LCLS Preliminary Hazards Analysis

Introduction

In accordance with requirements of DOE Program and Project Management Practices, the SLAC Integrated Safety Management Plan (ISM) and the DOE Accelerator Safety Order, this Preliminary Hazard Analysis Report (PHA) has been prepared as part of the Critical Decision 1 (CD-1) process for the Linac Coherent Light Source (LCLS). A Free-Electron-Laser (FEL) R&D facility operating in the wavelength range 1.5–15 Å that utilizes the SLAC Linac and produces sub-picosecond pulses of short wavelength x-rays with very high peak brightness and full transverse coherence.

As of this time, the LCLS organization at the system level has been identified, the proposed building layouts have been determined and the required configuration of the accelerator has been established. Hazard identification and assessment is provided to the degree possible in these early stages of design. Ultimately it will fold into a larger program that will address all sources of risk, ensure that they are understood, and subsequently controlled or mitigated in a manner consistent with the assumptions defined in the Safety Assessment Document (SAD). These assumptions and limits define the Safety Envelope.

The PHA does not encompass operations, experiments, closure or decommissioning. These will be addressed at a later time in the both the Safety Assessment Document and Accelerator Readiness Review.

1.1 Facility Description

The Stanford Linear Accelerator Center (SLAC) is a national research facility operated by Stanford University for the U.S. Department of Energy. Research at SLAC centers around experimental and theoretical particle physics using accelerated electron beams, and a broad program of atomic and solid state physics, biology and chemistry using synchrotron radiation from accelerated electron beams.

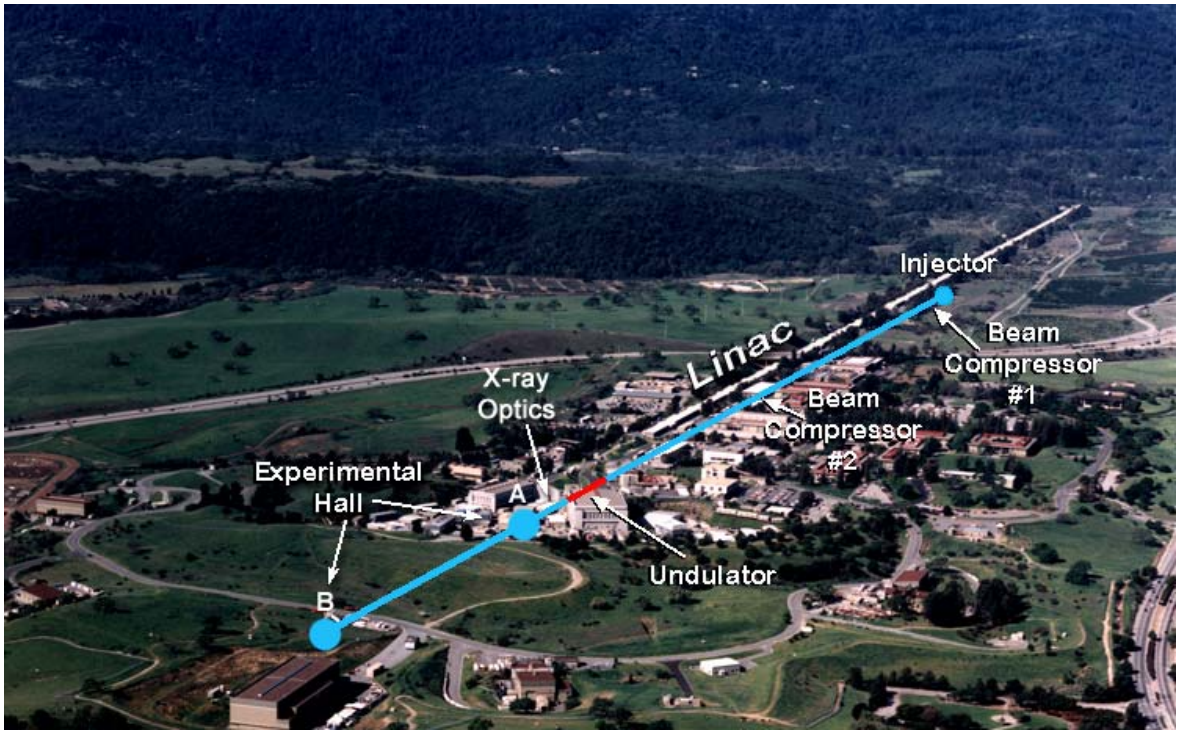
The DOE proposes to construct and operate a new research facility at SLAC, the Linac Coherent Light Source (LCLS), as a collaborative effort with SLAC, Argonne

National Laboratory, Lawrence Livermore National Laboratory, University of California at Los Angeles, Los Alamos National Laboratory, and Lawrence Berkeley National Laboratory. The purpose and need for the LCLS is the creation of a new type of X-ray light source from a single pass free electron laser (FEL). The FEL will have a peak brightness 10 orders of magnitude greater and with faster pulses (in the sub-picosecond range, resulting in much greater resolution) than the most intense synchrotron equipment currently available. Construction of this facility will further research in a broad range of fields, including physics, biology and chemistry. The LCLS will take advantage of the existing SLAC Linear Accelerator (Linac), infrastructure and utilities, resulting in construction of the most powerful FEL in the world at this time. Construction would be accomplished within SLAC's developed areas and within land leased to SLAC.

The proposed facility would consist of:

- A photoinjector and a short linac, where a bright electron beam is generated and accelerated to 150 MeV.
- The main linear accelerator, consisting of the last one-third of the SLAC 3 km linac, where the electron bunch is compressed and accelerated to 14.3 GeV.
- The transport system to the undulator.
- The undulator, where the electrons emit FEL and spontaneous radiation.
- The undulator-to-experimental area transport line.
- Two new experiment halls, connected via tunnel approximately 250 meters (800 feet) in length. (Figure S-1)
- X-ray optics for control of focus, intensity and spectral bandwidth
- Basic infrastructure for future experiments.

Figure S-1. *Proposed LCLS Facilities at SLAC, view from east to west*



1.2 Injector Housing

When the SLAC linac was originally constructed in 1962, two short tunnels were built on the north side of the main linac tunnel. One is at the 1/3-point (sector 10) and another at the 2/3-point (sector 20). These tunnels were included to house future injectors that would allow efficient use of segments of the linac. The tunnel at sector 20 is located in the right place for the LCLS injector. The original construction included a surface building to support the injector. Neither the tunnel nor the surface building has been used for this purpose in the 36 years of operation of the linac.

The shielding between the off-axis tunnel and the main tunnel will be reconfigured to accommodate the beam pipe, the waveguides, an alignment pipe and other utilities. There are three penetrations between the surface building and the injector tunnel to accommodate the laser beam transfer pipe, control signals, and power connections.

The support building will be modified to have a clean room for the laser. Personnel exclusion walls will be built with a pair of doors on the west side for personnel access to the tunnel. The interlock for these doors will be integrated into the existing linac Personnel Protection System.

The injector will be powered by existing klystrons in the klystron gallery and the power will be redirected to the off-axis tunnel via a new waveguide system.

Utilities will be provided for the magnet power supplies, controls, lasers, vacuum, and diagnostics. Cooling water will come from the main linac tunnel to cool the accelerator components and from the klystron gallery for the laser and the equipment in the support building.

1.3 Linac Housing

The LCLS uses the last 1 km of the existing linac, from sector 20 through sector 30. In two sectors, sector 20 and sector 25, sections of the linac will be removed and replaced with magnets and vacuum chambers for electron beam pulse compression. While a new x-band accelerating structure will also be added at sector 20.

1.4 Undulator Hall

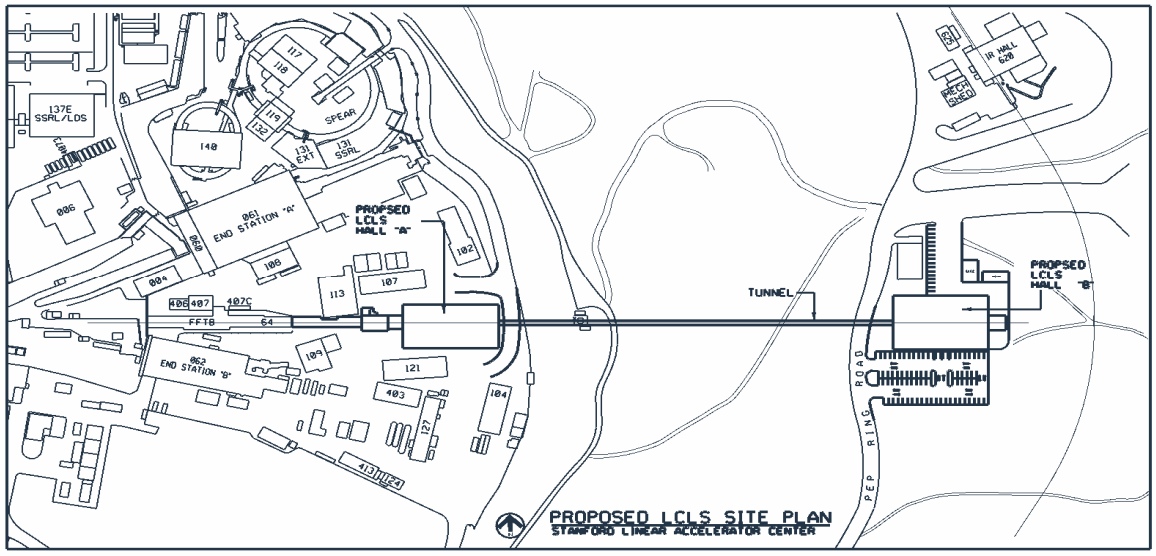
The Undulator Hall will house the electron beam dogleg, the undulator and the electron beam dump. The upstream end of this tunnel is underground and in line with the linac. The downstream part is constructed in the Research Yard from shielding blocks.

Prior to the construction of the LCLS, this hall housed the technical equipment associated with the FFTB. It will all be removed to make room for the LCLS.

The LCLS undulator requires exceptional mechanical and environmental stability. New stable supports will be installed in the tunnel for the undulator. The air handling in the tunnel will be improved to reduce the tunnel temperature variation.

1.5 Experimental Halls

The LCLS requires two experimental halls, one 40 meters downstream of the end of the undulator and the other 322 meters downstream of the end of the undulator. A tunnel for the beam line, utilities and access connects the halls.



1.5.1 Near Experimental Hall – Hall A

The near experimental hall will be constructed immediately downstream of the electron beam dump. This hall will be 30 meters wide by 55 meters in the direction of the x-ray beam. It will have 10 offices for LCLS users and on-site operations staff. This hall will include three shielded enclosures for x-ray diagnostic equipment.

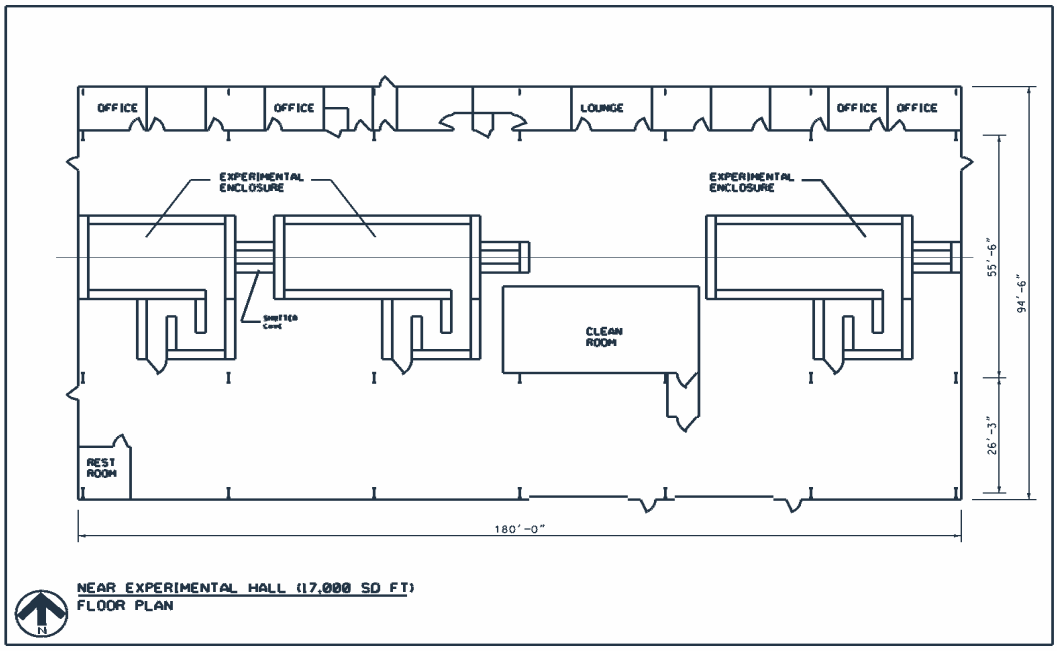
1.5.2 Far Experimental Hall – Hall B

The far experimental hall is located east of the PEP ring road. It is 57 meters in the beam direction and 35 meters wide. The floor is 6 meters below grade with the x-ray beam line 1.25 meter above the floor. The ceiling of the experimental hall is at grade level. A laboratory and office structure will be constructed on top of this hall with 95 offices and 18 laboratory and support areas. There is a service ramp from the ring road to

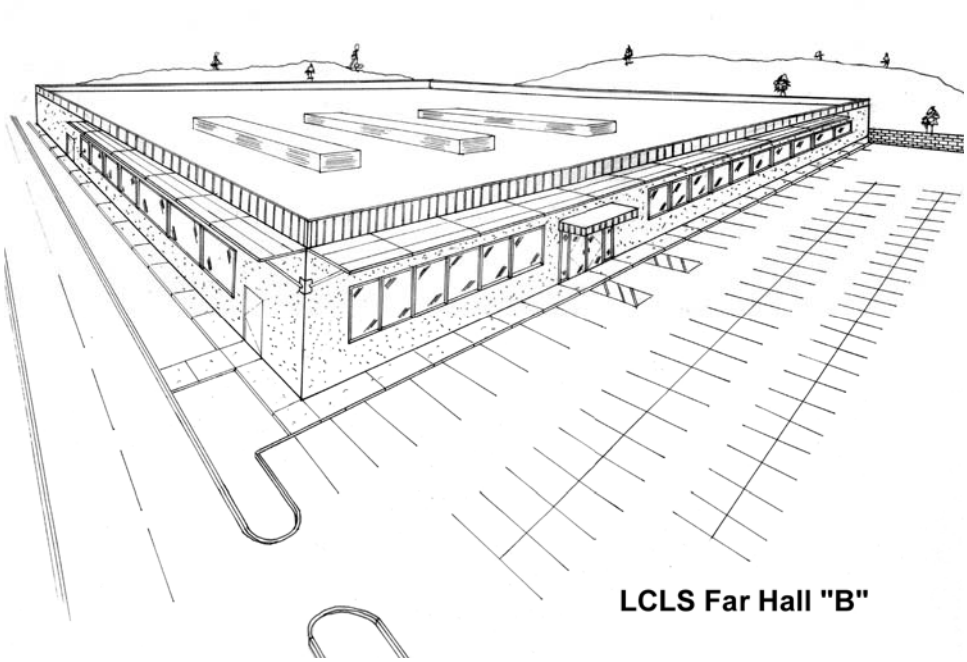
the floor of the experimental hall to allow bringing equipment directly to the experiments. Parking is provided for 70 cars.

The interior of the experiment hall will be open, allowing flexible configuration of shielding for experiments. It will have a 15-ton capacity bridge crane with a 15-foot hook height covering the experimental areas. Low conductivity water and power will be available at the walls of the building. The Far Hall will have its own low conductivity water plant. It will exchange heat with the cooling tower water from the MCC cooling tower.

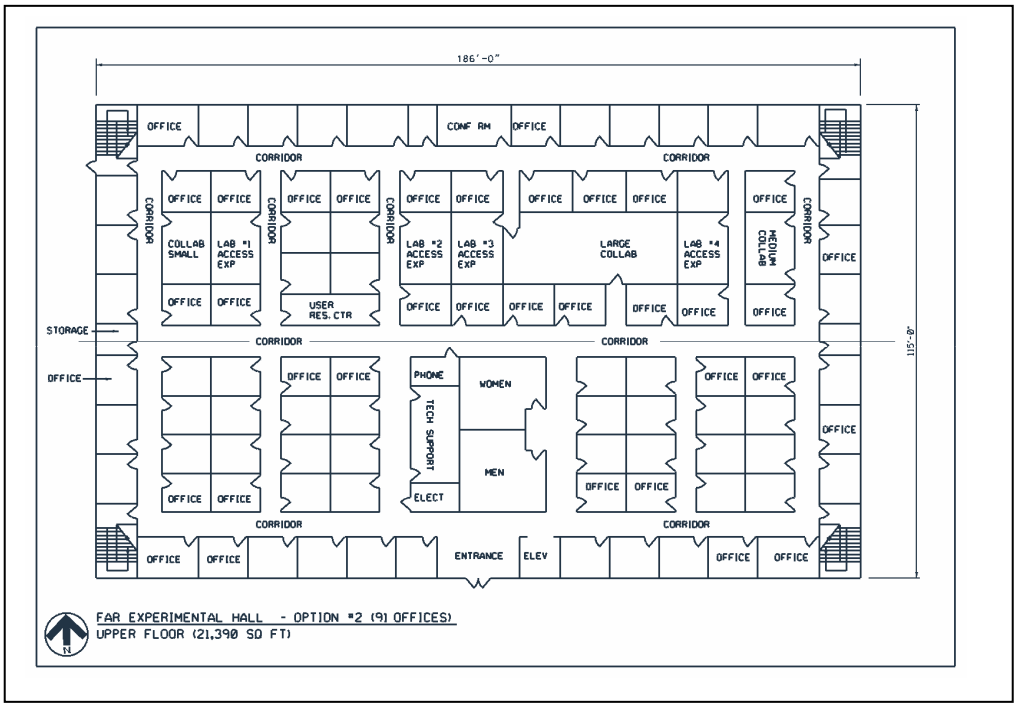
Near hall architectural rendering



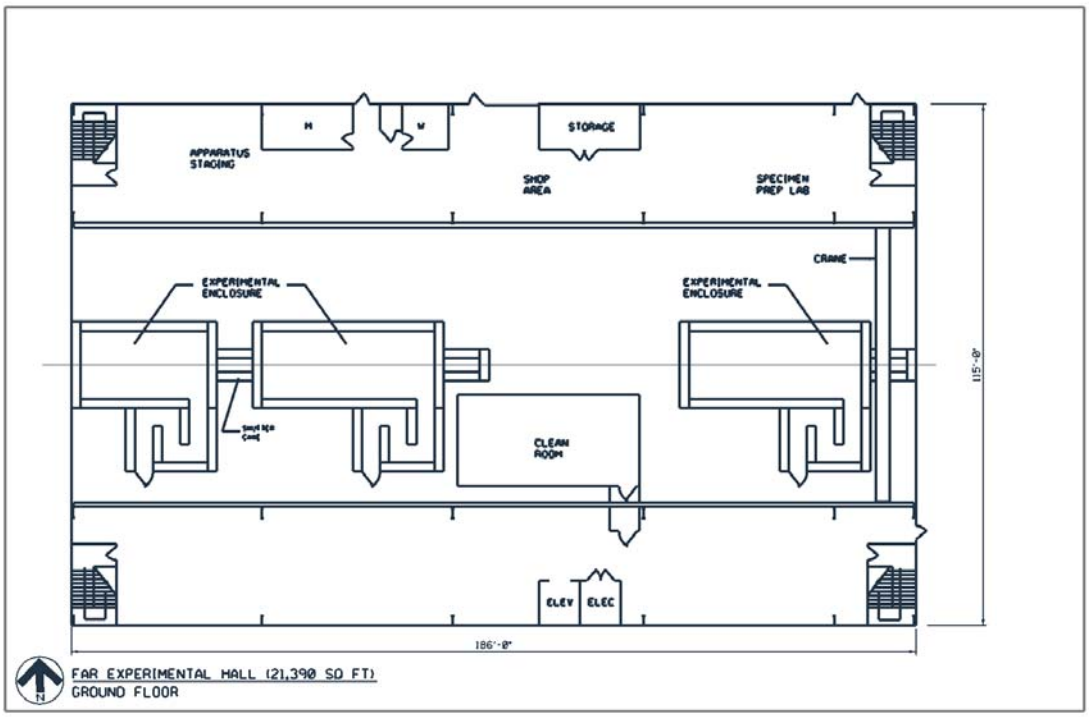
Near hall floor plan



Far hall architectural rendering



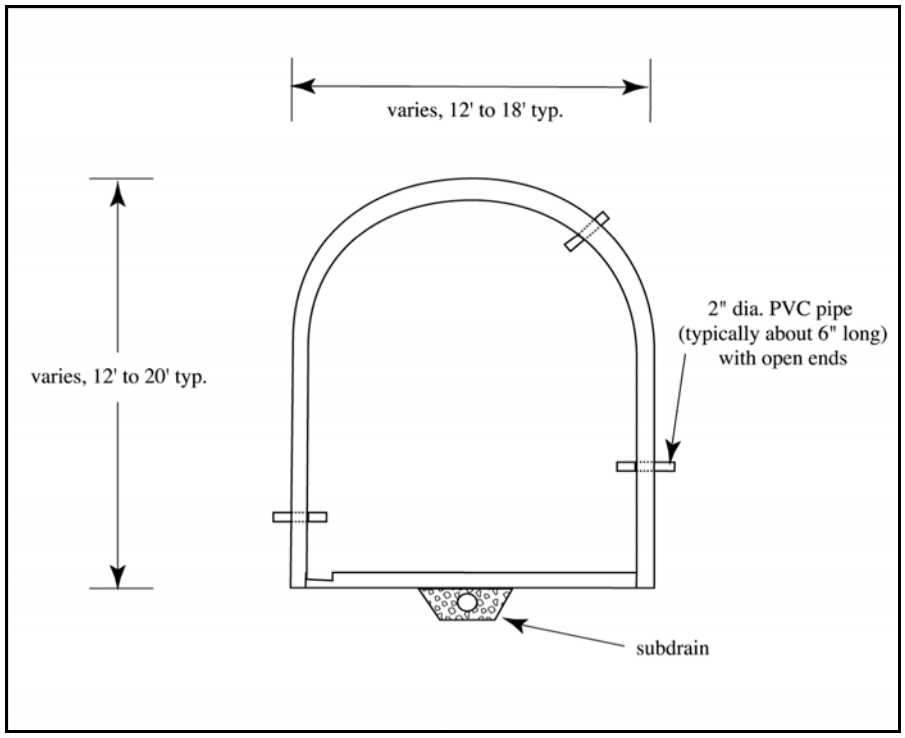
Floor plan for Far Hall second floor



Floor plan for far hall experimental floor

1.6 Beam Tunnel

The two experimental halls are connected by a 3 by 3 meter enclosure that is 227 meters long. The x-ray beam will be transferred in a vacuum pipe in this tunnel, and control and timing cables required between the halls also will be carried in this tunnel.



Typical SLAC tunnel design

1.7 Methodology

The preliminary assessment of hazards associated with the LCLS during the design, fabrication, installation and testing phases of the project, was achieved by pertinent system managers reviewing their proposed activities (Appendix A – List of Systems) and equipment identified at the conceptual design phase, and noting hazards irrespective of risk, on a facility developed hazards checklist (Appendix B – Hazards Checklist).

From a practical approach, System Managers are closest to both the hazard(s) associated with their systems and to the personnel who may be affected by the adverse condition or practice and be put at risk. They also have the added line responsibility for the control or mitigation to acceptable levels of these hazards or conditions.

Completion of the Hazards Checklist allowed the LCLS to compile a baseline of possible hazards that may be found during this phase of the project and commence the necessary and more detailed review process for the Safety Assessment Document. No hazard was excluded because of engineered solutions at this time.

1.8 Hazard Identification and Proposed Mitigation

Item	Hazard	Activity	Possible Causes	Mitigating Controls
1	**Ionizing radiation exposure, outside accelerator housing:** - prompt radiation - airborne radionuclides	▪ Routine Operations ▪ Accelerator Physics ▪ Mis-steering	▪ Personnel error ▪ Interlock failure	▪ Safety Procedures ▪ Design, maintenance and inspection of radiation safety systems ▪ Training. ▪ Time delays for entry
2	**Ionizing radiation exposure, inside accelerator housing:** - prompt - residual (activated components) - contamination	▪ Routine Operations ▪ Accelerator Physics ▪ Mis-steering	▪ Personnel error ▪ Interlock failure	▪ Safety Procedures ▪ Design, maintenance and inspection of radiation safety systems ▪ Training.
3	**Fire; inside accelerator housing:** - electrical - welding/cutting - smoking - hot work (soldering)	▪ Fault condition during routine operations ▪ Planned Maintenance ▪ Responding to unplanned maintenance	▪ Equipment failure ▪ Personnel error	▪ Sprinklers ▪ Smoke Detectors ▪ Fire Alarms ▪ Exit Routes ▪ Training ▪ On site Fire Department
4	**Fire; equipment and control areas:** - electrical - welding/cutting - smoking - hot work (soldering)	▪ Fault condition during routine operations ▪ Planned Maintenance ▪ Responding to unplanned maintenance	▪ Equipment failure ▪ Personnel error	▪ Sprinklers ▪ Smoke Detectors ▪ Fire Alarms ▪ Exit Routes ▪ Training ▪ On site Fire Department
5	**Electric Hazards:** - high voltage - low voltage/high current - exposed 110v - high power - RASK entry - stored energy (capacitors & inductors)	▪ Fault condition during routine operations ▪ Planned Maintenance ▪ Responding to unplanned maintenance	▪ Personnel error ▪ Equipment failure ▪ Interlock failure	▪ NEC Compliance ▪ Design, maintenance and inspection of electrical interlock systems. ▪ Procedures (LOTO) ▪ Training. ▪ PPE

Item	Hazard	Activity	Possible Causes	Mitigating Controls
6	**Non-Ionizing radiation exposure:** - R.F. - alignment lasers - photocathode gun operation - ultra violet light	▪ Fault condition during routine operations ▪ Planned Maintenance ▪ Responding to unplanned maintenance ▪ Accelerator alignment ▪ Accelerator Operation	▪ Personnel error ▪ Equipment failure ▪ Interlock error	▪ Design, maintenance and inspection of interlock systems ▪ Procedures ▪ Training.
7	**Construction activities:** - heavy equipment - material handling - slips/trip/falls - vibrating equipment - scaffolding - demolition - excavations - stationary combustion engines	▪ LCLS conventional construction ▪ Shielding reconfiguration	▪ Personnel error ▪ Equipment failure	▪ Barriers ▪ Procedures ▪ Training ▪ Inspections
8	**Natural Phenomena:** - Seismic hazards - Flooding - Wind - Landslide	▪ Earthquake ▪ Rain (Flooding, landslide) ▪ High Wind	▪ Earthquake ▪ Unique weather patterns	▪ Design, construction and upgrade of structures (buildings, accelerator housings) and equipment to applicable building and structural codes ▪ Sitting of LCLS buildings ▪ Field inspections ▪ Engineered Controls i.e. retaining walls, drainage etc.

Item	Hazard	Activity	Possible Causes	Mitigating Controls
9	**Exposure to hazardous materials, including transportation:** - cryogen's. - solvents - acids - oils - welding/cutting fumes - nuisance dusts from grinding operations - lead - beryllium windows - use of compressed gases	▪ FFTB demolition work ▪ LCLS fabrication & installation ▪ Component cleaning ▪ Maintenance activities ▪ Routine operation (gases) ▪ Shielding	▪ Personnel error ▪ Equipment failure	▪ Engineering analysis and inspection of systems using hazardous materials ▪ Procedures ▪ PPE ▪ Training ▪ Ventilation
10	**Adverse effects to the environment:** - Spills - Water discharges to sanitary and storm drains - Noise - Air emissions (dust, leaks) - Soil contamination - Non PCB transformer oil	▪ Routine operations (activated air, ozone production, LCW use) ▪ Construction activities ▪ Planned/Unplanned maintenance ▪ Failure of secondary HV transformer 2-ndry containment	▪ Construction and installation activities ▪ Equipment failure ▪ Personnel error	▪ Training ▪ Procedures ▪ Inspections ▪ Secondary Containment
11	**Thermal Hazards:** - High temp equipment (bakeouts) - Vacuum Pumps - Cryogen’s	▪ Component installation, testing and acceptance ▪ Routine maintenance	▪ Equipment failure ▪ Personnel error	▪ Barriers ▪ Training ▪ Procedures
12	**Mechanical Hazards:** - machine shop tools - industrial vehicles - drilling, cutting, grinding - pressure/vacuum vessels & lines	▪ Component fabrication ▪ Installation	▪ Equipment failure ▪ Personnel error	▪ Barriers ▪ Training ▪ Procedures

Item	Hazard	Activity	Possible Causes	Mitigating Controls
13	**Occupational Hazards:** - sharp edges - traffic - pinch points - lifting/carrying objects - housekeeping - noise - slips, trips and falls - hand tool - ladders - wet surfaces	▪ All activities have some OSHA component related to them.	▪ Equipment failure ▪ Personnel error	▪ Barriers ▪ Training ▪ Procedures ▪ Vigilance
14	**Material Handling Hazards:** - Forklift Operations - Hoisting and Rigging Operations	▪ Construction activities ▪ Installation activities	▪ Equipment failure ▪ Personnel error	▪ Training ▪ Procedures
15	**Magnetic Fields:** - High Magnetic Fields - Fringe Fields	▪ RASK entry (testing in situ) ▪ Testing (pre-acceptance)	▪ Equipment failure ▪ Personnel error	▪ Barriers ▪ Training ▪ Procedures
16	**Oxygen Deficiency Hazards:** - LN2 spill/leak - use of inert gases (nitrogen, helium) - specialty gases for accelerator operation (i.e. SF6)	▪ Vacuum chamber installation and bakeout	▪ Equipment failure ▪ Personnel error	▪ Limiting volumes of cryogens & other hazardous gases ▪ Training ▪ Procedures
17	**Tunneling** - Cave in - Construction Hazards - Oxygen Deficiency Hazards	▪ Boring/Tunneling for far hall	▪ Equipment Failure ▪ Personnel Error ▪ Ground Failure	▪ Use of Licensed Contractor ▪ Use of Mine Safety Expert ▪ Barriers/Procedures ▪ Training ▪ Ground Assessment

The “hazards” listed above were identified by the LCLS System Managers and may be found during different phases of the LCLS construction and operation. They have been cross-referenced to the SLAC Work Smart Standard set in order to show how they relate to standards already adopted by SLAC for existing hazards. There are many documents within the ES&H realm that addresses the above listed activities, allowing supervisor to make correct end educated decisions when attempting to mitigate or control hazards or hazardous situations. These documents include, the SLAC ES&H Manual, the SLAC Safety Management System, ES&H bulletins, site specific and activity specific procedures, Employee Training Assessment, etc. In as much hazards have been identified for the LCLS project and SLAC/SSRL has a system in place that can address and mitigate hazards on a real time basis.

1.9 Hazard Classification

The results of the Preliminary Hazards Analysis support consideration of the LCLS as a low hazard facility in accordance with DOE 5481.1B, Safety Analysis and Review System.

This is reflected by findings in the Preliminary Hazard Assessment that:

- LCLS requirements for SLAC Linac operations are well within existing safety and operating envelopes of the facility. While the peak brightness of the LCLS x-ray beam is unprecedented; it should be understood, however that this peak brightness is a measure of the instantaneous power density. The average power of the LCLS x-ray beam, the energy and power of the electron beam and hence radiation hazard they pose are all well within the range of applicability for SLAC and SSRL shielding, safety systems and procedures. In as much, early work in the area of radiation shielding has indicated that the LCLS presents some complex geometry questions, however the models used to provide minimum shield wall thickness are well understood.
- The risk (probability & consequences) of all hazards will be similar in nature and magnitude to those already found in the present accelerator or synchrotron radiation programs.
- Existing and mature programs (citizen safety committees, ES&H division, LCLS Safety Officer) will be used to ensure that all aspects of the design, installation, testing and operational phases of the LCLS project will be properly managed and that they conform to the applicable Work Smart Standards (Appendix C – Identifies present Work Smart Standards) that SLAC has adopted and written into its contract with the DOE.
- That any hazard impact will have only the potential for minor onsite and negligible off-site impacts to people or the environment.
- That Integrated Safety Management (ISM) has been fully implemented at SLAC via the DEAR clause and incorporated through the contract between Stanford University and DOE in 1998.

- DOE's Office of Science has classified SLAC as a "Radiological Facility", as specified in the DOE Standard "Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports", DOE-ST-1027-92, December 1992.
- The Environmental Assessment did not identify and new hazards or conditions that would affect worker safety and health or the environment during construction or operation of the LCLS. Potential environmental effects have been identified as follows:

Summary of potential environmental effects.

Task	**SLAC Current Operations**	**Proposed LCLS Facility - effects**
Building construction	None in proposed LCLS area	Negligible. Two new experimental halls, each about 2,000 square meters or 20, 000 square feet will be constructed in current operational areas.
Tunnel Construction	None.	Negligible. One new tunnel will be built, 227 meters (745 feet) in length. The proposed tunnel will be entirely above the water table. The tunnel area consists of non-serpentine type of rock that does not contain asbestos fibers. Groundwater and soil in the tunnel area is natural background quality, or below applicable regulatory criteria. SLAC has three large-scale tunnels that total nearly 9 km in length that are both above and below the groundwater table demonstrating the viability of the proposed new tunnel.
Roads	None.	Negligible. One small road realignment within SLAC
Parking	New parking is planned.	Negligible.
Traffic	Traffic plan will be aligned with Stanford for Long Range Planning.	Minor. Traffic plan will be aligned with Stanford for Long Range Planning.
Utilities (electrical, water supply and sanitary sewer)	Minor increases are projected.	Minor. Minor increases are projected, but are not beyond SLAC's current capacity to provide these resources.
Air Quality	A facility-wide permit application is in process.	Negligible Projected emissions from LCLS will be below proposed cap in permit application

Task	SLAC Current Operations	Proposed LCLS Facility - effects
		for construction and operations phases.
Soil Quality	Existing voluntary soil and groundwater investigation and cleanup are ongoing.	Negligible to minor. Soil in the area of tunnel and the Far Hall to our knowledge has not been affected by operations at SLAC. Soil in the Research Yard by the Far Hall may contain PCBs greater than the detection limit, but generally less than 1 ppm. (1 ppm total PCBs is the residential cleanup standard under TSCA[1]).
Surface Water Quality	Existing site-wide stormwater pollution prevention plan and best management practices are in place.	Negligible. A stormwater management plan will be developed for construction, and the area would be integrated into the site-wide plan, triggering the development of specific best management practices for the operations phase.
Groundwater Quality	Existing voluntary soil and groundwater investigation and cleanup are ongoing.	Negligible. Groundwater in area of LCLS Near Hall contains volatile organic chemicals near the detection limit that are less than the drinking water standard. Groundwater beneath the proposed tunnel and Far Hall is of natural background quality.
Sensitive Environments: Wetlands and Designated Critical Habitats	Associated with San Francisquito Creek South of SLAC	Negligible. Construction areas are not near San Francisquito Creek.
Radiological Aspects	Existing safety program to protect workers and public. No radiation worker injury since SLAC began operations almost 40 years ago. SLAC total dose to maximally exposed individual of public is 5 millirems per year (DOE mandated limit is 100 millirems per year).	Negligible. Worker heath and safety addressed by current program and design features. Additional estimated contribution from LCLS operations to maximally exposed public individual is 0.2 millirems per year, a negligible increase from the current 5 millirems per year, and well below the 100 millirems per year mandated by DOE.
Hazardous materials	Chemical usage is subject to review by SLAC Industrial Hygienists to determine minimization, substitution and site specific usage guidance.	Negligible. Chemical use will be similar to current programs.
Hazardous waste	Existing RCRA Hazardous Waste 90-day generator. Active waste minimization and pollution prevention plans.	Negligible.

1.10 Appendix

A – List LCLS Systems to which the Hazards Checklist was applied

B – Hazards Checklist

C – SLAC adopted Work Smart Standard set

A – List of systems to which Hazards Checklist was applied.

Conventional Systems:

- Vacuum System
- RF System
- Power Supplies
- Magnets & Supports
- Facilities (Infrastructure)
- Beamlines
- Installation
- Operation

SLAC Linac

Injector Facility

Free Electron Laser Physics

Scientific Experiments

X-Ray Optics

Undulator

B – Hazards Checklist

Used by system managers to help identify hazards pertaining to their operation.

Hazards Checklist

	Yes	No		Yes	No
Thermal Hazards			**Hazardous Materials Transportation**		
cold work environments		X	loading/unloading	X	
cryogen's	X		spills/chemical releases	X	
high temperature equipment	X		emergency response/spill clean-up	X	
vacuum pumps	X		fire/explosion	X	
battery bank and UPS equipment	X		packaging hazardous materials	X	
			bad road conditions (e.g., icy)		X
Chemical Hazards			prolonged periods of driving		X
acids, solvents, toxic agents and haz. liquids	X				
heavy metals such as lead	X		**Other Personnel Hazards**		
chemical reactions	X		sharp edges	X	
toxicity in smoke or fumes		X	vacuum tanks	X	
pesticides		X	traffic hazards	X	
welding fumes	X		pinch hazards	X	
use of toxic materials	X		work on wet surfaces	X	
carbon monoxide		X	confined spaces	X	
carcinogens	X		lifting/carrying heavy objects	X	
nuisance dusts	X		repetitive motion	X	
cutting/burning	X		vibrating equipment (tools or surfaces)	X	
chemical exposure exceeding PEL		X	dry environment		X
beryllium	X		high noise levels	X	
			housekeeping	X	
Other Mechanical Hazards			icy walking/working surfaces		X
machinery and rotating parts	X		slips, trips and falls	X	
pressurized tanks, containers and lines	X		hazards requiring PPE	X	
moving vehicles carts, forklifts	X				
material grinding, cutting drilling	X		**Construction Hazards**		
special hand tools-power driven nail guns	X		heavy equipment	X	
work with roads and grounds equipment	X		local community impact		X
means of egress	X		earth cave in/collapse	X	
powered platforms	X		flooding-rain or groundwater	X	
medical and first aid		X	environmental-air/water pollution	X	
machine guarding	X		dewatering hazard		X
general environmental control	X		transportation and logistics	X	
			materials handling	X	
Non Ionizing Radiation			possibility of hitting utilities	X	
lasers	X		hand tools	X	
radio frequency radiation	X		high winds		X
ultraviolet light	X		fall hazards	X	
intense light sources	X		scaffolding	X	
			ladder	X	
			compressed gas	X	
			earth moving equipment	X	
			demolition	X	
			earth clearing	X	

Hazards Checklist

	Yes	No		Yes	No
Oxygen Deficiency Hazards			**Fire Hazards**		
cryogenic spills	X		electrical	X	
cryogenic gas or liquid leak	X		flammable liquids or gases	X	
gaseous argon or other detector gas	X		welding	X	
chemical spills	X		spark producing tools near combustibles	X	
leak of supplied gases	X		spontaneous combustion	X	
toxic gases		X	storage of combustibles	X	
			special occupancies (NFPA)	X	
Electrical Hazards			mobile structures (portakamps)	X	
low voltage/high current	X		transportation (rail, vehicle, fueling)	X	
exposed 115 V	X		special hazardous materials	X	
high voltage	X		boiler, furnace, heating system, appliances	X	
high power	X		stationary combustion engines	X	
stored energy/capacitors	X		cigarette smoking		X
stored energy/inductors	X				
lightning	X		**Material Handling Hazards**		
battery	X		cranes & hoists	X	
RASK (restricted access safety key)	X		fork lift operation	X	
			chemical spills	X	
Magnetic Fields			lifting objects	X	
quench effects	X		falling objects	X	
fringe fields	X		moving objects	X	
high magnetic fields	X		hazardous tools, equipment and machinery	X	
bioelectronic implants (hazard to user)	X		transportation	X	
			elevators used for hazardous materials		X
Radiation Hazards			storage/handling of toxic materials	X	
prompt radiation	X				
radiation check sources	X		**Environmental**		
residual radiation/activated components	X		PCB's	X	
contamination	X		hazardous waste	X	
storage/handling of radioactive materials	X		asbestos	X	
radioactive waste	X		surface water discharges	X	
mixed waste	X		endangered species issues		X
radioactive liquids or gasses	X		archeological requirements		X
activated soil	X		air emissions sources-radioactive		X
depleted uranium		X	air emissions sources-nonradioactive		X
special nuclear materials		X	transformer oil (non-PCB)	X	
			solid waste management units	X	
Biological Factors			regulated chemical wastes	X	
animals		X	groundwater protection	X	
insects		X	ozone depleting substances	X	
poison plants		X	pesticide application/use		X
bloodborne pathogens	X		sewer discharges	X	
bacteria (water)	X		offsite radiation exposure	X	
allergies	X		sanitary effluent discharge	X	
			drinking water quality		X

C - SLAC Adopted Work Smart Standards set.

Description	Primary Standard	Supplementary Standard	Internal Standard
Chemical Accident Prevention	40CFR68		
Protection of Stratospheric Ozone	40CFR82		
Toxic Chemical Release Reporting	40CFR372; EO 13148 (Section Sections 501-503, 505)		
Clean Air Act	42USC7401 et seq. (as amended)		
Air Quality	BAAQMD Rules & Regulations	BAAQMD Manual of Procedures	
Accidental Release of Regulated Subs.	19CCR Div. 2, Ch. 4.5		
Hazard. Materials Release Response	CA H&SC Div. 20, Ch. 6.95, 25531-25543.3		
Air Toxics Inform. & Assessment	CA H&SC Div. 26, Part 6, 44300 et seq.		
Pollution Prevention Act	42USC13101 et seq. (as applicable)		SLAC ES&H Manual, Ch. 22
Hazard. Materials Acquisition & Procurement	Executive Orders 13101; 13148 (Sections 701-704)		SLAC ES&H Manual, Ch. 22
Laser Safety	29CFR1910.269(w)(8), 1926.54	ANSI Z136.1 and Z136.2	
Accessibility, Public Accommodation	28CFR36		
Construction Codes		Uniform Building Code (UBC), Uniform Mechanical Code (UMC) & Uniform Plumbing Code (UPC) (Latest versions as adopted by State of California Building Standards Commission)	
California Contractor's License Law	Business and Professions Code, Div 3, Ch. 9 Contractors Art. 2-5, 11	Contractors State License Board Rules & Regulations Art. 3 Classifications 830-834	
Electrical Safety		National Electrical Safety Code (NESC)	SLAC ES&H Manual, Ch. 8
Electrical Safety		National Electrical Code (NEC)	See current Electrical Safety related SLAC ES&H Bulletins
Electrical Safety	OSHA 1910 and 1926 (Applicable parts of)	NFPA 70E	
Package & Transport Radioact. Mat.	10CFR71		
Occupational Radiation Protection	10CFR835; Atomic Energy Act	DOE-N-441.4	
Environmental Protection	40CFR61, Subpart H		

Environmental Protection	DOE-O-5400.1, Ch. IV, para. 1.a, 3, 4, 5 [except 5.a.(2).d], 6, 9 &10c		
Radiation Protection, Public & Environment	DOE-O-5400.5, Ch. II, para. 1 (except 1.a.3.c & 1.c), 2, 5, 6, 7, 8a; Ch. III & IV		
Releases to Sanitary Sewer	10CFR20, Subpart K, Sec. 20.2003(a)4		
Management of Nuclear Materials		DOE Orders 5633.3B, 5660.1B	
Greening the Government	Executive Order 13148 Section 401 (EMS)		
Accelerator Safety	DOE-O-420.2A Contractor Requirements Document	SLAC Guidelines for Operations	
Facility Compliance Audits	Executive Order 13148 Section 402		
Occurrence Reporting	DOE-O-232.1A Contractor Requirements Document	SLAC Technical Division Document 01-03	
Seismic Safety	Executive Order 12699	DOE-O-420.1, Cont. Req. Doc., Sec. 4.4.2	Specification for Seismic Design of Buildings, Structures, Equipment, and Systems at the SLAC
Hazard Communication	29CFR1910.1200	SLAC ES&H Manual, Ch. 4	
Emergency Planning	40CFR355 (Except 40CFR355.40)		
Emergency Planning and Reporting	Executive Order 13148 Section 504		
Occup. Injury Record & Report	29CFR1904	DOE O 231.1	
Protection of Water	33CFR320, 322, 323, 328-330		
Water Quality Certifications	23CCR Div. 3, Ch. 28, Article 4,3855-3861		
Discharge of Pollutants to Streams	CA Fish & Game Code, Sec. 5650-5656		
Toxic Substance Control	15USC2601-2692		
Permits for Dredge Material	33CFR301, 401, 404; 33USC1344		
Petroleum Storage	CA HSC, Div. 20, Ch. 6.67, Sec. 25270-25270.13		
Emergency Release Notification	40CFR355.40		
General Duty-Safe Workplace	Occupational Safety & Health Act Sec. 5(a)(1)		
OSHA General Industry	29CFR1910 (Applicable parts of)		
OSHA Construction	29CFR1926 (Applicable parts of)		
Mechanical Refrigeration		ASHRAE-15	
Cryogenic Safety		SLAC ES&H Manual, Ch. 36	
Hooks	ANSI/ASME B30.10		

Traffic and Vehicular Safety	California Vehicle Code (Applicable parts of)	SLAC ES&H Manual, Ch. 13	
Pressure & Vacuum Vessels			SLAC Pressure and Vacuum Vessel Safety Comm. Charter
Emerg. Eyewash and Shower Equip.		ANSI Z358.1-1998	
Office & Industrial Illumination		IES RP-1 & RP-7	
Cranes, Hoists & Forklifts		ANSI B30.5, .9, .20; ASME B30.20	
Spider Bites			See current Animal Hazards related SLAC ES&H Bulletins
Piping Systems		ASME/ANSI B31.1, .3, .5, .8	
Pressure Vessels		ASME Pressure Vessel Code: I-IX Inclusive	SLAC Mechanical Engineering Safety Inspection
Ergonomics; Repetitive Motion Inj.	8CCR5110	ANSI/HFS 100	
Hanford Solid Waste Acceptance Crit.	HNF EP 0063		
Washington Dangerous Waste Reg.	WAC 173-303		
Radioactive Waste Management	DOE-O-435.1(except 4.b.)		
Radioactive Waste Management		DOE-M-435.1-1, Chapters I and IV (except I.1.E, IV.D.4, IV.E, IV.G.(1)(d), IV.M.(1)(c), IV.M.(2)(e), IV.M.(3), IV.N.(2), IV.P, IV.Q, IV.R.(1), and IV.R.(3))	
Emergency Management	NFPA 1600 2000 Edition	29CFR1910; DOE-O-151.1A Ch. IX & Ch. X Sec. 3a & 3b	Campus Emergency Plan (Stanford University)
Environmental Management Systems	Executive Order 13148 Sections 401 & 403		
Well Construction Standards	Calif. Well Std. Bulletin 74-81	Calif. Well Std. Bulletin 74-90	
Well Permitting & Destruction	San Mateo Co. Ord. 04023		
Hazardous Chemical Reporting	40CFR370		
Business Plan	19CCR, Div. 2 (OES), Ch. 4, Art. 4		
Fire Safety	Uniform Fire Code (UFC), National Fire Prot. Assoc. Codes and Standards	DOE-O-420.1, Sec. 4.2.2 & 440.1A (applic. parts)	SLAC ES&H Manual, Ch. 12
Water Pollution/Flammable Liquids and Hazardous Materials	24CCR Part 9 (CA Fire Code Sections 79 & 80)		
Landscaping Management Practices	Executive Order 13148 Sections 601 & 602		

EPA Waste Management	40CFR260-279, 302, 761		SLAC ES&H Manual, Ch. 17
Resource Conserv. & Recovery Act	42USC6901 et seq. (as applicable)		
DOT Hazardous Material Regulations	49CFR 171-180		
Calif. Code for Waste Management	22CCR Div. 4.5		
Hazardous Waste Control	CAHSC, Division 20, Ch. 6.5		
Hazardous Materials Management			SLAC Hazardous Materials Management Handbook
Asbestos	40CFR763		
Chemical Substance Exposures	29CFR1910 (1000-1018)	ACGIH TLV	
Explosives	DOE Explosives Safety Manual (Pantex Version) DOE M 440.1-1		
UV & RF Radiation; Noise		ACGIH TLV uv & rf radiation; noise	
Hand-arm & Heat Stress		ACGIH TLV hand-arm; heat stress	
Industrial Ventilation		ACGIH, Industrial Ventilation	
Biological Safety	29CFR1910.1030 (Bloodborne Pathogens); Stanford University Biosafety Manual; NIH Guidelines for Research Involving Recombinant DNA Molecules	Biosafety in Microbiological and Biomedical Laboratories (CDC)	
Beryllium Disease Prevention	10CFR850		
Plant Pests	7CFR330		
Genetically Altered Organisms	7CFR340		
Protection of Human Subjects	10CFR Part 745; 29CFR1910.1030 (Bloodborne Pathogens)	Office of Energy Research "A Human Subjects Handbook;" Stanford University Administrative Panel on Human Subjects in Medical Research	
Training for Animal Research	9CFR2 Subpart C	Animal Welfare Act	
Care of Humans & Animals		NIH Public Health Service Policy on Human Care and Use of Laboratory Animals (appl. portions)	
Historical & Archeological Sites	40CFR6.301		
Historical & Archeological Sites	16USC 469 et seq. & 470 et seq.		

Wetlands, Fish & Wildlife	40CFR6.302		
Fish & Wildlife	16USC661, et seq.		
Endangered Species, plants	16USC1531 et seq.		
Endangered Species	7CFR355		
Endangered Species	California Fish & Game Code Section 1603 - Streambed Alteration Agreements		
Endangered Species	California Fish & Game Code Section 2050-2089		
Endangered Wildlife & Plants	50CFR17		
Waste Water	Regulations of the South Bayside System Authority		
Waste Water	Code of General Regs. of the West Bay Sanitary Dist.		
Storm Water	Industrial Activities, Stormwater General Permit		
Floodplains & Wetlands	10CFR1022		
Oil Pollution; Hazardous Substance	40CFR110-125		
Water Quality Standards	40CFR131		
Tests for Pollutants	40CFR136		
Release Reporting	40CFR300-302		
Emergency Planning	40CFR355		
Pretreatment Regulations	40CFR403		
Electroplating Standards	40CFR413		
Metal Finishing	40CFR433		
Polychlorinated Biphenyls (PCB)	40CFR761		
Backflow Preventers	17CCR7605		
Clean Water	33USC1251 et seq.		
Clean Water	Calif. Water Code, Div. 7, Sec. 13369 -- Nonpoint Source Pollution Control Program, Sec 13370-13389 -- Compliance with Clean Water Act		
Oil Spills, prevention & response	California Government Code, Sec. 8670.2(f), .25.5(a)		