EIS

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Subject: LANSCE NEPA document

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Kirk, attached is the LANSCE NEPA Determination Document updates.

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Title: ESH-20 NEPA Determination Document 11
Los Alamos Neutron Science Center (LANSCE)

Los Alamos
NATIONAL LABORATORY

Table of Contents

Tables

Figures

1.0 Introduction

This document describes the *National Environmental Policy Act of 1969* (NEPA) operational envelope for operations, capabilities, and parameters analyzed for Los Alamos Neutron Science Center (LANSCE), a key facility in the *Site-Wide Environmental Impact Statement for the Continued Operation of Los Alamos National Laboratory* (SWEIS; DOE 1999a). The principal buildings and structures for this key facility are shown in Table 1. The purpose of this document is to determine whether a proposed project for this facility has NEPA coverage in the SWEIS as implemented by the Department of Energy (DOE) in the Record of Decision (ROD) for the SWEIS. As long as LANSCE operates within the bounds of the impacts projected by the SWEIS, the facilities are in compliance with NEPA. If there is potential to exceed projected impacts, further NEPA review would be required.

Table 1. Principal Buildings and Structures of the Los Alamos Neutron Science Center

Technical Area	Principal Buildings and Structures
TA-53	Linear Accelerator Injector: 53-003J Proton Beam Linear Accelerator: 53-003A through H Linear Accelerator Switchyard: 53-0038 Accelerator Control Room: 53-004 LEDA Building: 53-365 (Stand alone experimental area) Experimental Area A: 53-003M Experimental Area B: 53-003N Experimental Area C: 53-003P Proton Storage Ring: 53-008 Proton Storage Ring Equipment: 53-028 Manuel Lujan Center Target, ER-1, Weapons Neutron Research Target #2: 53-007 40-Meter Experiment Station: 53-029 Manuel Lujan Center ER-2: 53-030 Weapons Neutron Research Target #4: 53-369 Detector Development Laboratory: 53-010 Accelerator Technology Laboratory (High-Powered Microwave and Advanced Accelerator: 53-014 Weapons Neutron Research Support Laboratory: 53-015 Pulsed-Power and Structures Laboratories: 53-017 High-Powered Microwave, Injector, and RF Laboratories: 53-018 Accelerator Technology Laboratory: 53-019 LANSCE Office Building: 53-001 Equipment Maintenance and Test Shop: 53-002 “Orange Box” Office Building: 53-006 Office Building: 53-024 Office Building: 53-031 Manual Lujan Center Office Building: 53-622 Isotope Production Facility: 53-984

Under the Laboratory Implementation Requirement (LIR) entitled “NEPA, Cultural Resources, and Biological Resources (NCB) Process,” (LANL 2000a) proposed projects are screened by the authorized facility NCB reviewer as part of the NCB assessment. The screening requires the facility NCB reviewer to decide

- if the project is new or modified from a previous determination and
- if DOE has already made a determination that covers the proposed project.

The Facility NCB Reviewer uses the Facility NEPA Determination Document (LANL 2000b) for screening. Table 2 summarizes the capabilities, and the operations examples for the capabilities, that were published in the SWEIS to estimate the impacts. If the facility NCB reviewer finds that the proposed activity is one of the capabilities in the SWEIS and is within one of the operations examples for that capability as shown by Table 2, the reviewer could determine that the proposed activity is covered by the SWEIS and does not require further NEPA analysis.

Table 2. Los Alamos Neutron Science Center[a]

Capability	Operations Levels[b]
1. Accelerator Beam Delivery, Maintenance and Development	1.1 Deliver LANSCE linac beam to Areas A, B, C, WNR facility, Manuel Lujan Center, Dynamic Experiment Facility, and new isotope production facility for 10 months/year (6400 hours). Positive ion current 1250 microampere and negative ion current of 200 microampere. 1.2 Reconfigure beam delivery and support equipment to support new facilities, upgrades and experiments [b]
2. Experimental Area Support	2.1 Full-time remote handling and radioactive waste disposal capability required during Area A interior modifications and Area A-East renovation. 2.2 Support of experiments, facility upgrades, and modifications 2.3 Increased power demand for LANSCE linac
3. Neutron Research and Technology [c]	3.1 Conduct 1000 to 2000 experiments/year using Manuel Lujan Center, WNR facility, and LPSS. Establish LPSS in Area A (requires modification). 3.2 Support contained weapons-related experiments: • With small quantities of actinides, high explosives, and sources (up to approximately 80/yr. • With nonhazardous materials and small quantities of high explosives (up to approximately 200/yr.) • With up to 4.5 kg high explosives and/or depleted uranium (up to approximately 60/yr). • Shock wave experiments involving small amounts, up to (nominally) 50 grams plutonium. 3.3 Provide support for static stockpile surveillance technology research and development.
4. Accelerator Transmutation of Wastes (ATW)[d]	4.1 Conduct lead target tests for two years at Area A beam stop 4.2 Implement LIFT (establish one-megawatt, then five megawatt ATW target/blanket experiment areas) adjacent to Area A. 4.3 Conduct five-megawatt experiments for 10 mon./yr for four yrs using about 3 kg of actinides. 4.4 Support materials science and research for the certification of nuclear fuels and transmutation of high-level radioactive waste.
5. Subatomic Physics Research	5.1 Conduct 5 to 10 physics experiments/yr at Manuel Lujan Center, WNR facility, and LPSS. 5.2 Conduct proton radiography experiments, including contained experiments with high explosives: • With up to 100 experiments/yr • With dynamic experiments in containment vessels limited to 10 lbs of high explosives, and 100 lbs of depleted uranium • With dynamic experiments in powder launcher to 300g of Class 1.3 explosives (gun powder) 5.3 Conduct research using ultracold neutrons: • Operate up to 10 microampere/yr of negative beam current
6. Medical Isotope Production	6.1 Irradiate up to approximately 100 targets/yr for medical isotope production.

	6.2 Added production of exotic, neutron-rich, and neutron-deficient isotopes (requires modification of an existing target area).

Table 2 cont.

7. High-Power Microwaves and Advanced Accelerators	7.1 Conduct research and development in these areas, including microwave chemistry research for industrial and environmental applications.

a: Source: Modified from SWEIS 1998 Yearbook (LANL 1999).
b: Includes the completion of proton and neutron radiography facilities, the LEDA, the isotope production facility relocation, the Short-Pulsed Spallation Source enhancement, and the LPSS.
c: Numbers of neutron experiments represent plausible levels of activity. Bounding conditions for the consequences of operations are primarily determined by i) length and power of beam operation, and ii) maintenance and construction activities.
d: Formerly, Accelerator-Driven Transmutation Technology.

However, a proposal that does not match a capability description in Table 2 or that is not included with one of the operations examples for that capability in Table 2 could still be covered by the SWEIS. The SWEIS analysis is based on information in background documents prepared for each of the key facilities; these background documents provide more detailed descriptions of the ongoing and potential operations for each key facility. In addition, the levels of activity called the “operations examples” for each of the capabilities reflects scenarios that were developed for each capability to provide an estimate for calculating potential impacts. The SWEIS was not intended to set stringent limits on the level of activity for a particular capability. In most facilities the operations examples for every capability would not be reached at one time because of the ebb-and-flow-like nature of the work at LANL. Thus it would be possible to exceed the operations examples for one capability and still be within the parameter limits for the facility or the LANL operations limit. If the proposal reviewer can demonstrate this, the proposal would still have NEPA coverage through the SWEIS. This document presents the procedure for a more detailed review and supporting information from the SWEIS and background documents.

2.0 Procedure

A proposed project can be screened by the Facility NCB reviewer or ESH-20 reviewer to determine if it is included in the descriptions in Table 2. Under that procedure, if a proposal does not clearly fit those descriptions of capabilities and operations examples, it will be referred to ESH-20 for review under this procedure, which requires more familiarity with SWEIS supporting documentation and projected additive impacts of other proposed work at LANL. The ESH-20 reviewer will use the data on LANSCE facilities and capabilities from the SWEIS document and the background documentation. The supporting documentation on the LANSCE facilities and capabilities is presented in Sections 3 and 4 below.

A flow chart that summarizes the procedure for the ESH-20 reviewer to use in screening a proposal is presented in Attachment 1. Upon receiving a proposal, the reviewer should answer the following:

1. Is this a new capability? Review the detailed descriptions of the LANSCE facilities and capabilities from the SWEIS (Section 3 of this document) and from the background documents (Section 4 of this document).
   a. If this is a new capability, go to 4.
   b. If this is not a new capability, go to 2.

2. Does the proposal fit within one of the operations levels for that capability in the SWEIS? Compare description to second column of Table 2.
   a. If the proposal is within the operations levels for that capability, go to 5.
   b. If the proposal is not within the operations examples, go to 3.
3. Is the proposal within the facility operations data envelope? Work with the facility manager and other Environment, Safety, and Health subject matter experts (SMEs) to calculate if the proposal is within the envelope of facility operations data (Table 3).
   a. If the proposal is within the facility operations data envelope, go to 5.
   b. If the proposal is not within the facility operations data envelope, go to 4.
4. ESH-20 will prepare a NERF to complete the NEPA process.
5. Proposal is covered by the SWEIS. Attach explanation/calculations to NCB Screening Checklist (Attachment 2) to complete the NEPA process.

Table 3. Los Alamos Neutron Science Center Data

Parameter	Units [a]	SWEIS ROD
Radioactive Air Emissions:		
Argon-41	Ci/yr	17.44×10^{1}
Arsenic –73	Ci/yr	Not Projected [c]
Beryllium-7	Ci/yr	Not Projected
Bromine-76	Ci/yr	Not Projected
Bromine-77	Ci/yr	Not Projected
Bromine-82	Ci/yr	Not Projected
Carbon-10	Ci/yr	2.65×10^{0}
Carbon-11	Ci/yr	2.96×10^{3}
Chlorine-39	Ci/yr	Not Projected
Mercury-197	Ci/yr	Not Projected
Nitrogen-13	Ci/yr	5.35×10^{2}
Nitrogen-16	Ci/yr	2.85×10^{-2}
Oxygen-14	Ci/yr	6.61×10^{0}
Oxygen-15	Ci/yr	6.06×10^{2}
Potassium-40	Ci/yr	Not Projected
Sancium-44M	Ci/yr	Not Projected
Sodium-24	Ci/yr	Not Projected
Tritium as Water	Ci/yr	Not Projected
Vanadium-48	Ci/yr	Not Projected
NPDES Discharges:[b]		
Total Discharges	MGY	81.8
03A-047	MGY	7.1
03A-048	MGY	23.4
03A-049	MGY	11.3
03A-113	MGY	39.8

Table 3 cont.

Wastes:		
Chemical	kg/yr	16,600
Low-level waste	m^3/yr	1085 [e]
Mixed low-level waste	m^3/yr	1

TRU waste/Mixed transuranic waste	m^3/yr	0
Utilities Electric Power Electricity Water	 Megawatts Gigawatt-hours MGY	 63 437 265

a: Ci/yr = curies per year; MGY = million gallons per year.
b: NPDES is National Pollutant Discharge Elimination System.
c: The SWEIS ROD did not contain projections for these radioisotopes.
d: This outfall was not listed in the SWEIS.
e: LLW volumes include decommissioning and renovation of Experimental A (Building 53-03M) due to the LPSS project

3.0 SWEIS Data for LANSCE

This section provides information directly from the SWEIS. Section 3.1 is a description of the LANSCE facilities from Chapter 2 of the SWEIS. Section 3.2 is a description of the capabilities at TA-55 at the time the SWEIS was written, while Section 3.3 is a description of the capabilities under the preferred alternative as selected under the Record of Decision.

3.1 SWEIS Description of LANSCE Facilities

LANSCE is the name applied to a group of facilities located at TA-53 (Figures 1-3). Initial construction of the original facility (then called the Los Alamos Meson Physics Facility or LAMPF) was completed in 1970, and it remains one of the highest powered and largest research accelerators in the world. The LANSCE facility is located on a 750-acre (303-hectare) mesa top area, contains approximately 400 buildings and other structures, and houses about 700 personnel. The number of personnel can increase by several hundred when the accelerator is in operation, as additional scientists are on site to monitor and participate in experiments. LANSCE is LANL's major accelerator research and development complex. The facility produces intense proton beams and sources of pulsed spallation neutrons for neutron research and applications. The facility is composed of a high-power 800-million electron volt proton linear accelerator (linac), a proton storage ring (PSR), production targets at the Manuel Lujan Neutron Scattering Center (Manuel Lujan Center), and the Weapons Neutron Research (WNR) facility, and a variety of associated experiment areas and spectrometers. This facility uses particle beams to conduct basic and applied research in the areas of condensed matter science, materials science, nuclear physics, particle physics, nuclear chemistry, atomic physics, and defense-related experiments. LANSCE also produces medical radioisotopes. As a National User Facility for research in condensed matter sciences, LANSCE hosts scientists from universities, industry, LANL, and other research facilities from around the world.

LANSCE has 375 administrative, technical, physical support, and other buildings and structures assigned a no hazard classification. LANSCE also has 27 low hazard facilities. Twenty-one of these are classified as low hazard because of their radionuclide inventory and five due to potentially hazardous energy sources. LANSCE also contains one Hazard Category 3 nuclear facility, the isotope production facility within Building 53–003M.

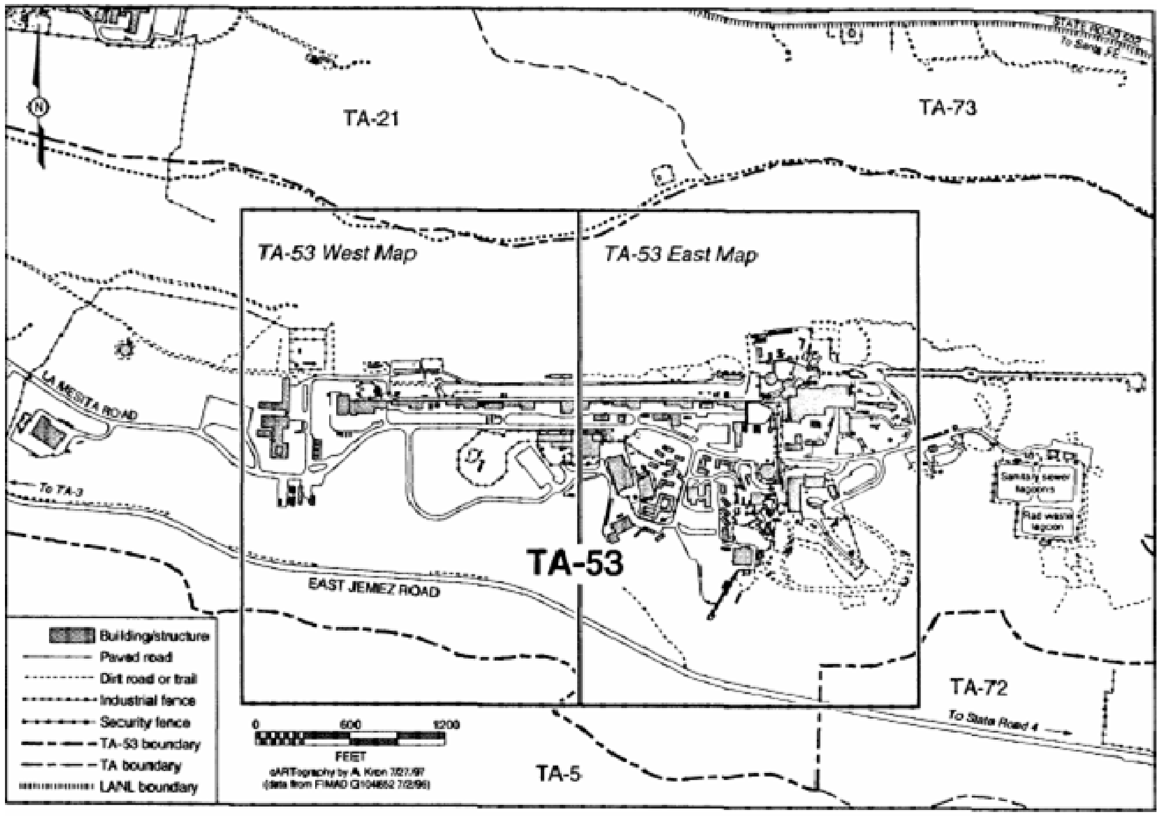

Figure 1. LANSCE is Located at TA-53

LANSCE accounts for more than 90 percent of all radioactive air emissions from LANL. These emissions come predominantly (greater than 95 percent) from stack ES–3, which ventilates Building 53–003, the linear accelerator and adjacent experimental stations. Additional emissions come from stack ES–2, which exhausts the PSR and experimental stations at the Manuel Lujan Center and WNR buildings. Both ES–2 and ES–3 are equipped with continuous monitoring equipment.

TA-53 contains four NPDES-permitted and NPDES-monitored outfalls. All of these outfalls discharge cooling tower blowdown. Three of the outfalls discharge into Los Alamos Canyon. The three remaining outfalls discharge into Sandia Canyon, one of which is slated for outfall reduction as part of LANL's Outfall Reduction Program. Effluent from two of the outfalls and from a former outfall has created three wetland areas in TA-53.

Low-level radioactive liquid wastes produced at LANSCE are collected and allowed to decay in three process tanks, located in 53-945, prior to discharge to two lined evaporative basins. Two unlined wastewater lagoons (no longer used) collected sanitary wastes prior to construction of the sanitary waste treatment facility at TA-46. Traces of both radioactive and hazardous wastes were discovered in the sludges in these lagoons, and they were remediated under a formal closure plan per RCRA requirements. Notification of final approval of closure has been pending with the State regulatory agency since 2003 Radioactive solid wastes such as beam line components and scrap metals, papers, and plastics are also produced at LANSCE. Small quantities of hazardous and toxic wastes such as liquid solvents, solvents on wipes, lead, and solder are produced from accelerator maintenance and development. Support activities at TA-53 provide for facility and plant operating and engineering services,

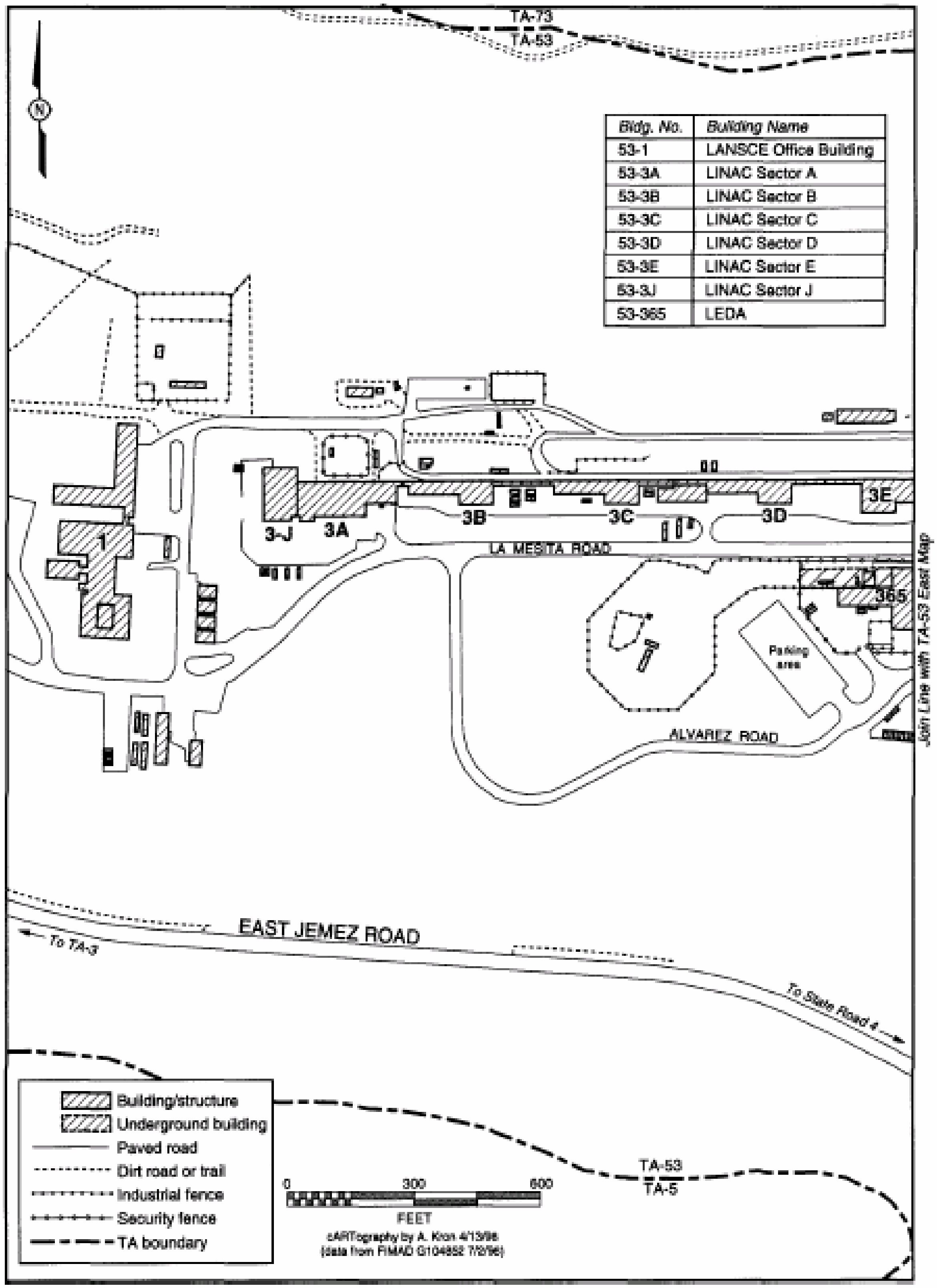

Figure 2. TA-53 Los Alamos Neutron Science Center West

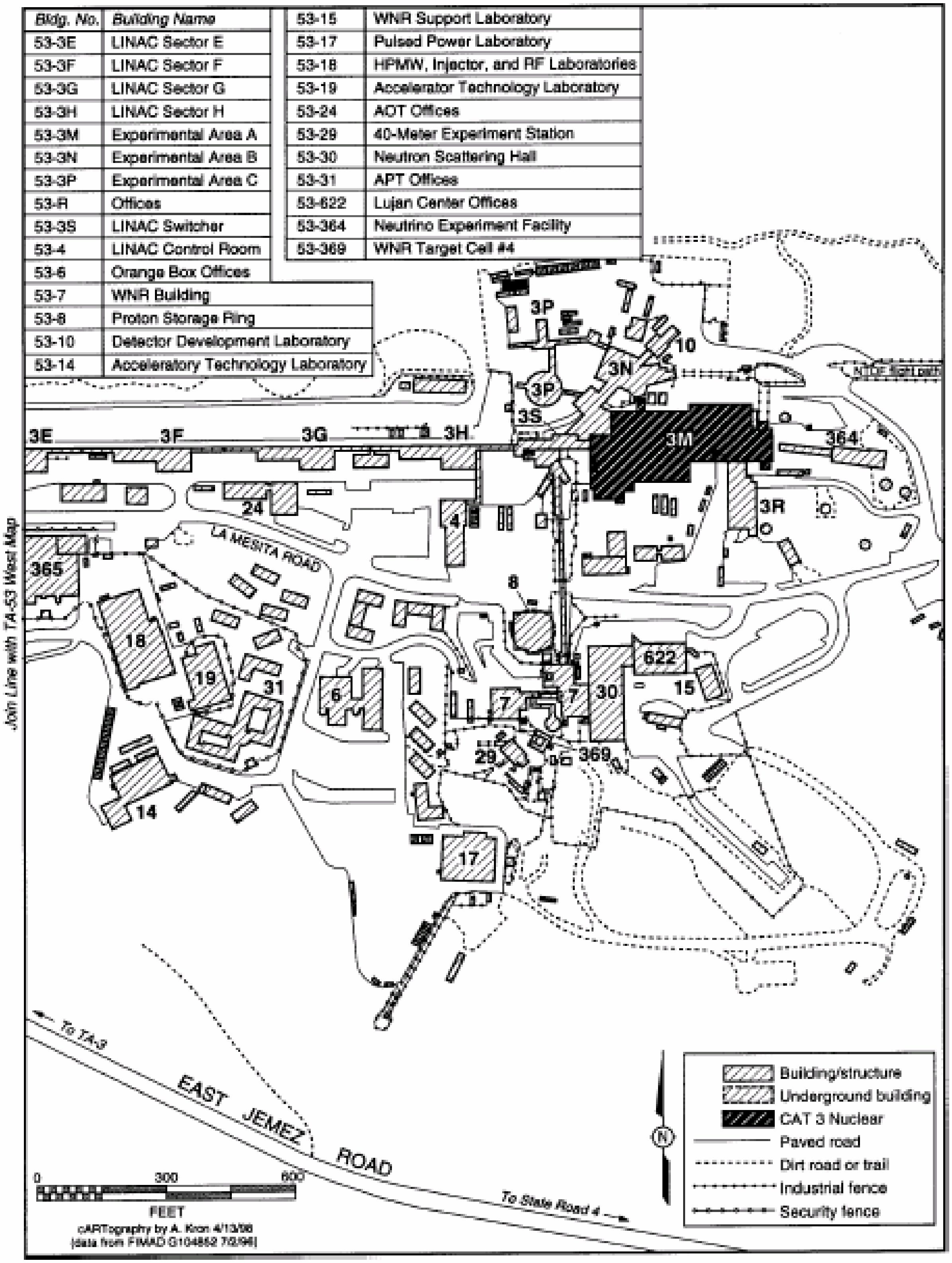

Figure 3. TA-53 Los Alamos Neutron Science Center East.

environment, safety, and health services and oversight, site and building physical security, visitor control, and facility specific training.

The heart of TA-53 is the linear accelerator, or linac, itself, Building 53–003. It is more than 0.5 mile (0.8 kilometer) in length, and has 316,000 square feet (29,390 square meters) of floor space. The building contains equipment to form hydrogen ion beams (protons and negative hydrogen ions), and to accelerate them to 84 percent of the speed of light. Ancillary equipment is used to transport the ion beams, maintain vacuum conditions in the beam transport system, and provide ventilation and cooling. Creating and directing the ion beam requires large amounts of power; much of it ultimately removed as excess heat. The beam tunnel itself is located 35 feet (11 meters) below grade (i.e., below the ground) to provide radiation protection. Above surface structures house radio frequency power sources used to accelerate the beam.

In the linear accelerator, an 800-million electron volt proton beam is generated in three stages. The linear accelerator has the capability to simultaneously accelerate both H^+ and H^- ion beams. In the first stage, three injectors (Building 53–003J) generate ionized H^+ or H^- beams, which are accelerated to 4 percent of the speed of light (corresponding to an energy level of 0.75 million electron volts).

The second stage (Building 53–003A) consists of a 203-foot (62-meter) series of drift-tube linear accelerator sections. By alternately exposing the proton ion beam to, and shielding it from, an externally generated electromagnetic field, ions are accelerated and exit this second stage at 43 percent of the speed of light (corresponding to an energy level of 100 million electron volts).

The third stage (Buildings 53–003B through 53–003H) consists of a 2,400-foot (731-meter) long side-coupled cavity accelerator. Ions exit at 84 percent of the speed of light with an energy level of 800 million electron volt (Allred and Talley 1987, pp. 10-13).

The ion beam then enters a switchyard (Building 53–003S), where the H + and H –beams are split and directed to Experimental Areas A, B, C, WNR Building, and/or the PSR. The PSR converts the negatively charged beam into short (250 nanoseconds) intense pulses of protons. These pulses are delivered to the Manuel Lujan Center neutron production target at a rate of 20 per second.

3.2 SWEIS Description of LANSCE Capabilities (Baseline)

The major categories of LANSCE activities are described below. The manner in which these activities would vary under the Preferred Alternative is described in Section 3.3.

3.2.1 Accelerator Beam Delivery, Maintenance, and Development

Generation and delivery of the proton ion beams requires significant development and maintenance capabilities for all components of the 800-million electron volt accelerator, including the ion sources and injectors, the mechanical systems in the accelerator (including cooling water), all systems for the PSR and its associated transfer lines, and beam diagnostics in the accelerator and transfer lines. Beam development activities include beam dynamics studies, and design and implementation of new capabilities. This activity requires the coordination of many disciplines, including accelerator physics, high-voltage and pulsed-power engineering, mechanical engineering, materials science, radiation shielding design, digital and analog electronics, high vacuum technology, mechanical and electronics design, mechanical alignment, hydrogen furnace brazing, machining, and mechanical fabrication. These activities take place throughout Building 53-003 (800-million electron volt accelerator), and in Buildings 53-008/028 (PSR), 53-365 (LEDA), 53-002 (equipment maintenance and test shop), and Line D (Manuel Lujan Center and WNR).

The short-pulse spallation source enhancement will result in higher neutron flux and greater beam availability from experimenters in WNR and the Manuel Lujan Center. (This project was categorically excluded from further NEPA review.) The upgrade would enhance the existing H^+ beam and the PRS to operate at 200 microamps and 30 hertz (versus the current 70 microamps at 20 hertz) and will add from five to seven new neutron-scattering instruments to the Manuel Lujan Center. All modifications will occur within existing buildings.

3.2.2 Experimental Area Support

Experiments using proton and neutron beams are conducted by personnel from the LANSCE and Physics Divisions, other LANL organizations, and other users such as scientists from universities, other laboratories, and the international scientific community. These beam users require support from TA–53 personnel, whether preparing for, performing, or closing out their experiments. This support capability focuses on the maintenance, improvement, and operational readiness of the high intensity beam line (Line A) and associated secondary beam lines and experimental areas at LANSCE. This requires the specification, engineering, and design utilizing computer-aided design (CAD), fabrication (often using computer-aided manufacturing), installation, and checkout and maintenance of various beam line components (and their controls and interlocks) including: particle production targets, uncooled and water-cooled devices such as magnets, beam stops, vacuum enclosures and beam collimators (fixed and movable), and absorbers.

Support also includes: the design, operation, and maintenance of remote handling systems for highly activated components; the handling and transportation (usually for disposal) of highly activated components; and the specification, engineering, design and installation of radiation shielding. Shielding activities include Monte Carlo shielding calculations and heavy equipment (bridge cranes and forklifts) operation.

Support activities occur in all of the experimental support areas: A (Building 53–003M), B (53–003N), C (53–003P), Manuel Lujan Center (53–007, 53–029, and 53–030), WNR (53–007 and 53–369), and the neutrino experiment hall (53–364).

Radiofrequency Technology and Operation. The 800-million electron volt and LEDA accelerators require large power sources, and both are supplied at TA-53 by radiofrequency (RF) power sources. The capability to design, fabricate, operate, and maintain RF systems for accelerators and other applications is an important support function for LANSCE operations. This capability also provides the RF systems, including state-of-the-art fast feedback controls and high-power klystron amplifiers used in electron accelerator projects and other advanced accelerator concepts at TA-53. RF technology development also supports microwave materials processing and RF system design. Design work includes determining optimal systems for very high-power continuous-duty systems for applications such as accelerator production technology.

RF power generation for the 800-million electron volt accelerator primarily occurs in the above-surface portions of Building 53–003, Sectors A through H, and will occur in Building 53–365 for LEDA.

3.2.3 Neutron Research and Technology

Fundamental research is conducted on the interaction of neutrons with various materials, molecules, and nuclei to advance condensed matter science (including material science and engineering and aspects of bioscience), nuclear physics and LANL's capability in the study of dynamic phenomena in materials. Applied neutron research is conducted to provide scientific and engineering support to weapons stockpile stewardship and nonproliferation surveillance. Efforts include resonance neutron spectroscopy and neutron radiography. (Radiography using protons rather than neutrons is discussed below under Subatomic Physics Research.) Research is also performed to develop instrumentation and diagnostic devices by scientists from universities, other federal laboratories, and industry.

3.2.4 Materials Research

3.2.5 Subatomic Physics Research

Historically, a wide variety of subatomic physics research was conducted at this accelerator facility. Research built on subatomic physics techniques and knowledge is also developing the technology for, and use of, neutron and proton radiography for stockpile stewardship applications. Experiments to date have been directed at radiographing static objects using WNR and small, contained dynamic experiments in Line B, utilizing appropriate locations for access to the proton beam. These experiments have demonstrated the utility of the technique and provide data on explosives behavior. Experiments take place in Line C, which allows room for continued dynamic materials research studies and technique development. This research includes development and demonstration of advanced detectors.

3.2.6 Medical Isotope Production

The 800-million electron volt accelerator proton beam is used to produce radioisotopes used by the medical community for diagnostic procedures, therapeutic treatment, clinical trials, and biomedical research. Nearly 40 different medical radioisotopes have been produced and shipped in the 20 years of production at LANL. During 1995, for example, 75 shipments were made to user facilities in nine countries, including France, Germany, and Australia.

Isotopes are currently produced at the Isotope Production Facility (IPF, 53-984). The IPF currently makes use of that portion of the proton beam that is not consumed by and used for proton and neutron experiments and research. The IPF has nine independent stringers or target stations. A small amount of target material is loaded onto each movable stringer, and the stringer is inserted into the proton beam path. Remote handling equipment and water-cooled targets are required due to the high radiation levels (up to 50,000 roentgen per hour) and temperatures (up to 1,832 o F [1,000 o C]) generated by the spallation process. Isotope production and facilities will be relocated to a new 100-million electron volt station in an add-on to Building 53–003B. This change will result in more selective and more efficient isotope production and the generation of fewer byproduct isotopes (as compared to the current use of the 800-million electron volt beam).

Targets are transported from TA-53 to the Radiochemistry Facility in TA-48 for recovery of the desired radioisotopes from the target material.

3.2.7 High-Power Microwaves and Advanced Accelerators

High-power microwave research and experiments, mostly conducted in Buildings 53–014 and 53–018, occur in a number of technology areas: (1) high-power microwave, RF, and electromagnetic pulse sources that typically use multi-kiloampere, relativistic electron beams; (2) future linac power sources and directed energy; (3) explosively driven high-power microwave and RF systems for defense applications; (4) intense beam physics and modeling for application to high-power microwave source development; (5) high-power, free-electron lasers based on high-brightness electron accelerators; (6) high-brightness accelerator as a driver for an extreme UV source for lithography; (7) high-performance ground penetrating radar for environmental remediation; (8) application of high-power microwaves to industrial processing, such as chemical catalysis and environmental remediation; (9) microwave and electromagnetic pulse vulnerability and effects testing of weapons systems; (10) novel high-power microwave sources based on shock compression of solid materials; (11) advanced pulsed-power modulator development; (12) development of room-temperature and superconducting RF linac structures; and (13) development of advanced electron accelerators. Research also will be conducted to support development of the spallation neutron source (as discussed in chapter 1, section 1.5.9 of the SWEIS).

3.3 SWEIS Description of LANSCE Capabilities (Preferred Alternative)

The following is the description of activities under the expanded operations (preferred) alternative, which was adopted in the ROD for the SWEIS (DOE1999b).

3.3.1 Accelerator Beam Delivery, Maintenance, and Development

LANSCE would deliver a linear accelerator beam to Areas A, B, and C; the Weapons Neutron Research buildings; the Manuel Lujan Center; the dynamic test facility; and a new Isotope Production Facility for 10 months each year (6,400 hours). The H + beam current would be 1,250 microamps and the H - beam current would be 200 microamps. The beam delivery and support equipment would be reconfigured to support new facilities, upgrades, and experiments.

A 40-million electron volt low-energy demonstration accelerator (LEDA) would be built and operated in an existing facility (TA-53-365) for 10 to 15 years, operating up to approximately 6,600 hours per year, as described under the No Action alternative. LEDA would be used to demonstrate the practicality of using continuous-wave accelerator beam technology to produce tritium, as an alternative to the historical use of nuclear reactors. This facility would be located in existing Building 53–365, as described in Section 3.1.

The LEDA building consists of two major parts: an underground, shielded beam tunnel (16,200 square feet [1,500 square meters]) and a four-story, steel-frame building (53,800 square feet [5,000 square meters]). The heating, ventilation, and air conditioning system would allow short-lived radioisotopes to decay in the beam tunnel prior to release via the 82-foot-high (25-meter-high) exhaust stack.

The construction and operation of LEDA was analyzed under NEPA in an environmental assessment that supported a finding of no significant impact (DOE 1996b).

3.3.2 Experimental Area Support

Support activities would continue, consistent with the levels of operation under this alternative, to ensure availability of the beam lines, beam line components, handling and transportation systems, and shielding, as well as radiofrequency power sources (including technology development and application). Remote handling and packaging of radioactive materials and wastes at LANSCE would increase to handle waste generation that results from the facility construction and modifications at LANSCE under this alternative.

3.3.3 Neutron Research and Technology

LANL would conduct 1,000 to 2,000 different experiments annually, using neutrons from the Manuel Lujan Center, Weapons Neutron Research (WNR), and the Long-Pulse Spallation Source (LPSS). The LPSS would be a new experimental facility that would provide advanced capabilities for neutron scattering and subatomic physics using cold and ultracold neutrons. Together with the SPSS at the Manuel Lujan Center, the LPSS would provide U.S. scientists with a complementary pair of neutron sources for research in materials, biological, and nuclear science.

The LPSS neutron production system, which would be located in Area A, would consist of a tungsten target, moderators, and a reflector surrounded by a large iron and concrete biological shield. The Area A building has 100,000 square feet (9,300 square meters) of space and a usable height of 45 feet (14 meters). No modifications would be required to the building or floor of Area A, but existing experimental stations and other equipment in Area A would have to be dismantled and removed, including Area A experimental stations, the Neutrino Scintillation Detector Station, and Area A shielding. This removal of existing experimental stations, instrumentation, and related hardware would generate an estimated 118,000 cubic feet (3,300 cubic meters) of suspect contaminated concrete that would be disposed at TA-54/Area G (8,400 tons [7,620 metric tons], 420 shipments), and another 48,000 cubic feet (1,350 cubic meters) of activated metals and debris (for which 200 Type B cask shipments would be required, and 900 low specific activity and Type A shipments, all to TA-54).

As part of the LPSS project, the linear accelerator would be upgraded to deliver an average proton current of 1.25 milliampere (versus 1.0 at present), for a power of 1.0 megawatt (versus 0.8 at present). This upgrade would increase LANSCE electricity and cooling water requirements.

The LPSS design would use an evacuated target cell that would largely eliminate short-lived activation products. This newer design would decrease radioactive air emissions by an order of magnitude (per unit basis of microampere-hours of linear accelerator operation). This design would result in LPSS operations contributing no more than 1 millirem per year to the dose received by the maximally exposed individual defined for LANSCE. (The term “maximally exposed individual” is discussed in the Air Quality sections of chapters 4 and 5 of the SWEIS).

The LPSS target, moderators, and hot cell would be constructed inside Building 53–003M, and would thus require no additional land disturbance. There would be no change from the current industrial use of these disturbed areas.

LANL also would construct and operate a Dynamic Experiment Laboratory (DEL) to provide both neutron and proton radiography and resonance neutron spectroscopy of materials for the study of dynamic materials phenomena under a single roof. Such techniques are currently employed for experiments at LANSCE but in varying locations; they complement x-ray radiographic and other techniques for dynamic materials studies used at LANL and other DOE facilities. The DEL also would provide improved support for these experiments and some added capabilities. It would provide more effectively utilized physical space and dedicated infrastructure for these experiments; it would enable proton radiography experiments to use beam from the Proton Storage Ring, thereby reducing interference of these experiments with other LANSCE uses and increasing the beam intensity available for proton radiography; and it would incorporate gas guns to enable additional shock wave experiments and simplify some such experiments. The DEL would be constructed as a new facility adjacent to WNR. It would make use of existing LANSCE infrastructure, including the 800-million electron volt linear accelerator, the Proton Storage Ring, and existing personnel.

The proton radiography experimental program requires a containment vessel, beam tubes in the upstream and downstream lenses, three beam axes with two matching lenses and two downstream lenses on each axis, and a gas gun pointing at the center of the containment vessel. The resonance neutron spectroscopy and neutron radiography experiments require a neutron production target and moderator, a flight path about 66 feet (20 meters) in length, and a gas gun pointing at the center of the containment vessel.

A high explosives assembly area and magazine would be attached to the outside of DEL, with an explosion-proof door separating the two. Separate from DEL with its high explosives areas, a counting house and a building for support equipment (e.g., power supplies, deionized water system) would be needed. This laboratory would be established in a previously disturbed area. There would be no change from the current industrial use of these areas.

LANL would also conduct an accelerator production of tritium target neutronics experiment for 6 months. In addition, LANL would continue to support contained weapons-related experiments using small to moderate quantities of high explosives. These experiments would include:

- Experiments with nonhazardous materials and small quantities of high explosives (up to approximately 200 per year)
- Experiments with up to 10 pounds (4.54 kilograms) of high explosives and/or depleted uranium (up to approximately 60 per year)
- Experiments with small quantities of actinides, high explosives, and sources (up to approximately 80 per year)
- Shockwave experiments involving small amounts, up to nominally 1.8 ounces (50 grams), of plutonium.

In addition, LANL would provide support for static stockpile surveillance technology research and development.

3.3.4 Accelerator-Driven Transmutation Technology

LANL would conduct lead target tests for 2 years at the Area A beam stop, as well as the 1 megawatt target/blanket experiments, as described in section 3.1.11 of the SWEIS. Once these experiments were completed, LANL would construct a 5-megawatt target/blanket experimental area (referred to as the Los Alamos International Facility for Transmutation [LIFT]) adjacent to Area A, and conduct 5-megawatt experiments for 10 months per year for 4 years.

LIFT would be used to demonstrate the practicality of using accelerator technology to transmute plutonium and high-level radioactive wastes into other elements or isotopes. LIFT would be constructed adjacent to Area A in a previously disturbed area. There would be no change from the current industrial use of these areas.

3.3.5 Subatomic Physics Research

LANL would conduct five to ten physics experiments annually at the Manuel Lujan Center, WNR, and LPSS and conduct proton radiography experiments. Proton radiography experiments would include contained experiments using small to moderate quantities of high explosives similar to those discussed above under Neutron Research and Technology.

3.3.6 Medical Isotope Production

Up to approximately 50 targets per year would be irradiated for medical isotope production and exotic and neutron rich/deficient isotopes would be produced.

In addition, LANL would establish the Exotic Isotope Production Facility in an existing facility, which would complement the 100-million electron volt IPF by using the 800-million electron volt proton beam available at the end of the half-mile-long linear accelerator to fabricate radioisotopes used by the medical community for diagnostic and other procedures. This facility would be established within an existing building and would not result in either land disturbance or a change from the current industrial land use of these areas.

Also under the Expanded Operations Alternative, Area A East would be stripped of existing contaminated and uncontaminated items so that it could be put to use as a staging area for shipments, receipts, equipment storage, and limited maintenance activities. (This portion of Experimental Area A currently houses a beam stop, shielding, and equipment related to isotope production and materials irradiation activities.) Removal of existing items would generate wastes for disposal, including an estimated 50,000 cubic feet (1,400 cubic meters) of suspect contaminated concrete, 20,000 cubic feet (560 cubic meters) of activated metal used for shielding, and another 14,000 cubic feet (400 cubic meters) of equipment and debris. Wastes would total an estimated 1,700 tons (1,540 metric tons), the disposal of which would require 200 Type B cask shipments, 530 Type A shipments, and 290 low specific activity shipments, all to TA-54.

3.3.7 High-Power Microwaves and Advanced Accelerators

Research and development would be conducted for advanced accelerator concepts, high-power microwaves, room-temperature and superconducting linear accelerator structures, and in support of the Spallation Neutron Source Program. Research and development also would be conducted microwave chemistry for industrial and environmental applications.

Under all alternatives, the following facilities would be constructed and operated based on previous NEPA reviews, as discussed in section 3.2: The LEDA would be constructed. Proton radiography and neutron spectroscopy facilities (for neutron research and technology) would be constructed within existing buildings and would house photographic equipment and experiments contained within closed vessels. IPF (for medical isotope production) and equipment would be relocated to a new 100-million electron volt station, instead of using the full 800-million electron volt beam as is currently done. The short-pulse spallation source (SPSS) enhancement will result in higher neutron flux and greater beam availability for experimenters in WNR and the Manuel Lujan Center.

It is recognized that project plans change over time. If this alternative is selected, the construction projects proposed under this alternative (as described above), would be reviewed prior to construction to determine whether additional NEPA analysis is required.

4.0 Background Document Information for LANSCE

This section presents information from the "Background Information for LANSCE Facilities at TA-53 for Site-Wide Environmental Impact Statement for Los Alamos National Laboratory" (LANL 1997).

4.1 Background Document Description of Facilities

The Clinton P. Anderson Meson Physics Facility, now known as the Los Alamos Neutron Science Center or LANSCE, was first proposed in 1962 for research into sub-atomic particles and physics. Congress funded the concept three years later, and construction was completed in 1970. Today, the facility is one of the largest research accelerators in the world; the accelerator itself generates a proton beam more intense than that combined from all comparable accelerators in the world. Researchers from 300 institutions from the United States and more than 30 other countries provide input to the goals and policies governing the facility.

LANSCE currently supports both basic and applied research programs. Basic research has included studies of sub-atomic and particle physics, atomic physics, neutrinos, and the chemistry of sub-atomic interactions. Applied research programs include the production of radioisotopes for medical research and use, materials science studies using neutron spallation, and contributions to defense programs such as stockpile stewardship and the production of tritium. LANSCE also supports programs for accelerator-related technologies such as radio-frequency power sources, high-power microwaves, and free-electron lasers.

LANSCE programs are located at Technical Area 53. This 750-acre mesa top contains approximately 400 buildings and other structures, and houses about 800 personnel. This population can increase by several hundred when the linear accelerator is in operation as visiting scientists from around the globe flock to Los Alamos to monitor and participate in experiments.

4.1.1 Linear Accelerator Building

These programs and activities are housed in three categories of buildings at TA-53. The first is the linear accelerator building itself, Building 53-003. It is more than a half-mile in length and has 316,000 square feet of floor space, which is about one-third of the total area under roof at TA-53. The building contains equipment to form H^+ and H^- proton ion beams, and accelerates the beams to 84% of the speed of light. Ancillary equipment is used to transport the proton ion beams, maintain vacuum conditions in the beam transport system, and provide heating, ventilation, and cooling. The beam tunnel itself is located 35 feet below grade to provide radiation protection. Above-surface structures house the radio-frequency power sources used to accelerate the beam. Building 53-004 houses the accelerator control room.

4.1.2 Laboratories and Experimental Areas

Experimental laboratories and areas comprise the second category of buildings. The high-energy proton beam is transported from the accelerator building to six of these areas; several others exist. These buildings house the large, complex, state-of-the-art instrumentation and equipment needed for the basic and applied research conducted at TA-53. The most important:

- Experimental Area A, Building 53-003M -- This largest (~32,000 square feet) of the experimental areas has housed numerous meson experiment stations in the past. Medical isotopes are also currently produced here. By 1998, however, all experimental stations will be dismantled and removed, to be replaced by the Long-Pulse Spallation Source (LPSS). The LPSS will be a major new experimental facility that will place the United States at the forefront of worldwide neutron-scattering research. LPSS will include the use of ultracold neutrons as a research tool, an area of research that is just beginning to emerge in the international physics community. Together with the existing Short-Pulse Spallation Source (SPSS) at the MLNSC, the LPSS will provide U.S. scientists with a complementary pair of neutron research sources that will rival the world's leading facilities in Europe and Japan. LPSS will be designed to have 14 beam lines for neutron scattering research, and another for high-energy neutron research (Browne et al. 1995).

- Experimental Area B, Building 53-003N -- This area currently houses several no-longer-funded experimental stations. Facilities for the production of exotic medical isotopes may be located here within the next five years.

- Experimental Area C, Buildings 53-003P -- This area currently holds the High-Resolution Spectrometer, which will be dismantled and removed by 1998. A Proton Radiography Firing Site will be constructed in its stead as part of the Science-Based Stockpile Stewardship Program.

- Proton Storage Ring, Buildings 53-008 and 53-028 -- The proton linear accelerator sends 75 of its 1,000 microamps of beam current to this 90-meter-diameter storage ring. The ring compresses the time structure of the proton beam from several hundred microseconds to 270 nanoseconds, which is then directed to downstream experimental stations at WNR and the Lujan Center (Allred and Talley 1987).

- Manuel Lujan Neutron Scattering Center (MLNSC, or the Lujan Center), Buildings 53-007 and 53-030 -- The compressed proton beam is directed to Target 1, from which time-of-flight beam pipes carry neutrons to various detectors. Research tests conducted at the MLNSC are Short-Pulsed Spallation (SPSS) neutron scattering experiments, primarily in the area of materials science.
- Weapons Neutron Research, Buildings 53-007, 53-029, and 53-369 -- Targets 2 and 4 are housed at WNR. Time-of-flight beam pipes carry neutrons to various SPSS experimental stations.
- RF and High-Power Microwave Laboratories, Buildings 53-014, 53-017, and 53-018 -- These house equipment and instrumentation used for the research, development, and testing of advanced concepts for radiofrequency power sources, high-power microwaves, and advanced accelerator and injection systems.
- Detector Development Laboratory, Building 53-010 -- This houses equipment and stations for advancing the art of detecting particles created by spallation experiments.
- Neutrino Experiment Facility, Building 53-364 -- The liquid scintillator neutrino detector will remain here through 1997. It will then be supplanted by one or more LPSS experimental stations.
- Low-Energy Demonstration Accelerator (LEDA), Building 53-365 -- Building 365 was built for the Ground Test Accelerator, which was canceled in 1994. Instead, the 40-megawatt LEDA will be built here starting in 1997. LEDA will be the proving ground and demonstration center for the concept of tritium production using a continuous-wave proton accelerator (instead of using a nuclear reactor as in the past). If the demonstration is successful, a production accelerator may be constructed at Savannah River (if the DOE selects accelerator technology as a means of producing tritium, either instead of, or as a backup to, reactor production).

4.1.3 Other Structures

There are approximately another 400 structures at TA-53 that house experimental support operations and advanced technology programs (Del Signore 1996a). The more important of these buildings are as follows:

- 53-001, the main office building for LANSCE, housing the LANSCE/ER program office, and the division office for Accelerator and Technology Operations
- 53-002, the primary equipment maintenance and test shop
- 53-004, accelerator control room
- 53-006, Accelerator Technology office building
- 53-019, Accelerator Technology laboratory
- 53-024, office building
- 53-031, APT office building
- 53-622, MLNSC office building

Other structures at TA-53 include cooling towers, storage tanks, storage buildings, and craft shops.

4.1.4 Prominent Environmental Structures

LANSCE contributes to environmental consequences of operations at the Los Alamos National Laboratory. Chief among these are airborne radioactive emissions. These structures are discussed below.

Airborne Radioactive Emissions: LANSCE operations account for more than 90% of all airborne radioactive emissions from the Los Alamos National Laboratory. These emissions come from Stacks ES-2 and ES-3, which are equipped with continuous monitoring equipment. Stack ES-2, with a flow rate of 16,000 cubic feet per minute (CFM), exhausts the Proton Storage Ring and experimental stations at the Lujan Center and Weapons Neutron Research buildings. Stack ES-3, with a flow rate of 17,500 CFM, ventilates Building 53-003, the linear accelerator and adjacent experimental stations (LATA 1996).

LAMPFNET: Levels of external penetrating radiation are monitored on three TLD networks in and around LANL. One of these three networks (LAMPFNET) is located 800 meters north of TA-53 to measure the effects of LANSCE operations.

NPDES Outfalls: TA-53 contains six outfalls permitted by and monitored under LANL's NPDES Permit NM0028355. All of these fall into Permit Category 03A, and all consist of cooling tower blowdown:

Outfall	From	Effluent
047	53-060	Cooling tower blowdown
048	53-062	Cooling tower blowdown
049	53-064	Cooling tower blowdown
113	53-293, 365, 1032	Cooling tower blowdown
125	53-028	Cooling tower blowdown
145	53-006	Cooling tower blowdown

Underground Tanks: Prior to discharge to the lined lagoon, low-level radioactive wastewaters are collected and allowed to decay in four underground tanks. Tanks 78 and 79 are located adjacent to Building 53-003S; tanks 144 and 145 are underground between Buildings 53-030 and 53-622 (Merrick 1994).

Surface Impoundments: Three wastewater lagoons are located at the east end of TA-53. Two unlined lagoons (no longer used) collected sanitary wastes prior to construction in 1994 of the LANL-wide sanitary waste treatment facility at TA-46. Traces of both radioactive and hazardous wastes have been discovered in the sludges in these lagoons, and they now require closure under RCRA regulations. The third lagoon, lined with hypalon, continues to receive low-level radioactive liquid wastes from floor drains in the LANSCE accelerator building and experimental halls. All three lagoons will undergo RCRA closure prior to 2002.

Wetlands: Effluent from Outfalls 047 and 113, and from former outfall 114, have created three wetland areas in TA-53. These areas are protected by EPA regulations that place restrictions on activities such as vegetation control and water flow adjustments.

4.2 Discussion of Missions/Programs Under the Expanded Operations Alternative

Since the construction of the proton accelerator at TA-53 in 1970, activities have centered around research into sub-atomic particles and physics. These activities have boosted LANL and the personnel who work at TA-53 into prominence in the worldwide scientific and physics communities. As accelerator technology has advanced around the world, however, the scientific community has begun to realize that accelerators have practical, even production, applications. Hence, while TA-53 facilities and personnel will continue to play a strong role in the worldwide scientific research community, programs at TA-53 have started a shift towards a mixture of basic research, applied research, and practical applications of accelerator technology. As explained below, these newer endeavors include areas such as the production of radioisotopes for medical use, the transmutation of long-lived radioactive wastes to less harmful elements, and a role in the stewardship of this country's nuclear weapons program. The seven major LANSCE missions are:

Science-Based Stockpile Stewardship, under which TA-53 facilities and personnel will play an important role in maintaining a safe and reliable nuclear weapons program in the post-cold-war era with no nuclear testing, negotiated reductions in the size of the nuclear stockpile, suspension of weapons development, and reduced spending on defense programs.

Accelerator Production of Tritium, under which TA-53 personnel will design, construct, and test the practicality of using accelerators to produce tritium, as an alternative to the historical use of nuclear reactors as tritium producers.

Accelerator-Driven Transmutation Technology, under which TA-53 personnel will design and construct facilities for research and development of the concept of using an accelerator beam to convert plutonium and high-level radioactive wastes into safer elements.

Neutron Scattering, under which research will continue at the existing Short-Pulse Spallation facilities (Proton Storage Ring, Manuel Lujan Neutron Scattering Center, and Weapons Neutron Research Building), and under which new research will be conducted using the soon-to-be-constructed Long-Pulse Spallation Source (LPSS) facility. The LPSS will make Los Alamos a world-class facility at the forefront of basic research using cold neutrons.

Nuclear Physics, under which TA-53 personnel will continue basic research into neutrinos and other subatomic particles. This program also makes use of other domestic and international research facilities.

Medical Isotope Production, under which the TA-53 proton accelerator beam is used to fabricate radioisotopes used by the medical community for diagnostic procedures, therapeutic treatment, clinical trials, and biomedical research. During 1995, for example, 75 shipments were made to user facilities in nine countries, including France, Germany, and Australia. Nearly 40 different medical radioisotopes have been produced and shipped in the twenty years of production at LANL.

High Power Microwaves (HPMW) and Advanced Accelerators, under which TA-53 personnel perform research on new concepts for the use of microwaves and accelerators for industrial, environmental, and defense applications. This program uses the Free Electron Laser and the Extreme UV Lithography Experiment located within Building 53-014, and several HPMW experiments in Buildings 53-014 and 53-018.

The text in the following paragraphs compares information for each of these seven major programs under the SWEIS Expanded Operations Alternative. Expanded accelerator operations would see additional construction beyond that planned or in progress under the No Action alternative. In addition to projects discussed in the No Action alternative (the LEDA for the APT Program, new medical isotope production facilities, SPSS upgrade, new instruments at the Lujan Center), major new construction projects will also include the Long-Pulse Spallation Source for the Neutron Scattering Program, an upgrade to the linac, a five-megawatt target/blanket facility for ADTT, and a Dynamic Test Facility for the Stockpile Stewardship Program. The seven major programs would, for the most part, be conducted at higher levels of experimentation and/or production than in the No Action alternative. The three surface impoundments will be remediated prior to 2002, and in addition, significant decontamination and equipment removal will occur in Areas A (1998-2000) and A-East (2004-2005).

4.2.1 Science-Based Stockpile Stewardship

Materials and nuclear science research will be conducted at the Lujan Center and at WNR. This research will focus on weapons materials and will include:

- experiments with nonhazardous materials; and
- experiments involving small quantities of actinides, high explosives (<1 pound), hazardous materials, and radiation sources.

Dynamic experiments will be conducted using proton and/or neutron radiography in both Area C and WNR. The experiments will be contained within closed vessels to permit the use of existing facilities. The dynamic experiments will be used to study the extremely brief (nanosecond to microsecond) behaviors that occur within a nuclear weapon, and will complement studies being performed at other DOE facilities. Plans include:

- experiments involving up to 10 pounds of high explosives and/or depleted uranium; and
- shock wave physics experiments involving small quantities (nominally 5 grams) of plutonium.

In addition, the Stockpile Stewardship Program will also perform static surveillance research on weapons-like components and on SRD components.

Under the Expanded Operations Alternative, materials and nuclear science research will be conducted at the Lujan Center and at WNR. Experiments will be conducted in greater numbers than in the No Action alternative, and will include:

- experiments with nonhazardous materials; and
- experiments involving small quantities of actinides, high explosives (<1 pound), hazardous materials, and radiation sources;

Dynamic experiments will be conducted using proton and/or neutron radiography in both Area C and WNR. The experiments will be contained within closed vessels to permit the use of existing facilities. In addition, a Dynamic Test Laboratory with proton and neutron radiography firing sites will be built adjacent to WNR. Experiments will be conducted in greater numbers than in the No Action alternative, and will include:

- experiments involving up to 10 pounds of high explosives and/or depleted uranium; and

- shock wave physics experiments involving up to 50 grams of plutonium.

In addition, the Stockpile Stewardship Program will also perform static surveillance of weapons components, including Category 1 levels of plutonium, uranium, and SRD components.

Under the Expanded Operations Alternative, both the RNR and proton radiography firing sites would be constructed, as in the No Action alternative. Planned experiments will include:

- approximately 50 experiments annually involving small quantities of actinides, high explosives (HE), and radioactive sources (versus 40 for the No Action alternative);
- approximately 15 larger-scale experiments annually involving up to 20 kilograms of actinides or HE (versus 15); and
- approximately 200 experiments annually with nonhazardous materials (versus 100).

In addition, the program would sponsor static stockpile surveillance at the RNR firing site, an activity that would involve Category 1 special nuclear material and SRD components.

4.2.2 Accelerator Production of Tritium

Under the No Action alternative, the Low-Energy Demonstration Accelerator (LEDA) will be constructed by 1998 within existing Building 53-365. The existing Ground Test Accelerator will be dismantled, and additional electrical and cooling capacity will be installed, in addition to the LEDA and its diagnostic instrumentation. LEDA will use a different technology (continuous wave) to provide a higher beam power (8 MW) than the existing proton accelerator, and will enable TA-53 personnel to evaluate the performance of the low-energy section of an accelerator that would be used for production of tritium. LEDA will be operated for six years, and experimental data will be factored into the Secretary’s recommendation for this country’s future source of tritium (DOE 1996b).

In addition to LEDA experiments, the APT Program will sponsor materials irradiation/corrosion studies at the proton beam stop (Building 53-003M), and target neutronics experiments in Building 53-003P. Irradiation/corrosion studies will provide data needed to make design decisions for a production-scale accelerator for tritium production (which would be constructed at the Savannah River Site). The irradiation/corrosion studies will be conducted for approximately 12 months. Neutronics experiments, which would last approximately six months, will direct a low-current proton beam into neutron-producing targets to determine proton:neutron ratios that can be achieved. This knowledge, too, would be used for the design and construction of the production-scale accelerator.

Under the Expanded Operations Alternative, this program would proceed during the ten-year EIS period. LEDA would still be constructed, but it would be operated for 10-15 years instead of the six assumed for the No Action alternative.

4.2.3 Accelerator-Driven Transmutation Technology

This program will construct an experimental facility in or adjacent to Experimental Area A, and will conduct a target test experiment in order to develop and study waste transmutation technology. Tests will be conducted up to ten months per year. Planned experimental progression is as follows:

1999-2001: Perform tests to establish a technology base for materials handling and operation of liquid lead (lead/bismuth) spallation neutron targets, including the assembly and testing of a Russian-built liquid lead/bismuth target.

2002-2005: Construct LIFT (Los Alamos International Facility for Transmutation) with a target/blanket that uses liquid lead technology acquired in the previous stage. Conduct experiments of up to five megawatts with representative fission products and fissionable materials. These experiments will allow measurement of spallation product and fission product production and removal, and testing of transmutation effectiveness in different configurations. The higher power level of 5 MW will provide added realism to the tests. Tests will be conducted up to eight months per year.

Under the Expanded Operations Alternative, this program will conduct a series of target test experiments in or adjacent to Experimental Area A in order to study transmutation. Planned experimental progression is as follows:

1999-2001: Perform tests to establish a technology base for materials handling and operation of liquid lead (lead/bismuth) spallation neutron targets, including the assembly and testing of a Russian-built liquid lead/bismuth target.

2002-2005: Liquid lead technology development will be conducted at existing experimental stations. No fission products will be produced.

4.2.4 Neutron Scattering

Under the Expanded Operations Alternative, the neutron scattering program will witness the construction of the new Long-Pulsed Spallation Source (LPSS) in and around Building 53-003M, Experimental Area A. Construction is expected to start in 2000, preceded by the dismantlement, recycling, and disposal of the numerous experimental setups and instrumentation already in Area A. The LPSS will be a major new experimental facility that will place the United States at the forefront of worldwide basic research into sub-atomic physics. LPSS will include the use of ultracold neutrons as a research tool, an area of research that is just beginning to emerge in the international physics community. Together with the existing Short-Pulse Spallation Source (SPSS) at the MLNSC, the LPSS will provide U.S. scientists with a complementary pair of neutron sources that will rival the world's leading facilities in Europe and Japan. LPSS will be designed to have 14 beam lines for neutron scattering research, and another for high-energy neutron research (Browne et al. 1995).

Once LPSS is operational, planned for 2002, the Neutron Scattering program will conduct several hundred experiments annually. The facility will support the stockpile stewardship program and basic research. Studies will include condensed matter and materials research.

Under the No Action alternative, the Neutron Scattering Program also plans an upgrade to the existing 90-meter-diameter Proton Storage Ring (Buildings 53-008 and 53-028). Upon completion of the upgrade, the storage ring would operate at 200 microamps and 30 hertz, versus its present 70 microamps at 20 hertz. Benefits of this upgrade include higher neutron flux and greater beam availability. As in the No Action alternative, the SPSS will be upgraded so that the Proton Storage Ring operates at 200 microamps and 70 hertz, and new instruments will be added to the Lujan Center. In addition, linac current will be increased 25% to 1.25 milliamp in order to supply power needed for the LPSS.

4.2.5 Nuclear Physics

Under the Expanded Operations Alternative, the Liquid Scintillator Neutrino Detector, in existing Building 53-364, will be operated through 1997, at which time this segment of the Nuclear Physics program will be discontinued. (The detector will be dismantled as part of the LPSS construction project.) Other basic research activities will include a small number of experiments annually at the MLNSC, and research that uses other national and international facilities.

4.2.6 Medical Isotope Production

Under the No Action alternative, isotopes are currently produced at the IPF, or Isotope Production Facility, at the linac beam stop in Building 53-003M. The IPF makes use of that portion of the proton beam that is not consumed by and used for proton and neutron experiments and research. The IPF has nine independent stringers or target stations. A small amount of target material is loaded onto each movable stringer, and the stringer is inserted into the proton beam path. Remote handling equipment and water-cooled targets are required due to the high radiation levels (up to 50,000 R/hr) and temperatures (up to 1,000 ^{o}C) generated by the spallation process.

Targets are transported from TA-53 to TA-48 for recovery of the desired radioisotopes from the target material. Complex separation process must be employed, including ion exchange, solvent extraction, distillation, and electrochemical deposition. TA-48 operations are conducted in hot cells.

Isotope production currently within Experimental Area A will continue through 1997, at which time the remote handling equipment and ancillary instrumentation will be dismantled. Production equipment will be relocated to a 100-MeV station adjacent to 53-003B. Except for this brief relocation interruption, approximately 40 targets will be irradiated annually.

Under the Expanded Operations Alternative, the production facility would be relocated as in the No Action alternative. Isotope production will be increased approximately 25% from that in the No Action alternative. In addition, a new production line would be established, probably within an existing building, in order to fabricate more exotic medical isotopes. Further, Molybdenum-99, currently planned to take place at Sandia National Laboratory, would be produced at TA-53. (Molybdenum-99 is the most widely used medical radioactive isotope used in the United States, and is used in most of the 38,000 diagnostic procedures that are performed daily.)

4.2.7 High-Power Microwaves and Advanced Accelerators

Under the Expanded Operations Alternative, this program will sponsor research and development in the following areas:

- Advanced accelerators, which includes efforts to advance accelerator technology by generating sub-picosecond bunch, high-brightness electron beams, by using extreme ultraviolet lithography in conjunction with bright electron beams.

- Gigawatt-class high power microwave sources, which includes use of the free-electron laser for collider applications, and the development of high-current relativistic klystron amplifiers for rf power generation.
- Advanced pulsed-power systems such as explosively driven flux compression generators. (Experiments for this effort are conducted at Technical Areas 33, 39, and 49.)
- Microwave-driven chemistry such as No_x abatement and catalysis, with strong industrial ties and interest.
- Advanced free electron laser development and user experiments
- Other research areas, including novel microwave sources, ground penetrating radar, electron gun technology, and technology transfer programs with Russia.

Current experimental setups at Buildings 53-014 and 53-018 will be used, along with design capabilities housed in Building 53-019. In addition to experiments designed and conducted by TA-53 personnel, HPMW facilities will annually support approximately five experiments conducted by and for other national and international users.

4.3 Discussion of Operational Capabilities as They Support Programs

LANSCE operational capabilities can be grouped under eleven different headings, as discussed in this section. TA-53 requires the use of these capabilities. Within TA-53, generation and delivery of the 800 MeV proton ion beam accounts for nearly all of the radioactive air and water generated by operations at TA-53. Likewise, operation of the 800 MeV accelerator and the Low Energy Demonstration Accelerator will account for most of the electricity, natural gas, and water consumed at TA-53. Radioactive solid wastes result primarily from maintenance activities and removal of materials used in experiments. In addition, small quantities of common chemical wastes (solvents, adhesives, solder, etc.) are generated by most operations. These points are detailed in the following paragraphs.

4.3.1 Capability #1 -- Linac Operation & Beam Delivery

4.3.1.1 Description

800-MeV Beam Generation: An 800-MeV proton beam is generated in three stages. Three injectors (Building 53-003J) generate ionized proton beams, which are accelerated to four percent of the speed of light (0.75 MeV) by Cockroft-Walton devices. The second stage (Building 53-003A) consists of a 62-meter series of drift-tube linear accelerator sections. By alternately exposing the proton ion beam to, and shielding it from, an externally generated electromagnetic field, ions exit this second stage at 43% of the speed of light, and have an energy level of 100 MeV. The third stage (Buildings 53-003B through 53-003H) consists of a 731-meter-long side-coupled cavity accelerator. Ions exit at 84% of the speed of light, and with an energy level of 800 MeV (Allred and Talley 1987).

800-MeV Beam Delivery: The proton ion beam then enters a switchyard (Building 53-003S), where the beam is split and directed to Experimental Areas A, B, and C, WNR, and/or the proton storage ring. The proton storage ring converts the negatively charged beam into micropulses of 60 picoseconds duration separated by five nanosecond current “breaks”. Each micropulse delivers about one-third of a billion protons to the Lujan Center neutron production target, and 120 micropulses are delivered each second.

Low Energy Demonstration Accelerator: At present, the 800 MeV accelerator is the only operating proton beam at TA-53. This will change when LEDA becomes operational in 1998. LEDA will generate lower-energy protons (40 MeV vs. 800), but at a much higher beam current (200 milliamps vs. one). Continuous wave technology will be employed. LEDA operations will be conducted in Building 53-365.

4.3.1.2 Programs Supported

800 MeV Accelerator: Generation and delivery of the 800 MeV proton ion beam supports six of the seven major programs at TA-53 and, in fact, experiments and operations of other programs directly affect the schedules established for beam operation and downtime. Only the High Power Microwave and Advanced Accelerator Program is independent of beam operations.

Low Energy Demonstration Accelerator: LEDA will support Accelerator Production of Tritium. (Parts of the APT Program also use the 800 MeV accelerator.)

4.3.1.3 Radioactive Materials

Radioactive Air Emissions. *800 MeV Accelerator*: Operation of the 800 MeV Accelerator has in the past generated more than 90% of the radioactive air emissions from LANL. Part of these are created when the proton ion beam exits its vacuum enclosure at the beam stop and comes in contact with air. Air is also activated by neutrons indirectly produced by impingement of a small fraction of the beam on accelerator structures. Radioactive isotopes of components of the air result, primarily oxygen and nitrogen (^{14}O, ^{15}O, ^{13}N, and ^{16}N). Other radionuclides are ^{41}Ar (Argon is present in the air in small amounts.), ^{3}H (from water vapor), and carbon (from carbon dioxide) as ^{10}C and ^{11}C. About half of these radioactive air emissions come from ^{15}O, which has a half-life of two minutes. Most radioactivity decays before reaching the LANL site boundary (LANL 1995b).

In 1994, a delay line was installed on the air exhaust from the accelerator beam stop. Used as necessary to reduce emissions, the delay line provides additional time for decay of activated air components before the air is exhausted through stack ES-3. Reconfiguration of Area A when the Long-Pulsed Spallation Source is constructed in 1998 will also include design features to reduce radioactive air emissions significantly -- a source reduction technique that will eliminate the need for the delay line.

Low Energy Demonstration Accelerator: The LEDA facility is designed to allow short-lived radionuclides to decay before being released to the environment. The beam stop will be enclosed in a nearly sealed shielded enclosure that will minimize migration of activated air into the beam tunnel and, subsequently, into the atmosphere. As a result of this design, radioactive air emissions from LEDA operations are expected to be a small fraction of historical emissions from the 800 MeV accelerator. The same radioisotopes of oxygen, nitrogen, argon, and carbon will result.

Radioactive Water. *800 MeV Accelerator*: Low level radioactive liquid waste is generated as a result of operating the TA-53 accelerators. The 800 MeV accelerator beam distributes 800 KW of power to be dissipated. Magnets accelerator components, and other equipment also generate heat that must be removed. Cooling systems are employed to remove this heat, and some of the cooling water becomes radioactive. The primary radionuclides thus generated are ^{3}H and ^{7}Be, while ^{22}Na, ^{54}Mn, ^{57}Co, and ^{60}Co are also present. The lesser elements result from leaching of aluminum, copper, and stainless steel materials that come in contact with the cooling waters (Merrick 1994).

There are eight cooling water systems used for the 800 MeV accelerator, the beam stop, and the magnets used to focus and direct the beam. The beam stop cooling system is the source of more than 90% of the low-level radioactive liquid water (both volume and radioactivity) generated by beam operations. This cooling system is drained (and re-filled) at a rate of 40-60 gallons per hour when the beam is in operation. The remaining seven cooling systems generate liquid wastes only during maintenance outages, typically once per year, when they are emptied and re-charged with fresh cooling water. Low-level radioactive water is currently discharged to underground holding tanks, which are periodically drained to the low-level radioactive water holding lagoon. Alternative treatment techniques are under evaluation.

Low Energy Demonstration Accelerator: LEDA operations have only a slight potential for activating cooling waters. Water will be allowed to decay in a holding tank, from where it will be removed by truck for disposal or released if the levels of radioactivity are below regulatory limits.

Radioactive Solid Wastes. All radioactive solid wastes resulting from beam generation and delivery are low-level wastes. Materials consist of beam line components and scrap metals, plastics, and papers. Components include shielding, magnets, targets, etc. Radionuclides of prominence are constituents of stainless steel -- cobalt (^{56}Co, ^{57}Co, ^{58}Co, and ^{60}Co), iron ^{55}Fe and ^{59}Fe) and chromium (^{51}Cr). Lesser radioisotopes include ^{7}Be, ^{22}Na, ^{46}Sc, ^{48}V, and ^{65}Zn. Mixed wastes in the form of lead seals and lead shielding are also generated.

4.3.1.4 Nonradioactive Toxic or Hazardous Substances

As with all TA-53 operations, small quantities of RCRA hazardous and TSCA toxic wastes result from beam generation and delivery. Examples include waste liquid solvents, solvents on wipes, lead, and solder.

4.3.1.5 Hazardous Energy Sources

The proton beam itself is a hazardous energy source. Numerous safety systems and procedural controls exist as precautionary measures to protect workers from the beam. Beam delivery also requires strong magnetic fields at the proton storage ring, the beam switchyard, and other points throughout the accelerator complex. Other energy sources include compressed gases and cryogens, high voltage, non-ionizing radiation, and flammable liquids and gases.

4.3.1.6 Other Consequences of Operations

Electricity. Generating a proton ion beam with energy of 800 MeV and current of one milliamp requires 800 kilowatts of power from the electric grid. Generating a 40-MeV, 200-microamp proton ion beam will consume 8,000 kilowatts of electric power once LEDA is in full operation. Historically, the 800 MeV accelerator accounts for about one-fourth of LANL’s electrical power consumption, and this should continue. Operation of the Low Energy Demonstration Accelerator will triple this demand by 2000 (DOE 1996b).

Natural Gas. Natural gas is consumed by boilers that keep cooling tower water from freezing, and by water pumps that supply cooling tower waters. Operation of the 800 MeV accelerator requires three cooling towers; LEDA will have five.

Water. LANSCE accelerator structures, magnets, rf power sources, and other support equipment are cooled by water. Three cooling towers (Structures 53-060, 53-062, and 53-064) are used to cool water, remove heat, and reduce water consumption by recycling most of the cooling water. Makeup water is required, however, to replace water lost to evaporation and to replace blowdown water discharged to prevent mineral buildup and fouling of cooling tower surfaces and associated equipment. A fourth cooling tower (Structure 53-1070) removes heat generated by the proton storage ring, although this heat load is most often removed by cooling tower 53-064. These have historically required about 77 million gallons of water annually, or about 15 per cent of the water consumption for all of LANL. LEDA cooling requirements will be even greater, and the existing cooling tower (Structure 53-1032) will be supplemented with two more cooling towers. In all, LEDA will consume about 86 million gallons annually beginning in 2000 (DOE 1996b).

NPDES Industrial Water Discharges. Cooling tower blowdown waters are discharged through outfalls permitted under the National Pollutant Discharge Elimination System (NPDES) of the Clean Water Act. The waters contain commercial chemical additives that reduce corrosion and inhibit scale formation, and are restricted to discharge concentrations of less than 30 PPM suspended solids, 20 PPM phosphorous, and 1-PPM chlorine. Four outfalls (047, 048, 049, and 145) receive cooling tower blowdown from cooling towers for the 800 MeV accelerator and the proton storage ring, and outfall 113 receives blowdown from LEDA. Effluent volume from generation and delivery of the 800 MeV proton beam averages about 35 million gallons per year (Del Signore 1996c), while discharges from LEDA operations will total about 39 million gallons per year beginning in 2000 (DOE 1996b).

4.3.2 Capability #2 -- Accelerator Maintenance & Development

4.3.2.1 Description

Generation and delivery of the proton ion beams requires significant development and maintenance capabilities for all components of the 800 MeV accelerator, including the ion sources and injectors, the mechanical systems in the accelerator (including cooling water), all systems for the Proton Storage Ring and its associated transfer lines, and beam diagnostics in the accelerator and transfer lines. Beam development activities include beam dynamics studies, and design and implementation of new capabilities. This capability requires the coordination of many disciplines, including accelerator physics, high voltage and pulsed power engineering, mechanical engineering, materials science, radiation shielding design, digital and analog electronics, high vacuum technology, mechanical and electronics design, mechanical alignment, hydrogen furnace brazing, machining, and mechanical fabrication. These activities take place throughout Building 53-003 (800 MeV accelerator), and in Buildings 53-008 and 53-028 (proton storage ring), 53-365 (LEDA), and 53-002 (equipment maintenance and test shop).

4.3.2.2 Programs Supported

Accelerator maintenance and development supports six of the seven major programs at TA-53. Only the High Power Microwave program is independent of beam operations

4.3.2.3 Radioactive Materials

All radioactive solid wastes resulting from beam maintenance are low-level wastes. Materials consist of pumps, magnets, other beam line components, and scrap metals, plastics, and papers. Radionuclides of prominence are constituents of stainless steel -- cobalt (^{56}Co, ^{57}Co, ^{58}Co, and ^{60}Co), iron ^{55}Fe and ^{59}Fe) and chromium (^{51}Cr). Lesser radioisotopes include ^{7}Be, ^{22}Na, ^{46}Sc, ^{48}V, and ^{65}Zn. Mixed wastes in the form of lead seals and lead shielding are also generated.

4.3.2.4 Nonradioactive Toxic or Hazardous Substances

As with all TA-53 operations, small quantities of RCRA hazardous and TSCA toxic wastes result from accelerator maintenance and development. Examples include waste liquid solvents, solvents on wipes, lead, and solder.

4.3.2.5 Hazardous Energy Sources

Strong magnetic fields exist at the proton storage ring, the beam switchyard, and other points throughout the accelerator complex. Other energy sources include compressed gases and cryogens, high voltage, non-ionizing radiation, and flammable liquids and gases.

4.3.2.6 Other Consequences of Operations

None significant

4.3.3 Capability #3 -- Experimental Area Support

4.3.3.1 Description

Experiments using proton and neutron beams are conducted by personnel from the Physics Division and by other users such as scientists from universities, other laboratories, and the international physics community. These beam users require support from TA-53 personnel, whether preparing for, performing, or closing out their experiments. This support capability focuses on the maintenance, improvement and operational readiness of the high intensity beam line (Line A) and associated secondary beam lines and experimental areas at LANSCE. This requires the specification, engineering, design (utilizing CAD), fabrication (often using CAM), installation, checkout and maintenance of various beam line components (and their controls and interlocks) including: particle production targets, uncooled and water-cooled devices such as magnets, beam stops, vacuum enclosures and beam collimators (fixed and movable) and absorbers.

Support also includes: the design, operation, and maintenance of remote handling systems for highly activated components; the handling and transportation (usually for disposal) of highly activated components; and the specification, engineering, design and installation of radiation shielding. Shielding activities include Monte Carlo shielding calculations and heavy equipment (bridge cranes and forklifts) operation.

Support activities occur in all of the experimental support areas -- A (Building 53-003M), B (53-003N), C (53-003P), Lujan Center (53-007, 53-029, and 53-030), WNR (53-007 and 53-369), and the neutrino experiment hall (53-364).

4.3.3.2 Programs Supported

Experimental area support is provided to six of the seven major programs at TA-53. Only the High Power Microwave program is not supported.

4.3.3.3 Radioactive Materials

Radioactive Air Emissions. Operation of the 800 MeV Accelerator has in the past generated more than 90% of the radioactive air emissions from LANL. Part of these is created when the proton ion beam exits its vacuum enclosure at the beam stop and comes in contact with air. Air is also activated by neutrons indirectly produced by impingement of a small fraction of the beam on accelerator structures. Radioactive isotopes of components of the air result, primarily oxygen and nitrogen (^{14}O, ^{15}O, ^{13}N, and ^{16}N). Other radionuclides are ^{41}Ar (Argon is present in the air in small amounts.), ^{3}H (from water vapor), and carbon (from carbon dioxide) as ^{10}C and ^{11}C. About half of these radioactive air emissions come from ^{15}O, which has a half-life of two minutes. Most radioactivity decays before reaching the LANL site boundary.

In 1994, a delay line was installed on the air exhaust from the accelerator beam stop. Used as necessary to reduce emissions, the delay line provides additional time for decay of activated air components before the air is exhausted through stack ES-3. Reconfiguration of Area A when the Long-Pulsed Spallation Source is constructed in 1998 will also include design features to reduce radioactive air emissions significantly -- a source reduction technique that will eliminate the need for the delay line.

Radioactive Solid Wastes. All radioactive solid wastes resulting experimental support operations are low-level wastes. Materials consist of target materials, beam stop components, and scrap metals, plastics, and papers. Radionuclides of prominence are constituents of stainless steel -- cobalt (^{56}Co, ^{57}Co, ^{58}Co, and ^{60}Co), iron ^{55}Fe and ^{59}Fe) and chromium (^{51}Cr). Lesser radioisotopes include ^{7}Be, ^{22}Na, ^{46}Sc, ^{48}V, and ^{65}Zn. Mixed wastes in the form of lead seals and lead shielding are also generated.

4.3.3.4 Nonradioactive Toxic or Hazardous Substances

As with all TA-53 operations, small quantities of RCRA hazardous and TSCA toxic wastes result from neutron and other experiments. Examples include waste liquid solvents, solvents on wipes, lead, and solder.

4.3.3.5 Hazardous Energy Sources

Energy sources include compressed gases and cryogens, high voltage, non-ionizing radiation, and flammable liquids and gases.

4.3.3.6 Other Consequences of Operations

None

4.3.4 Capability #4 -- RF Technology & Operation

4.3.4.1 Description

The 800 MeV and LEDA accelerators require large power sources, and both are supplied at TA-53 by radiofrequency (rf) power sources. The capability to design, fabricate, operate, and maintain rf systems for accelerators and other applications is extremely important to TA-53 operations. The capability also provides the rf systems, including state-of-the-art fast feedback controls and high-power klystron amplifiers, used in electron accelerator projects and other advanced accelerator concepts at TA-53. RF technology development also supports microwave materials processing and rf system design. Design work includes determining optimal systems for very high-power continuous-duty systems for applications such as APT.

RF power generation for the 800 MeV accelerator primarily occurs in the above-grade portions of Building 53-003, Sectors A through H, and will occur in Building 53-365 for LEDA.

4.3.4.2 Programs Supported

RF technology and operations capabilities are required and used by all seven major programs at TA-53.

4.3.4.3 Radioactive Materials

None

4.3.4.4 Nonradioactive Toxic and Hazardous Substances

As with all TA-53 operations, small quantities of RCRA hazardous and TSCA toxic wastes result from neutron and other experiments. Examples include waste liquid solvents, solvents on wipes, lead, and solder. Although not a toxic or hazardous material, from 200-300 gallons of oil are contained in each klystron modulator tank.

4.3.4.5 Hazardous Energy Sources

RF power sources are hazardous energy sources. Very large rf power sources are supplied to the 800 MeV accelerator, and will be supplied to the LEDA. Smaller rf sources power laboratory-scale advanced accelerators and microwave experiments. X-Rays are generated as a by-product of rf power generation. Other energy sources include compressed gases and cryogens, high voltage, non-ionizing radiation, and flammable liquids and gases.

4.3.4.6 Other Consequences of Operations

Electricity. RF operations consume about 90% of the 21 MW of power from the electric grid to power the 800 MeV accelerator, and will consume another 8,000 kilowatts of electric power to power the LEDA. Historically, the 800 MeV accelerator accounts for about one-fourth of LANL's electrical power consumption, and this should continue. Operation of the Low Energy Demonstration Accelerator will triple this demand by 2000.

Water. LANSCE rf power sources and support equipment are cooled by water. Three cooling towers (Structures 53-060, 53-062, and 53-064) are used to cool water, remove heat, and reduce water consumption by recycling most of the cooling water. Makeup water is required, however, to replace water lost to evaporation and to replace blowdown water discharged to prevent mineral buildup and fouling of cooling tower surfaces and associated equipment. LEDA cooling requirements will be even greater, and the existing cooling tower (Structure 53-1032) will be supplemented with two more cooling towers.

NPDES Industrial Water Discharges. Cooling tower blowdown waters are discharged through outfalls permitted under the National Pollutant Discharge Elimination System (NPDES) of the Clean Water Act. The waters contain commercial chemical additives that reduce corrosion and inhibit scale formation, and are restricted to discharge concentrations of less than 30 PPM suspended solids, 20 PPM phosphorous, and 1-PPM chlorine. Three outfalls (047, 048, and 049) receive cooling tower blowdown from cooling towers that that service rf power, and outfall 113 will receive blowdown from LEDA. Effluent volume from generation and delivery of the 800 MeV proton beam averages about 35 million gallons per year; while discharges from LEDA operations will total about 39 million gallons per year beginning in 2000.

4.3.5 Capability #5 -- High Power Microwaves and Advanced Accelerators

4.3.5.1 Description

HPMW research and experiments, mostly conducted in Buildings 53-014 and 53-018, are conducted in a number of technology areas: (a) High power microwave, rf, and electromagnetic pulse sources that typically use multi-kiloampere, relativistic electron beams; (b) future linac power sources and directed energy; (c) explosively driven high power microwave and rf systems for defense applications; (d) intense beam physics and modeling for application to high power microwave source development; (e) high power free electron lasers (FELs) based on high brightness electron accelerators; (f) high brightness accelerator as a driver for an extreme ultraviolet source for lithography; (g) high performance ground penetrating radar for environmental remediation; (h) application of high power microwaves to industrial processing such as chemical catalysis and environmental remediation; (i) microwave and EMP vulnerability and effects testing of weapons systems; (j) novel high power microwave sources based on shock compression of solid materials; and (k) advanced pulsed power modulator development.

4.3.5.2 Programs Supported

High power microwave operations directly support only the HPMW and Advanced Accelerator Program.

4.3.5.3 Radioactive Materials

Levels of air activation from electron accelerator operations are well below levels required by EPA for monitoring or controls. HPMW and FEL experimental activities generate occasional low-level waste items (activated beam line components) in small quantities (less than 10 cubic feet per year).

4.3.5.4 Nonradioactive Toxic or Hazardous Substances

HPMW and FEL experimental activities use common solvents (alcohols, acetone, etc.) for cleaning components and a variety of adhesives lubricants, and other chemical products common to laboratory/shop operations; the total inventory is normally less than 250 gallons. Cesium, antimony, and potassium are used in gram quantities for photocathode preparation.

A total of approximately 6000 gallons of dielectric oil is used in rf power sources, a Marx generator, and other equipment in Building 53-014. A modulator tank in Building 53-018 and associated power supplies contain approximately 4000 gallons of dielectric oil. The oils have a high flash point (over 300 ^{o}F), and do not contain PCBs or constituents hazardous to personnel.

HPMW and FEL experimental activities generate small quantities (less than 30 gallons/year) of spent solvents, solvent-contaminated cleaning rags, and solder waste.

4.3.5.5 Hazardous Energy Sources

HPMW laboratories house microwave energy sources, a Class IV drive laser, a free-electron laser, and two small linear accelerators. Ionizing radiation exposures from HPMW and FEL experiments have normally been below the detectable range, though slightly increased exposure may be possible due to full power operation of the EUVL electron accelerator scheduled to begin in 1996 in Building 53-014. Nonionizing (microwave) radiation is controlled to levels safe for personnel exposure per ANSI C95.1.

4.3.5.6 Other Consequences of Operations

None

4.3.6 Capability #6 -- Neutron Research and Technology

4.3.6.1 Description

Basic research is conducted on the interaction of neutrons with nuclei to advance nuclear physics and LANL's capability in the diagnosis of nuclear and non-nuclear hydrodynamics. Applied neutron research is conducted to provide scientific and engineering support to weapons stockpile stewardship and nonproliferation surveillance. Efforts will include neutron radiography of weapons components and dynamics. Research is also performed to develop instrumentation and diagnostic devices, with a goal of transferring of technology to military and commercial applications.

Upon completion of the Long Pulse Spallation Source in 2000, research using ultracold neutrons (UCNs) will begin. The LPSS will be the only high-intensity, UCN source in the U.S., and will match the world's best facilities in several areas and exceed them in others. UCNs are critical to our understanding of physics principles such as the origin of parity violation in elementary particle and nuclear interactions, the detailed nature of time reversal nonconservation, and the relative abundance of light elements predicted by the Big Bang theory. Experiments conducted at the LPSS will place the U.S. in an immediate position of leadership in this new area of fundamental research.

4.3.6.2 Programs Supported

Neutron research and technology capabilities support programs for Stockpile Stewardship, Accelerator Production of Tritium, Accelerator Driven Transmutation Technology, and Neutron Scattering.

4.3.6.3 Radioactive Materials

As a beam user, neutron-related experiments contribute slightly to radioactive air emissions as a result of beam delivery to neutron production targets. Radioactive air emissions are the same as those resulting from beam generation and delivery (isotopes of oxygen, nitrogen, carbon, argon, and hydrogen), but are produced in far smaller than quantities.

Radioactive solid wastes are generated during maintenance and removal of experiments. All radioactive solid wastes resulting from neutron-related experiments are low-level wastes. Materials consist of target and experiment materials, and scrap metals, plastics, and papers. Radionuclides vary, being largely a function of the different materials used in experiments.

4.3.6.4 Nonradioactive Toxic or Hazardous Substances

As with all TA-53 operations, small quantities of RCRA hazardous and TSCA toxic wastes result from neutron experiments. Examples include waste liquid solvents, solvents on wipes, lead, and solder.

4.3.6.5 Hazardous Energy Sources

None. Beam delivery requires strong magnetic fields at points throughout the accelerator complex, such as where the beam is re-directed to experimental targets. Other energy sources include compressed gases and cryogens, high voltage, non-ionizing radiation, and flammable liquids and gases.

4.3.6.6 Other Consequences of Operations

None

4.3.7 Capability #7 -- Subatomic Physics Research

4.3.7.1 Description

Experiments will be conducted at the Liquid Scintillator Neutrino Detector facility (Building 53-364) through 1997. These are conducted in conjunction with several universities. Atomic parity nonconservation experiments are conducted in Area A. These use a thin target to produce unstable isotopes, and detectors to measure their properties. Subatomic physics research will also develop proton radiography as a viable technology for stockpile stewardship needs. Experiments to date have been directed at radiographing static objects in the P^3 channel of Area A, but will progress to dynamic experiments upon construction of a proton radiography firing site. Dynamic experiments will use varying amounts of high explosives in containment vessels to demonstrate the temporal performance of proton radiography. Experiments are also planned to demonstrate concepts for advanced detectors.

4.3.7.2 Programs Supported

Subatomic physics research efforts support only the Nuclear Physics Program.

4.3.7.3 Radioactive Materials

As a beam user, subatomic physics research has contributed to radioactive air emissions resulting from use of two Area A targets. These targets will be removed in 1998 when Area A is reconfigured for the Long Pulse Spallation Source. Radioactive air emissions are the same as those resulting from beam generation and delivery (isotopes of oxygen, nitrogen, carbon, argon, and hydrogen), but are produced in far smaller than quantities.

All radioactive solid wastes resulting from subatomic physics research are low-level wastes. Materials consist of target and experiment materials, and scrap metals, plastics, and papers. Radionuclides vary, being largely a function of the different materials used in experiments.

4.3.7.4 Nonradioactive Toxic or Hazardous Substances

As with all TA-53 operations, small quantities of RCRA hazardous and TSCA toxic wastes result from subatomic physics research. Examples include waste liquid solvents, solvents on wipes, lead, and solder.

4.3.7.5 Hazardous Energy Sources

Beam delivery requires strong magnetic fields at points throughout the accelerator complex, such as where the beam is re-directed to experimental targets. Other energy sources include compressed gases and cryogens, high voltage, non-ionizing radiation, and flammable liquids and gases.

4.3.7.6 Other Consequences of Operations

None

4.3.8 Capability #8 -- Physics and Engineering

4.3.8.1 Description

In order to produce high-performance accelerator systems for future projects at Los Alamos, research and development are necessary to advance the state-of-the-art in accelerator physics and engineering design and analysis. Activities include the design and construction and testing of electron and proton linear accelerators, and related structures and components, for a variety of applications.

Activities combine a wide range of expertise in:

- linac beam dynamics
- normal and superconducting rf structures
- magnet theory and design
- fast-magnet pulsed power
- beam diagnostic measurements
- high-order beam optics
- storage rings and beam transport
- mechanical engineering analysis and design
- computer aided engineering, drafting, and manufacturing
- accelerator fabrication, assembly, and commissioning.

Two activities are conducted in Building 53-017: an accelerating structures laboratory for development and tuning of room-temperature and superconducting rf cavities; and a beam-diagnostic development facility equipped with automated rf and electromagnetic diagnostics test equipment. Buildings 53-002 and 53-018 house a magnet laboratories for fabrication, testing, and measurement of accelerator magnets.

Engineering and design has been performed for a wide variety of hardware equipment such as; precision mechanisms, composite structures, accelerator related equipment, vacuum equipment, optical equipment, and other state of the art hardware. Capability exists for the design and assembly of accelerator and non-accelerator related hardware. In addition, capabilities have been used to develop, maintain, and distribute accelerator design and simulation codes used worldwide by the accelerator community.

4.3.8.2 Programs Supported

Physics and engineering capabilities are required and used by all major programs at TA-53.

4.3.8.3 Radioactive Materials

Ionizing radiation exposures from physics and engineering laboratory activities are normally below the detectable range.

4.3.8.4 Nonradioactive Toxic or Hazardous Substances

Laboratory activities use common solvents (alcohols, acetone, etc.) for cleaning components and a variety of adhesives lubricants, and other chemical products common to laboratory/shop operations; the total inventory is normally less than 250 gallons. Laboratory activities primarily generate small quantities (less than 30 gallons/year) of spent solvents, solvent-contaminated cleaning rags, and solder waste.

4.3.8.5 Hazardous Energy Sources

Nonionizing (microwave) radiation is controlled to levels safe for personnel exposure per ANSI C95.1. Magnetic fields are monitored, and appropriate safety practices are defined by procedure.

4.3.8.6 Other Consequences of Operations

None

4.3.9 Capability #9 -- Controls and Automation

4.3.9.1 Description

Controls and automation provides automated control systems, software tools, and support services for electronic design and computer networks for TA-53 and the domestic and international accelerator and astronomy communities. The primary products are control systems and control technology based on the Experimental Physics and Industrial Control System (EPICS) software tool kit. EPICS is used to build process control systems for a wide variety of applications, both experimental and industrial. The software tools in this kit are independent, expandable modules that can be tailored to serve specific process control functions, making EPICS extremely adaptable. EPICS is being developed in a collaboration, originated at TA-53, that includes LANL, ANL, SSCL, CEBAF, DESY, ORNL, SLAC, MIT, Duke and two industrial partners. EPICS is either being used or being evaluated for use on most of the new large accelerator, particle detector and optical telescope projects in the world. EPICS technology has successfully contributed to national defense, civilian and commercial technology needs. It is being produced by a unique collaboration of DOE laboratories; it is successfully employed on many research programs; and it has been successfully transferred to the process control and data acquisition industry.

4.3.9.2 Programs Supported

Controls and automation capabilities are required and used by all seven major programs at TA-53.

4.3.9.3 Radioactive Materials

None

4.3.9.4 Nonradioactive Toxic or Hazardous Substances

As with all TA-53 operations, small quantities of RCRA hazardous and TSCA toxic wastes result from the production of control systems. Examples include waste liquid solvents, solvents on wipes, lead, and solder.

4.3.9.5 Hazardous Energy Sources

None

4.3.9.6 Other Consequences of Operations

None

4.3.10 Capability #10 -- Medical Isotope Production

4.3.10.1 Description

The 800 MeV accelerator proton beam is used to produce radioisotopes used by the medical community for diagnostic procedures, therapeutic treatment, clinical trials, and biomedical research. Nearly 40 different medical radioisotopes have been produced and shipped in the twenty years of production at LANL. During 1995, for example, 75 shipments were made to user facilities in nine countries, including France, Germany, and Australia.

Isotopes are currently produced at the IPF, or Isotope Production Facility, at the linac beam stop in Building 53-003M. The IPF makes use of that portion of the proton beam that is not consumed by and used for proton and neutron experiments and research. The IPF has nine independent stringers or target stations. A small amount of target material is loaded onto each movable stringer, and the stringer is inserted into the proton beam path. Remote handling equipment and water-cooled targets are required due to the high radiation levels (up to 50,000 R/hr) and temperatures (up to 1,000 ^{o}C) generated by the spallation process.

Targets are transported from TA-53 to TA-48 for recovery of the desired radioisotopes from the target material. Complex separation process must be employed, including ion exchange, solvent extraction, distillation, and electrochemical deposition. TA-48 operations are conducted in hot cells.

4.3.10.2 Programs Supported

Isotope production facilities support only the Medical Isotopes Program.

4.3.10.3 Radioactive Materials

Nearly 40 different medical radioisotopes have been produced at the IPF. Routinely produced isotopes include ^{82}Sr, ^{68}Ge, ^{109}Cd, ^{22}Na, ^{67}Cu, and ^{88}Y. Other resources produced when time and resources permit include: ^{73,74}As, ^{26}Al, ^{7}Be, ^{207}Bi, ^{148}Gd, ^{172}Hf, ^{194}Hg, ^{92}Nb, ^{83}Rb, ^{72,75}Se, ^{32}Si, ^{85}Sr, ^{95m}Tc, ^{48}V, ^{65}Zn, and ^{88}Zr (Medical Isotope Program Office April 26, 1995).

4.3.10.4 Radioactive Air Emissions

Isotope production has in the past, and will for two more years, operate at the beam stop for the 800 MeV accelerator. The beam stop is the source of most of the radioactive air emissions from TA-53, and has been discussed in section 2.2.1.3.1 above. Radioactive isotopes include oxygen and nitrogen (^{14}O, ^{15}O, ^{13}N, and ^{16}N), ^{41}Ar), ^{3}H (from water vapor), and carbon (from carbon dioxide) as ^{10}C and ^{11}C.

4.3.10.5 Radioactive Water

Isotope production has in the past, and will for two more years, operate at the beam stop for the 800 MeV accelerator. The beam stop is the source of most of the radioactive water from TA-53, and has been discussed in section 2.2.1.3.2 above. The primary radioactive isotopes include ^{3}H and ^{7}Be, while ^{22}Na, ^{54}Mn, ^{57}Co, and ^{60}Co are also present. The lesser elements result from leaching of aluminum, copper, and stainless steel materials that come in contact with the cooling waters.

The beam stop cooling system is the source of more than 90% of the radioactive water (both volume and radioactivity) generated at TA-53. This cooling system is drained (and re-filled) at a rate of 40-60 gallons per hour when the beam is in operation. The low-level radioactive water is currently discharged to underground holding tanks, which are periodically drained to the low-level radioactive water holding lagoon. Alternative treatment techniques are under evaluation.

4.3.10.6 Radioactive Solid Wastes

All radioactive solid wastes resulting from medical isotope production are low-level wastes. Materials removed from the IPF are normally contaminated. Materials consist of miscellaneous components and parts, and scrap metals, plastics, and papers.

4.3.10.7 Nonradioactive Toxic or Hazardous Substances

As with all TA-53 operations, small quantities of RCRA hazardous and TSCA toxic wastes result from medical isotopes production. Examples include waste liquid solvents, solvents on wipes, lead, and solder.

4.3.10.8 Hazardous Energy Sources

The proton beam itself is a hazardous energy source. Numerous safety systems and procedural controls exist as precautionary measures to protect workers from the beam. Irradiated targets retrieved for processing generate high radiation fields (up to 50,000 R/hr), and can only be handled via remote equipment, and shipped in shielded casks.

4.3.10.9 Other Consequences of Operations

None.

4.3.11 Capability #11 -- Facility Management Services

4.3.11.1 Description

Facility Management Services provides facility and plant operating and engineering services, ES&H services and oversight, site and building physical security, visitor control, and facility specific training. The entire Facility Management Team is comprised of AOT-FM personnel; personnel from ESH-1, Radiation Protection; ESH-5, Industrial Health and Safety; and FSS-9, Facilities Operations and Maintenance. The TA-53 Facility Manager is responsible for ensuring that all operations at the facility are conducted within an approved safety envelope and in accordance with applicable federal and state laws and rules, DOE Orders, and Laboratory standards and requirements.

4.3.11.2 Programs Supported

Facility Management personnel support all of the programmatic activities at TA-53.

4.3.11.3 Radioactive Materials

Facilities Management does not generate radioactive wastes, but handles some radioactive materials as part of its waste management responsibilities.

4.3.11.4 Nonradioactive Toxic or Hazardous Substances

Facilities Management does not generate nonradioactive toxic or hazardous wastes, but handles these wastes as part of its waste management responsibilities.

4.3.11.5 Hazardous Energy Sources

None

4.3.11.6 Other Consequences of Operations

Facility Management services provide electricity, natural gas, and water all consumers throughout TA-53. Examples include electricity for lighting and other uses in office buildings, natural gas for space heating, and water for sinks, restrooms, and drinking fountains, as well as the programmatic operational needs discussed above.

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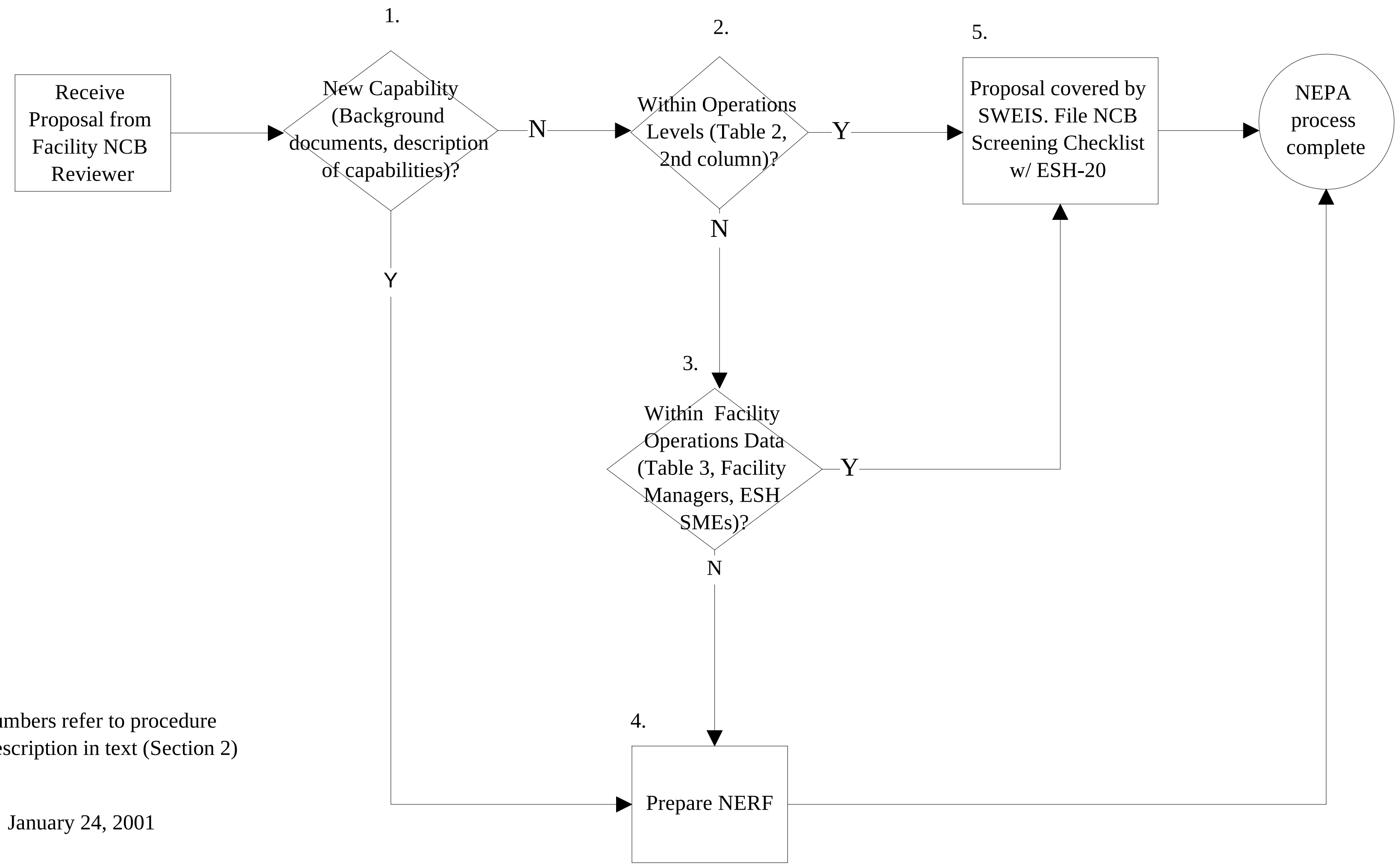
Attachment 1: ESH-20 Screening Flow Chart



Numbers refer to procedure description in text (Section 2)

January 24, 2001

Attachment 2: NCB Screening Checklist

REVIEWER: DATE:

PROJECT TITLE:

PROJECT IDENTIFIER/Reference No:

DESCRIPTION/Comments:

Air or water emissions to environment: Yes ☐ No ☐

Describe issue or resolution:

LOCATION: FMU No: FMU No:

TA:__ Building:_____ TA:__ Building:_____ TA:__ Building:_____

TA:__ Building:_____ TA:__ Building:_____ TA:__ Building:_____

Other: _____

CRITERIA:

2a. 1. Schedule or location modified to avoid T&E concerns?	Yes ☐	No ☐
2. After project modification is there an unresolved T&E issue?:	Yes ☐	No ☐
3. For T&E buffer areas, map of project footprint is attached or has been sent to ESH-20?	Yes ☐	No ☐
2b. Floodplain issue:	Yes ☐	No ☐
2c. Wetland issue:	Yes ☐	No ☐
Wetland BMPs implemented?	Yes ☐	No ☐
2d. Modifications to a historic building:	Yes ☐	No ☐
2e. Archaeological resources affected:	Yes ☐	No ☐
Sites within project area were avoided (notify ESH-20 and provide map):	Yes ☐	No ☐

3a. NEPA Documentation:

CX (specify): LAN-__-_____ LAN-__-_____

Site-wide EIS (specify): Facility NCB Document No.: _____ Operations Level (Use Table 2): _____

3b. Conditions that preclude a cx or SWEIS reference:

Connected action:	Yes ☐	No ☐
Extraordinary circumstances	Yes ☐	No ☐
Siting/expansion - Treatment, Storage, Disposal facility?	Yes ☐	No ☐
Uncontrolled releases of contaminants	Yes ☐	No ☐

Reviewed by ESH-20 NCB staff:

NEPA:	Name	Date	Comment:
Biological Resources:	Name	Date	Comment:
Cultural Resources:	Name	Date	Comment:
Other:	Name	Date	Comment: