PART 1 -GENERAL

1.1 INTRODUCTION

A. These Electrical Facility Design Guides are intended to be used as a general guideline for the electrical facility design for Stanford University Projects. The requirements of all sections of the Facilities Design Guides must be taken as a whole. It is the responsibility of the Consultants and Contractors to obtain and evaluate all sections together.

B. Provisions of this section shall apply to all Electrical sections.

C. The main objective for these Guides is to achieve consistent facility designs that will enable Stanford to optimize both performance and operating costs objectives.

D. The guides follow the CSI format, and in many cases can be used as the foundation for the formulation for Electrical Specifications.

E. It is the responsibility of the Design/build Contractors and Consulting Engineers to provide job-specific design & specifications.

F. All specifications provided by consultant shall follow the CSI format. In many cases, these Stanford Universities Facility Design Standards can not be used as the foundation for the formulation of Electrical Specifications. Any use of these Stanford Facility Design Guides, for any project, is the sole responsibility of the design consultant & must be approved, confirmed, and shown on the Design Engineers/Consultants own project drawings and specifications. Verbatim copying of the Stanford Electrical Facilities Design Guides, and issuing with Stanford logos will be disapproved.

1.2 REFERENCES

A. All work and materials shall comply with the latest rules, codes and regulations, including, but not limited to the following:

1. Occupational Safety and Health Act (OSHA).
2. California Electrical Code (CEC); this is the National Electrical Code with significant amendments.
6. Americans with Disabilities Act (ADA) as applicable to equipment mounting heights and alarm systems.
7. NFPA Standards, as applicable, including Generator Installations, Arc Flash Hazard, Fuel Storage, Hazardous Locations, and Fire Alarm Systems.
8. All other applicable Federal, State and local laws and regulations.

B. Code compliance is mandatory. Nothing in these Design Standards implies acceptance of work not conforming to those codes. Items that exceed minimum code requirements shall comply with these Standards.

C. No work shall be concealed until after inspection and approval by proper authorities. If work is concealed without inspection and approval, the Contractor shall be responsible for all work required to open and restore the concealed areas in addition to all required modifications.

1.3 LICENSE, FEES AND PERMITS:

A. Arrange for required inspections and pay all license, permit and inspection fees.

1.4 CONDITIONS AT SITE:

A. Lines of other services that are damaged as a result of this work shall promptly be repaired at no expense to the Owner to complete satisfaction of the owner.

1.5 DRAWINGS AND SPECIFICATIONS:

A. All drawings and these specifications shall be considered as a whole and work of this Division shown therein shall be furnished under this Division.

B. Drawings are diagrammatic and indicate the general arrangement of equipment and wiring. Most direct routing of conduits and wiring is not assured. Exact requirements shall be governed by the Architectural, structural and mechanical conditions of the job. Consult all other drawings. Extra lengths of wiring or addition of pull or junction boxes, etc., necessitated by such conditions shall be included.

1.6 SAFETY AND INDEMNITY:

A. Safety: The Contractor shall be solely and completely responsible for conditions of the job site, including safety of all persons and property
during performance of the work. This requirement will apply continuously and not be limited to normal working hours.

1.7 RECORD DRAWINGS:
   A. Contractor shall submit in writing PRIOR to installation, any proposed modifications to equipment layouts, device locations, conduit routings, or conductor groupings. Provide as-built drawings at close of project indicating all changes to the documents.

1.8 GUARANTEE:
   A. The Contractor shall issue a certificate of guarantee certifying that all materials and workmanship supplied and/or installed by the Contractor shall be free from defects for a period of not less than one year from the date of substantial completion or beneficial occupancy, whichever occurs first.

1.9 SUSTAINABILITY
   A. For a complete summary of Stanford’s vision refer to Stanford Guidelines for Sustainable Buildings.

   B. Electrical Systems

      1. Transformers
         a. Transformer losses represent a significant operating expense. Provide capacity for future load growth but not grossly oversized transformers. Design consultants shall use all available information to assist in right-sizing transformers.
            1) Obtain accurate equipment loads for use in calculations.
            2) Wherever available from Stanford, obtain verified metered load profiles of facilities with similar operational criteria.
            3) Design electrical system such that expected actual load profiles fall within specified transformers’ peak efficiency ranges as closely as possible.

   C. Energy

      1. Provide photovoltaic (PV) systems when requested. Collaborate with University to determine locations where PV panels can be installed, and to select type of system.
      2. Review plug and lighting loads and consider diversity.
3. Energy efficiency shall be a prime consideration in the selection of motors, lighting, as well as in the selection and sizing of transformers.

4. Electrical mains metering per FDG 33 71 73.33 and sub-metering per FDG 26 24 16 and as specified.

D. Commissioning

1. Commissioning: Provide system commissioning by the installing contractors and third party commissioning when specified to ensure systems are operating as designed.

1.10 DESIGN CRITERIA

A. Furnish and install all materials and equipment and provide all labor required as necessary to complete the work shown on the drawings and/or specified in all specification sections. All labor, materials, apparatus, tools, equipment, transportation, temporary construction, and special or occasional services shall be provided as required to make a complete working electrical installation, as shown on the drawings and described in the specifications.

B. Secondary Service

1. Where secondary service is required, provide conduits and cable from the new building to the University supplied transformer and include termination of the secondary cable to the transformer. Refer to ES-01 for transformer pad details. Refer to ES-06 for secondary termination details.

2. Provide the building system ground at the building services (ES-07). Do not include an equipment grounding conductor or other ground path with the service conductors between the outdoor transformer and main switchboard (ES-09).

3. Services larger than 1500 KVA may use a unit substation and primary service. Design of these services must be specifically approved in writing by the Project manager in consultation with the Utility System Manager. Refer to FDG 26 12 16 for specifications for unit substations.

C. Service Voltage

1. New building services rated 300 KVA and above shall be served at 480Y/277 volts except as specifically approved by Project Manager. 480Y/277 volt services rated less than 300 KVA are acceptable.

2. Provide 208Y/120 volt utilization transformers as necessary to meet the program requirements for the project.
3. Standard phase rotation is ACB.

D. Emergency Power

1. General
   a. Provide emergency power, when program-required. The size and location needs to be coordinated with both Utilities and the Stanford Planning Department.

2. Generators
   a. Stanford prefers that battery systems not be specified. Contact the Project Manager if no alternative is available.
   b. See FDG 26 32 13.13 and 26 36 23 for Generator and Transfer Switch guidelines.

E. Transformers

1. Refer to FDG 26 22 13 for Dry Transformers. Provide transformers meeting Candidate Standard Level (CSL) 3 efficiency levels, minimum, as defined by the Department of Energy.

2. Incorporate efficiency metering at all transformers to provide efficiency measurement where validation is required by project.

3. Transformers in office and electronic equipment areas shall be K-rated for non-linear loads and shall be provided with 200% rated neutral terminals. Do not use oversized transformers to accommodate non-linear loads.

F. Switchboards and Panelboards

1. Distribution panels shall be three (3) phase, except in those few cases where building power is single phase.

2. Refer to FDG 26 24 16 for Panelboard requirements.

3. Lighting and receptacle distribution panels shall be located in corridors or electrical closets. Panels shall not be located in janitorial closets. Panels in laboratory rooms shall be in accessible locations and shall not be located over lab benches or behind movable or fixed equipment.

G. Disconnect Switches
1. Enclosures: NEMA 1, code gauge sheet steel with hinged cover, or as shown on the drawings for interior locations. Switches in exterior locations shall be provided with NEMA 3R enclosures.

H. Protective Device Coordination and Settings

1. Provide for a coordination study by either the Engineer or the equipment manufacturer to determine the appropriate fuse size and breaker settings for selective coordination.
2. Stanford High Voltage Engineering will provide the necessary available short circuit currents in the System applicable to the projects.

I. Branch Circuits and Feeders

1. Provide a code sized, equipment grounding conductor within every branch circuit and feeder raceway. Bond the grounding conductor to grounding terminals and metallic enclosures.
2. Provide a separate or oversized neutral for each receptacle circuit in office and electronic equipment areas. Provide a 200% rated neutral with feeders to panelboards where non-linear loads are expected.
3. To the extent possible, circuits shall be grouped together by end use. For example, all mechanical, plug, lighting, IT loads shall be grouped together on with like loads on branch circuits.
4. The need and extent of sub-metering for branch circuits shall be specified during the project design phase. Consult with Stanford SEM personnel.

J. Field Testing

1. Provide for tests and inspection to determine that equipment is suitable for the intended purpose and safe to energize

K. Secondary Service Metering

1. Provide revenue grade metering on all main circuits per FDG 33 71 73.33.

1.11 GENERAL DESIGN CONSIDERATIONS

A. Life Cycle Cost Analysis

1. Life cycle cost analysis shall be used to evaluate alternative systems and equipment (refer to Stanford “Guidelines for Life Cycle Cost Analysis”).

B. Building Types
1. Wet lab:
a. High density of fume hoods and once through cooling with high levels of air-changes. Requires large amounts of chilled water and steam. Dense user electric loads. Health and safety issues associated with loss of power or supply air. Redundant switch gear may be required. Generator generally required. Examples: Mudd, Keck, Beckman, CIS.

2. Dry lab:
a. May have some fume hoods. Building may be mixed once through cooling and return air. Typically large amounts of chilled water. Large internal loads may reduce steam loads. Dense user electric loads. Health and safety issues may be associated with loss of power and or supply air. Redundant switch gear may be required. Generator generally required. Examples: Durand, Terman.

3. Library:
a. Low density for chilled water, steam, and electricity. Return air system used. Emergency power required for safe egress. Title-24 lighting. Redundant switch gear may be required. Generator may be required. Examples: Green East, Meyer.

4. Computer:
a. Facility High density electric loads. Return air system. Redundant switchgear may be required. Generator generally required. Large chilled water loads. Reduced stream required due to high internal heat loads.

5. Residence:
a. Heating only. Low electric load density. Title 24 lighting. Examples: Escondido Village, Governor’s Corner.

6. Office/classroom:

1.12 QUALITY ASSURANCE

A. Provide a meaningful Quality Assurance program. To assist the Contractor in this program, the specifications contained herein are set forth as the minimum acceptable requirements. This does not relieve the Contractor from executing other Quality Assurance measures to obtain a complete operating facility within the scope of this project.
B. The Contractor shall insure that all workmanship, all materials employed, all required equipment and the manner and method of installation conforms to accepted construction and engineering practices, and that each piece of equipment is in satisfactory working condition to satisfactorily perform its functional operation.

1.13 MATERIAL APPROVAL

A. The design, manufacture and testing of electrical equipment and materials shall conform to or exceed latest applicable NEMA, IEEE and ANSI.

B. All materials shall be new and bear listing or U.L. label. Material that are not covered by U.L. testing standards shall be tested and approved by an independent testing laboratory or government agency having code enforcing authority.

1.14 SUBMITTALS

A. General

1. Refer to Section 01 33 00, