Royalprint fixer and replenisher	48 gal	52.1 gal	52.1 gal	52.1 gal	52.1 gal
Luterium nitride	0.46 g	.5 g	.5 g	.5 g	.5 g
M-Aminobenaldehyde	110.4 g	120 g	120 g	120 g	120 g
Methacrylonitrile	92 ml	100 ml	100 ml	100 ml	100 ml
Methacryloyl chloride	184 g	200 g	200 g	200 g	200 g
Methyl alcohol	36.4 l	39.5 l	39.5 l	39.5 l	39.5 l
Methyl iodide	460 g	500 g	500 g	500 g	500 g
Methyl sulfoxide-D6	23 g	25 g	25 g	25 g	25 g
Methylamine	2.85 kg	3.1 kg	3.1 kg	3.1 kg	3.1 kg
Methyldiethoxysilane	92 g	100 g	100 g	100 g	100 g
Methylene chloride	29.44 l	32 l	32 l	32 l	32 l
Methyltrichlorosilane	1044 g	1135 g	1135 g	1135 g	1135 g
M-nitrobenzaldehyde	460 g	500 g	500 g	500 g	500 g
Molecular sieves	920 g	1,000 g	1,000 g	1,000 g	1,000 g
N-2-aminoethyl-3-aminoproyltrimethoxsilane	92 g	100 g	100 g	100 g	100 g
N-butyltrimethoxysilane	92 ml	100 ml	100 ml	100 ml	100 ml
N-decyldimethylchlorosilane	23 g	25 g	25 g	25 g	25 g
N-dodecyl triethoxy silane	23 g	25 g	25 g	25 g	25 g
N-heptylpentaoxyethylene	23 g	25 g	25 g	25 g	25 g
Nitric acid	25.2 kg	27.4 kg	27.4 kg	27.4 kg	27.4 kg
Nitric oxide	.09 kg	.1 kg	.1 kg	.1 kg	.1 kg
N-phenyl-DI-P-tolyamine	23 g	25 g	25 g	25 g	25 g
N-propyltrimethoxysilane	460 ml	500 ml	500 ml	500 ml	500 ml
N-triethoxsilypropyl urea, 50% in methanol	92 ml	100 ml	100 ml	100 ml	100 ml
N-trimethoxysilylpropyl-N,N,N-trimethylammonium	368 ml	400 ml	400 ml	400 ml	400 ml
N-trimethoxysilylpropyltributyl-ammonium bromide	9.2 ml	10 ml	10 ml	10 ml	10 ml
Oxalic acid	3.68 kg	4 kg	4 kg	4 kg	4 kg
Pentane	1.84 l	2 l	2 l	2 l	2 l
Pentane, anhydrous, 99+%	0.92 l	1 l	1 l	1 l	1 l
Peracetic acid, 32 Wt. % solution in dilute A	92 ml	100 ml	100 ml	100 ml	100 ml
Phenol	92 g	100 g	100 g	100 g	100 g
Picric acid	9.2 g	10 g	10 g	10 g	10 g
Pinacolone	92 ml	100 ml	100 ml	100 ml	100 ml
Pinacolone-96%	92 g	100 g	100 g	100 g	100 g
Poly (vinyl propinate)	9.2 g	10 g	10 g	10 g	10 g
Polyacrylamide	690 mg	750 mg	750 mg	750 mg	750 mg
Polymethylsilsesquioxane	92 g	100 g	100 g	100 g	100 g
Polystyrene	736 mg	800 mg	800 mg	800 mg	800 mg
Potassium ethoxide	46 g	50 g	50 g	50 g	50 g

Table 10-10. Alternatives for Chemical Inventories (Continued)

