Title **Project Electrical Review Criteria**		Revision History: Rev 04 Date: 04-18-2006 Initial Issue Date: 2005
SLAC ID	SLAC-I-730-0A11F-002-R003	
Location	SLAC site-wide	
Policy:	ES&H Chapter 2, 8, and 31	
Applicability	New design and design changes	
Audience	SLAC site-wide for new design and design changes	
Review Calendar	Document shall be reviewed in 1 year.	
Issuing Authorization	Electrical Safety Officer: Perry Anthony Electrical Safety Committee Chair: Marjorie Widmeyer	
Summary: This document is a guide to assist in preparation for ESO or ESC project review.		

1 Introduction

1.1 Scope

The following information is provided as a reference guide to be used during the design or modification process, for projects that involve (or could be affected by) electrical systems, premises wiring or utilization equipment[1].

1.2 Discussion

1.2.1 Specific Requirements

SLAC's Work Smart Standards (WSS) include specific code and regulatory requirements that must be followed by any project at SLAC. Deviations from requirements in these documents require case by case review and approval of the Electrical Safety Officer (ESO). The ESO will then perform the review or request ESC review. Projects intending to fully comply with these requirements also require ESO, (and as appropriate ESC) review to confirm compliance.

[1] Some projects may not need review, because of the low energies and hazards involved, but this is the exception and should be discussed with the lead department's ESC representative to make sure nothing is being overlooked.

1.2.2 Performance Requirements

Some of SLAC's electrical safety requirements are performance based; thus there are few specific numbers which may be quoted directly to a vendor or engineering contractor. For example, the ESC review is not simply to determine if a cable is big enough, but rather to see if design process sized the cable, breakers, transformers, and related equipment to meet the user's needs as well as limiting arc flash hazards to acceptable levels. The engineer must go through a design and analysis process to translate SLAC requirements into specific procurement and construction details for the project under consideration. The ESO, and ESC if requested by the ESO, review will examine the results of that process to see that the analysis was done, and that the end result provides for adequate safety. In practice, the ESC will follow an "As Low As Reasonably Practicable" (ALARP) approach to the mitigation of hazards posed by electrical systems.

2 Reviews

Three types of reviews are summarized here, design, electrical safety, and electrical equipment inspection. Reviews are not limited to those discussed.

2.1 Design Review

It is the responsibility of the cognizant department to perform the design review. An inter-department collaboration is strongly endorsed for the design review. The department may request assistance of ESC members in conducting design reviews, but in that capacity, they do not represent the ESC.

2.2 Electrical Safety Review

All project plans and specifications necessary to demonstrate conformance with SLAC Work Smart Standards must be submitted to the ESO for review and approval, prior to the commencement of any physical work. The ESO will then perform the review or request the ESC review the project. Large or complex projects will typically require review of the ESC.

2.2.1 Electrical Safety Review Process

For most projects a three step review process is recommended for the electrical safety review process. Examples of things considered in the review process are given 3.0 "Guidelines".

2.2.1.1 Pre-Design or Conceptual Design

A pre-design or conceptual design may include an informal discussion between members of the project and ESC representatives. Presentation materials are at the discretion of the project team, but should be adequate to provide sufficient understanding of the scope and nature of the project, so that the ESC representatives can provide appropriate references and guidance to the project.

2.2.1.2 Preliminary Construction Design

Design criteria and preliminary descriptions, vendor specifications, vendor drawings, calculations, construction drawings, all of sufficient quantity and detail to verify conformance to SLAC standards and requirements, are provided to the ESC. The ESC

reviews this information and provides formal comments to the project team. It should be noted that any equipment purchased before this review is at risk, if it must be revised or modified because it failed to meet SLAC requirements.

2.2.1.3 Final Fabrication and Construction Design

Final design details are submitted and approved before physical work begins.

2.2.2 Job Preparation

The time required for ESO and ESC review and approval is dependent on the size and complexity of the project. It will be worked out with the project team at the beginning of the design process, and may be facilitated by working with the ESC representatives to efficiently provide the information needed to perform the necessary reviews.

Planning and procedure preparation may require at least twice as much labor as the field electrician effort. Examples of normally required procedures include: Commissioning, Diagnostic Testing including Hi-Potting, and Decommissioning. Some electrical safety issues that procedures should consider include: non-contact voltage sensors do not detect DC current; pre-identification and protection of devices which must remain energized; and assuring no cuts are performed on energized cables.

2.3 Electrical Equipment Inspection Program (EEIP)

The Electrical Equipment Inspection Program performs review of all electrical equipment not listed or marked by a National Recognized Testing Laboratory (NRTL). Examples include: non-listed commercial equipment, listed commercial equipment modified for use at SLAC, and custom electrical equipment brought into or built at SLAC.

3 Guidelines

The following is not all inclusive, but listed to provide some guidance of typical design parameters that may be addressed during the Electrical Safety Review.

3.1 SLAC Policy

SLAC Electrical Safety policy requires the following:

3.1.1 Standards

All design and installation shall be in accordance with our Work Smart Standards (WSS). The WSS is updated annually and appended to the modified Management and Operations contract between the DOE and Stanford University. WSS map to many specific requirements and standards, contained in the references identified below. All design shall be done in accordance with the requirements of OSHA 1910 and 1926, as applicable. In addition, electrical systems, including all appropriate safety considerations, shall comply with NFPA 70E, NFPA 70, (the National Electric Code), NFPA 101 (Life Safety Code), NESC ANSI C2 (National Electrical Safety Code), the DOE Electrical Safety Handbook, SLAC's ES&H Manual Chapter 8 and Electrical Safety Guides.

3.1.2 Guidance

Safety should be considered an integral part of the design process. Protective devices, warning signs, and administrative procedures are supplement to good design, but can never fully compensate for design which does not inherently minimize risks and hazards. Good design limits exposed or hazardous systems, wiring and components, provides proper coordination and modularity to allow maintenance and work on appropriately isolated sections of systems, and so forth.

SLAC is a continuously operating facility. Good design facilitates safe maintenance and construction activities while minimizing impacts on the rest of the facility. Construction of new and maintenance of existing electrical utility systems, equipment and distribution systems requires adequate capability for isolation of equipment, systems, and branches of the distribution system. It is therefore imperative that the design and installation of new and modified utility systems include sufficient isolation capability. All work involving the central electrical utility systems, whether upgrade of the system or tie in to it, must include provisions for system isolation.

All systems and modifications to systems performing a safety function or controlling a potentially hazardous operation shall be reviewed and approved at the level of project engineer or above, in addition to the ESO/ESC review noted above.

3.2 Other Safety Considerations

3.2.1 Design Basis

Presentations to the ESC should provide a review of the subject's Design Basis. The design basis must include references to applicable codes and standards, which should also flow into the specifications. These codes and standards must be sufficiently detailed and specific to apply SLAC's WSS's, and to assure electrical safety both from a design perspective and during the demolition, construction, and installation of new or modified systems. In addition, specific electrical design bases to facilitate safety of operations and maintenance personnel must be included here, and applied to the specifications, calculations, and drawings.

3.2.2 Electrical Systems

3.2.2.1 Codes and standards applicable to electrical design and construction safety, such as equipment and conductor sizing, protection system design, load center or MCC design, demolition and construction in areas where live circuits remain, and other relevant safety considerations should be listed here, including OSHA 1910, 1926, NFPA 70, NFPA 70E. Equipment specifications, including NEMA and UL requirements should also be addressed.

3.2.2.2 If demolition is part of the project, a demolition procedure approved by the ESO is required prior to starting work.

3.2.2.3 Design criteria to minimize arc flash hazard shall be provided. Arc flash hazards should be "As Low As Reasonable Achievable" (ALARA).

3.2.3 Arc Flash Hazards

3.2.3.1 In areas where unqualified personnel will be working, all arc flash hazards should be hazard risk Category 0 PPE (per NFPA 70E) or less for the operation of that equipment with covers ON. Unqualified personnel are those who have not had training in the arc hazards presented by the equipment and the appropriate steps to mitigate that hazard.

3.2.3.2 All 208/120V circuits shall be fed from transformers rated at less than 125kVA to reduce arc flash hazards. Arc flash analysis (based on IEEE 1584 working group results) assumes that arcing ground faults do not re-strike and that the fault currents are high enough to promptly trip an upstream circuit breaker and reduce the total deposited arc flash energy. Any deviation from this requirement must be specifically approved by the ESO and an arc flash analysis performed to confirm the actual as found conditions.

3.2.3.3 A piece of equipment with an hazard risk Category 1 for operation with covers on, will need to be justified (e.g., needs to be a 1 in order to provide for in-rush current or other need). Equipment with arc flash hazards higher than 1 to operate with covers on needs to be in special areas designated off limits to unqualified personnel (e.g. electrical rooms or substations), and appropriately isolated from other areas of the facility.

3.2.3.4 Dedicated neutrals and dedicated grounds shall be provided for each circuit. The ground should be sized to carry possible fault currents. If you have several circuits in a conduit, you can pull one ground wire and branch out to the individual circuit locations. This is different for neutrals, where you need one neutral for each circuit. Any deviation shall be justified and require ESO approval.

3.2.4 Mechanical Considerations

3.2.4.1 All equipment shall be designed with isolation devices to accept a lockout device (29CFR 1910.147).

3.2.4.2 Electrical equipment shall be designed and installed so that it is accessible for preventative maintenance and repair work.

3.2.5 Installation and Maintenance Considerations

3.2.5.1 In addition to basic safety considerations, (such as breaker sizing, arc flash calculations, and labeling), the design must provide for safe maintenance and operations including design features such as appropriate isolation and separation of circuits, adequate illumination, and fall protection, as specified in NFPA 70B.

