8 Safety Analysis — Other

8.1 Fire Hazards

8.1.1 Hazard Event: Damage or injuries to personnel caused by fire in the accelerator housing or in the equipment areas outside the housing, or in the control room.

8.1.1.1 Description of Occurrence

The possibility exists of fire from overheating of electrical components or other causes which may present a risk to workers. No risk is presented to off-site personnel.

8.1.1.2 Prevention/Mitigation

The fire-protection systems currently installed in the NLCTA housing, control building, and substation were recently installed for the project, under the review of the SLAC Fire Protection Engineer. Heat-sensitive sprinkler systems are installed in End Station B (covering the instrumentation racks, power supplies, cable trays, klystrons, and modulators), in the accelerator housing, and in the control building. The sprinkler protection is hydraulically designed for Ordinary Hazard, Group II protection. The design density is 0.2 gpm per square foot over 1,500 square feet. The beam-line housing is additionally protected by a Fenwal high-sensitivity smoke-detection system. End Station B, the substation, and the control building are protected by ionization-type smoke detectors. All of these fire-protection systems were made operational early in the construction phase of the project.

SLAC subcontracts with the Palo Alto Fire Department (PAFD) to operate an on-site fire station, to provide emergency response services, to conduct ongoing fire safety inspections of SLAC facilities, and to train SLAC personnel on fire safety. All fire-alarm information from the NLCTA facility is available at the PAFD fire station at SLAC. The distance by road from the fire station to the NLCTA facility is 0.7 miles; driving time is two minutes.

SLAC submitted a Fire Hazards Analysis (FHA) to the DOE Site Office on May 11, 1995.

8.1.1.3 Consequence

The consequence may be minor injuries to on-site personnel, no off-site impact; consequence is Low.

8.1.1.4 Probability

Fire involving injury to personnel is not expected to occur during the life of the facility; probability is Low.

Hazardous Materials

Articles fabricated from lead are used in the facility. No cutting, welding, or machining of these articles will take place within the housing. Fabrication of lead articles will take place elsewhere on site and is guided by the provisions of Chapter 2 of the SLAC *Environment, Safety, and Health Manual.*

No other hazardous materials are planned to be used in the course of operation of the facility.

Electrical Hazards

8.3.1 Hazard Event: Electroshock due to worker contacting energized conductor of magnet, etc., within shielding enclosure.

8.3.1.1 Description of Occurrence

Personnel enter the shielding enclosure from time to time for maintenance purposes. Electrical loads within the enclosure (magnets) are in some cases un-insulated. Workers are involved in maintenance upon magnet power supplies, Klystron modulators, and other equipment capable of causing serious electroshock.

8.3.1.2 Prevention/Mitigation

It is SLAC policy that every necessary precaution should be taken in the performance of work to protect all persons on the site from the risk of electrical shock and to minimize the probability of damage to property due to electrical accidents. This policy is implemented by assigning responsibility and adhering to basic safety principles, as stated in the SLAC *Environment, Safety, and Health Manual,* Chapter 8, "Electrical Safety," and by complying with regulations and procedures appropriate to each operation. Appropriate electrical safety training courses are provided by the Laboratory for those workers who are likely to be exposed to high-voltage hazards. Several NLCTA subsystems, such as the Klystron pulse modulators, will employ high voltages. The controls and work procedures necessary to ensure safe work on these systems are well understood. The provisions for locking of these systems will utilize SLAC's established procedures for lockout and tagout as described in SLAC's document, *Lock and Tag Program for the Control of Hazardous Energy* (SLAC-I-730-0A10Z-001, current revision). Energized equipment will be worked on only under very limited and controlled conditions, and only qualified employees will perform such work. All work will be performed in accordance with safe work practices and in accordance with OSHA 1910, Subpart S. Special procedures are in place to permit authorized personnel to occupy areas adjacent to energized hazardous magnets. These procedures are called RASK, for "Restricted Access Safety Key." Under these procedures, a special RASK authorization form must be filled out to obtain a key that enables the hazardous supply under test. Testing is done in accordance with written procedures. The emergency-off buttons remain active and will turn off the power supply when pushed.

Ground Fault Circuit Interrupters (GFCIs) have been installed on all 110-V circuits inside the NLCTA housing, and in the control building, where appropriate. All new electrical installations are in accordance with the National Electric Code (NEC).

The SLAC Electrical Safety Committee has reviewed and approved the electrical safety design of the NLCTA housing, the electrical power distribution system, the control building, and the substation (memo Garg-Lavine, July 12, 1994).

All un-insulated electrical conductors (above 50 volts) within the shielding enclosure are automatically de-energized by the Personnel Protection System before access to the relevant zone of the shielding enclosure is allowed. In cases where work on or near a particular load is intended, the power source must also be isolated by means of lock and tag.[1]

8.3.1.3 Consequence

The consequence level of an inadvertent contact with an energized conductor may range from Extremely Low to Medium.

8.3.1.4 Probability

The probability of such an occurrence is Low.

8.4 Non-ionizing Radiation

8.4.1 Hazard Event: Workers may be exposed to non-ionizing radiation in the microwave spectrum.

8.4.1.1 Description of Occurrence

Personnel enter the shielding enclosure from time to time for maintenance purposes. Various pulsed high-power rf sources are used in the acceleration of particle beams.

8.4.1.2 Prevention/Mitigation

All high-power microwave sources are interlocked with the Personnel Protection System such that they are required to be de-energized before access is allowed in the relevant zone. In addition, the energy is fully contained within the envelope of the waveguides or vacuum chambers. If the vacuum chambers or waveguides are opened, separate interlocks prevent the source from being energized. In cases where work on or near a particular load is intended, the power source must also be isolated by means of lock and tag. Certain low power microwave sources are not enclosed in a vacuum envelope. In these cases (the Travelling Wave Tube (TWT) associated with each modulator) the bolts securing the assembly are secured with locking wire.[2]

8.4.1.3 Consequence

The consequence level of an exposure to one of these sources of non-ionizing radiation sources is Low.

8.4.1.4 Probability

The probability of such an occurrence is Low.

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[1] See *SLAC Guidelines for Operations*, Guideline 17, "Electrical Safety," (01-01-17-01) and Guideline 18, "Control of Work on Electrical Devices in Beam Housings" (01-01-18-01).

[2] See NLCTA Note #58, Wilson, Z. "Non-ionizing Radiation Leakage Protection," March 1, 1996.

8.5 Cryogenic Hazards

No cryogenic materials are planned to be used in the course of operations of this facility except for liquid nitrogen, in quantities consistent with light industrial practice. Since the NLCTA enclosure is not ventilated, a hazard could exist if more than 200 liters of liquid nitrogen is permitted to vent into the closed housing. Portable dewars exceeding this volume are not permitted inside the housing. A failure sequence which is capable of causing personnel injury due to oxygen deficiency is considered non-credible.

8.6 Flammable Gases or Fluids

No flammable gases or fluids are planned to be used in the course of operations of this facility, other than insulating oil used in the high voltage transformers which feed the klystrons. This has been included in the Fire Hazard Analysis filed on May 11, 1995.

8.7 Seismic Hazards

8.7.1 Hazard Event: Damage or injuries to personnel caused by collapse of structures consequent upon a major earthquake with an epicenter close to the site.

8.7.1.1 Description of Occurrence

The SLAC site is located close to a number of active earthquake faults (see Section 2.3, above). In the event of a major earthquake the possibility exists of structural damage to buildings or overturning of equipment, which may present a risk to workers. No risk is presented to off-site personnel.

8.7.1.2 Prevention/Mitigation

All NLCTA structures and equipment are subject to the seismic safety guidelines put forth by the SLAC Earthquake Safety Committee and stated in the SLAC document *Building Manager Manual* (SLAC-I-720-0A03Z-001), Section B, "Seismic Safety Guidelines." Consequently, all structures and non-structural equipment are designed and restrained so as to protect life, minimize injuries, prevent environmental damage, and maintain the basic mission of the laboratory in the event of an earthquake. The NLCTA project does not present any unique earthquake hazards for SLAC. The project will easily fit within ongoing site-wide earthquake safety practices.

Since the NLCTA lies in close proximity to known earthquake faults, a conservative seismic design was required from the beginning. For structures and equipment, the basis for seismic design was DOE-STD-1020-94 for Performance Category 2 buildings. Specifically, all new structures built for the NLCTA project (the accelerator housing, control building, and substation) are designed to withstand horizontal accelerations up to 0.6 g (50% greater than that required by the 1994 Uniform Building Code, Paragraph 1628), and vertical accelerations up to 0.4 g. Consequently, a portion of the south shielding wall of End Station B was seismically upgraded by the NLCTA project to meet the same base-shear requirements as the new structures.

The SLAC Earthquake Safety Committee has reviewed and approved (memo Youngman to Lavine, July 13, 1994) the seismic design of the NLCTA shielding, the overhead utilities and cable tray support system, the substation, the control building, and the structural modification to the south shielding wall of End Station B.

8.7.1.3 Consequence

The consequence may be minor injuries to on-site personnel, no off-site impact; consequence is Low.

8.7.1.4 Probability

Damage to the facility involving injury to personnel is not expected to occur during the life of the facility; probability is Low.