Chemical	Reduced Alternative	No Action Alternative			Expanded Alternative
		Base Year	FY2003	FY2008	
Potassium hydroxide (dry solid, flake, bead)	7.36 lb	8 lb	8 lb	8 lb	8 lb
Propanol, 1-	340.4 l	37 l	37 l	37 l	37 l
Propanol, 2-	84 l	91 l	91 l	91 l	91 l
PS9120	0.92 l	1 l	1 l	1 l	1 l
P-xylene	3.68 l	4 l	4 l	4 l	4 l
Pyrolidine	92 ml	100 ml	100 ml	100 ml	100 ml
Samium oxide	497 g	459 g	459 g	459 g	459 g
Silicon (IV) chloride	184 ml	200 ml	200 ml	200 ml	200 ml
Sodium hydroxide, dry solid, flake, bead	460 g	500 g	500 g	500 g	500 g
Sodium methyl siliconate	1.84 l	2 l	2 l	2 l	2 l
SPI #4998/4999 flash dry silver paint	27.6 g	30 g	30 g	30 g	30 g
Sulfuric acid	460 ml	500 ml	500 ml	500 ml	500 ml
Sulfuric acid or low particulate grade	0.92 gal	1 gal	1 gal	1 gal	1 gal
Sulfuryl chloride	0.92 kg	1 kg	1 kg	1 kg	1 kg
T-butyllithium 1.7M in hexanes	184 ml	200 ml	200 ml	200 ml	200 ml
Tetraethoxysilane	92 g	100 g	100 g	100 g	100 g
Tetrahydrofuran	7.36 l	8 l	8 l	8 l	8 l
Tetrahydrofuran	1.2 gal	1.26 gal	4 gal	4 gal	4 gal
Tetramethoxysilane	23 g	25 g	25 g	25 g	25 g
Tetramethyl orthosilicate	184 g	200 g	200 g	200 g	200 g
Thionyl chloride	94.4 l	3.621 l	3.621 l	3.621 l	3.621 l
Thiophene	460 g	500 g	500 g	500 g	500 g
Toluene	0.92 gal	1 gal	1 gal	1 gal	1 gal
Trans-1,4-dichloro-2-butene	46 g	50 g	50 g	50 g	50 g
Trichloroethylene	10.86 l	11.8 l	11.8 l	11.8 l	11.8 l
Triethoxysilane	460 ml	500 ml	500 ml	500 ml	500 ml
Trifluoroacetic acid	460 g	500 g	500 g	500 g	500 g
Trimethyl borate 99%	460 g	500 g	500 g	500 g	500 g
Trimethyl borate 99.9999%	92 g	100 g	100 g	100 g	100 g
Tungstic acid	3.68 lb	4 lb	4 lb	4 lb	4 lb
Zirconium (IV) butoxide	276 ml	300 ml	300 ml	300 ml	300 ml

9.2.5.2 Operations That Require Chemical Inventories

The programs and operations that utilize these chemicals are described in detail in “3.0 DESCRIPTION,” “4.0 PROGRAM ACTIVITIES,” and “5.0 OPERATIONS AND CAPABILITIES.”

9.2.5.3 Basis for Projecting the Values in the "No Action" Columns

Baseline values for the chemicals listed in Table 10-10 were obtained from the SNL Chemical Information System. In most cases, the values for the "no action," "reduced," and "expanded" alternatives were derived by adjusting the base year information in proportion to the changes in activity levels provided in "9.1 Activity Scenario for Research and Development of Material." However, where facility managers used process knowledge to estimate chemical applications, this more specific information was used instead.

Projections for highly toxic chemicals or those used in large quantity may have deviated from this methodology and used estimated values if deemed appropriate by the selected facility representatives.

9.2.5.4 Basis for Projecting the Values in the "Reduced" Column

Baseline values for the chemicals listed in Table 10-10 were obtained from the SNL Chemical Information System. In most cases, the values for the "no action," "reduced," and "expanded" alternatives were derived by adjusting the base year information in proportion to the changes in activity levels provided in "9.1 Activity Scenario for Research and Development of Material." However, where facility managers used process knowledge to estimate chemical applications, this more specific information was used instead.

Projections for highly toxic chemicals or those used in large quantity may have deviated from this methodology and used estimated values if deemed appropriate by the facility representatives.

9.2.5.5 Basis for Projecting the Values in the "Expanded" Column

Baseline values for the chemicals listed in Table 10-10 were obtained from the SNL Chemical Information System. In most cases, the values for the "no action," "reduced," and "expanded" alternatives were derived by adjusting the base year information in proportion to the changes in activity levels provided in "9.1 Activity Scenario for Research and Development of Material." However, where facility managers used process knowledge to estimate chemical applications, this more specific information was used instead.

Projections for highly toxic chemicals or those used in large quantity may have deviated from this methodology and used estimated values if deemed appropriate by the facility representatives.

9.2.6 Explosives Inventory Scenarios

This facility has no explosives inventories.

9.2.7 Other Hazardous Material Inventory Scenarios

This 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.

9.3 Material Consumption

9.3.1 Nuclear Material Consumption Scenarios

Nuclear material is not consumed at this facility.

9.3.2 Radioactive Material Consumption Scenarios

Radioactive material is not consumed at this facility.

9.3.3 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.

9.3.4 Explosives Consumption Scenarios

Explosives are not consumed at this facility.

9.4 Waste

9.4.1 Low-Level Radioactive Waste Scenario

Low-level radioactive waste is not produced at this facility.

9.4.2 Transuranic Waste Scenario

Transuranic waste is not produced at this facility.

9.4.3 Mixed Waste

9.4.3.1 Low-Level Mixed Waste Scenario

Low-level mixed waste is not produced at this facility.

9.4.3.2 Transuranic Mixed Waste Scenario

Transuranic mixed waste is not produced at this facility.

9.4.4 Hazardous Waste Scenario

9.4.4.1 Alternatives for Hazardous Waste at the Integrated Materials Research Laboratory

Table 10-11 shows the alternatives for hazardous waste at the Integrated Materials Research Laboratory.

Table 10-11. Alternatives for Hazardous Waste

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
2,000 kg	2,400 kg	2,100 kg	1,850 kg	2,000 kg

9.4.4.2 Operations That Generate Hazardous Waste

The research and development activities in the laboratories in the Integrated Materials Research Laboratory produce chemical waste.

9.4.4.3 General Nature of Waste

The waste is in the form of liquid and solid chemical waste, which is generated in small quantities in each lab and packaged for pickup and disposal per SNL requirements.

9.4.4.4 Waste Reduction Measures

Personnel in the Integrated Materials Research Laboratory are mindful of the need to reduce the amounts of chemical waste as much as reasonably practical. Waste reduction activities include solvent substitution, use of minimally required chemicals to perform the operation, use of less hazardous chemicals if possible, and reuse of chemicals.

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

There will continue to be emphasis on waste reduction in the Integrated Materials Research Laboratory. This will enable a reduction in the levels of chemical waste through the next decade. The reductions for both the "reduced" and "expanded" alternatives are based on waste reduction goals of 2.5 percent per year.

9.5 Emissions

9.5.1 Radioactive Air Emissions Scenarios

Radioactive air emissions are not produced at this facility.

9.5.2 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.

9.5.3 Open Burning Scenarios

This facility does not have outdoor burning operations.

9.5.4 Process Wastewater Effluent Scenario

This facility does not generate process wastewater.

9.6 Resource Consumption

9.6.1 Process Water Consumption Scenario

This facility does not consume process water.

9.6.2 Process Electricity Consumption Scenario

This facility does not consume process electricity.

9.6.3 Boiler Energy Consumption Scenario

This facility does not consume energy for boilers.

9.6.4 Facility Personnel Scenario

9.6.4.1 Alternatives for Facility Staffing at the Integrated Materials Research Laboratory

Table 10-12 shows the alternatives for facility staffing at the Integrated Materials Research Laboratory.

Table 10-12. Alternatives for Facility Staffing

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
230 FTEs	250 FTEs	250 FTEs	250 FTEs	250 FTEs

9.6.4.2 Operations That Require Facility Personnel

Scientists, engineers, and technicians who perform the research and development activities in the labs staff the Integrated Materials Research Laboratory. Support personnel, including secretaries, managers, computer technicians, and tradesmen, also work in the building.

9.6.4.3 Staffing Reduction Measures

No personnel reduction measures exist.

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

The Integrated Materials Research Laboratory will be staffed at the current level for the next ten years. There is no likelihood of increased numbers of personnel because the available office and lab space is fully utilized. There may only be a small change in the number of personnel in the "reduced" mode.

9.6.5 Expenditures Scenario

9.6.5.1 Alternatives for Expenditures at the Integrated Materials Research Laboratory

Table 10-13 shows the alternatives for expenditures at the Integrated Materials Research Laboratory.

Table 10-13. Alternatives for Expenditures

Reduced Alternative	No Action Alternative			Expanded Alternative
	Base Year	FY2003	FY2008	
$48 million	$45 million	$55 million	$60 million	$62 million

9.6.5.2 Operations That Require Expenditures

The labs in the Integrated Materials Research Laboratory require the expenditures in order to perform the research and development activities. These numbers represent total expenditures, which include salaries.

Salaries for regular employees represent approximately 73 percent of total expenditures. Salaries for regular employees, contractors, and postdoctoral workers represent approximately 80 percent of total expenditures.

9.6.5.3 Expenditure Reduction Measures

No reduction measures exist.

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

The values for the "reduced" and "expanded" columns are based on possible variations in the expected funding levels for the various program sources.

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