3.2.5.2 All construction work shall also be done in accordance with the same requirements. In other words, not only must the design provide for safe construction, installation, operation and maintenance, but the actual construction, operation, and maintenance practices must also be done safely. This requires knowledge of the requirements and appropriate construction specifications, training, and supervision as the work is being done.

3.2.5.3 All equipment should be designed and constructed to protect personnel. First-line and backup safeguards should be provided to prevent personnel from accessing energized circuits. Periodic tests should be established to verify that these protective systems are operative.

3.2.5.4 If needed, a cable tray system design and instrumentation plan should incorporate the following:

3.2.5.4.1 Size cable tray for type and number of cables, all of which are tray rated.

3.2.5.4.2 Ensure cable tray support structure is approved by the SLAC Seismic Safety Committee.

3.2.5.4.3 Cable trays and racks should be properly grounded to building ground in at least one or more locations using listed ground cable, fittings and technique.

3.2.5.4.4 Dividers will be added where needed to separate cables of differing insulation categories.

3.2.5.4.5 Add SLAC inventory numbers and labels designating cable types and warning labels, as needed.

3.2.5.4.6 Tray access, ventilation, percent fill, penetrations and fire-stops will be code compliant.

3.2.6 Non-Electrical Considerations

The ESO and ESC will also consider other issues that impact electrical safety and may require review by other committees before recommending approval. Examples of other considerations may include the following:

3.2.6.1 Work area lighting should be 75 fc or greater. This minimum is not sufficient for areas over racks containing electronic equipment which should be provided with a minimum level of at least 100 fc at the work elevation (~30 inches) or provisions for supplemental lighting at work areas provided.

3.2.6.2 Lamps for general illumination shall be protected from accidental contact or breakage. Protection shall be provided by elevation of at least 7 feet from normal working surface or by a suitable fixture or lampholder with a guard. OSHA 1910.305(a)(2)(iii)(F)

3.2.6.3 Fall protection tie off points for areas over 4’ above surrounding areas that are not otherwise provided for with railings, etc. to provide for safety maintenance. OSHA 29CFR 1910 Subpart D, 1910.23(c)(1)

3.2.6.4 ES&H Manual Chapter 8, “General Requirements for Equipment Safety”

3.2.6.5 Noise level should below 85 dB for the eight-hour time weighted average (TWA) as specified by ACGIH, or hearing protection is required.

SLAC Electrical Project Review Form			
Project Name:			Review No:
Review Start Date:	Review Finish Date:		
Project Review Contact:			Ext:
Project UTR:			Ext:
Operations Contact:			Ext:
Review by Electrical Safety Committee in Addition to ESO (Yes or No) :			

	Frequently Reviewed Items	Review Item (Y or N)	Review Finding No.	Project Response No.
Project Presentation Materials (Please attach)				
1	Design Drawings File			
2	Design Calculations File			
3	Design Specifications File			
4	Review Presentation File			
5	Project Documentation URL			
6				
AC Power Distribution				
1	One-Line Diagram			
2	Panels and Panel Schedules			
3	Panel Identification			
4	Breakers Identification			
5	Arc Flash Analysis & Signage			
6	Utilization Equipment & Outlets			
7	Rack Power Distribution			
8	Lock Out Tag Out			
9				
Cable Trays				
1	Tray Size-Type Specifications			
2	Tray Fill Initial-Final			
3	Tray Load and Seismic Supports			
4	Tray Cable by Class & Voltage			
5	Tray Dividers and Covers			
6	Tray Grounds			
7	Tray Ventilation			
8	Tray Fire Stops			
9	Tray Access			
10				
Cables				
1	Insulation Type by Class			
2	Fire Retardant Specifications			
3	Cable Jacket Markings			
4				
5				

SLAC Electrical Project Review Form				
Frequently Reviewed Items		**Review Item**	**Review Finding No.**	**Project Response No.**
Cables				
1	Rack Clearances			
2	Rack Grounds			
3	Rack Access			
4	Rack Internal Distribution			
5	Rack Ventilation			
6	Rack Fire Protection			
7	Rack LOTO			
8				
Equipment Approvals & Specifications				
1	EEIP Approved Equipment			
2	NRTL Approved Equipment			
3	Modifications to Equipment			
4				
Field Inspections				
1	Initial & Punch List			
2	50% Complete & Punch List			
3	Final & Punch List			
4				
Work Plans				
1	Electrical Hazards Analysis			
2	Electrical Work Plans			
3	Lock Out Tag Out Program			
4	Electrical Permits			
5	Other Safety Reviews			
6				
Brief Review Summary				
Project Review Approvals				
SLAC Electrical Safety Officer:		Signed:		Date:
SLAC Electrical Safety Committee, Chair:		Signed:		Date: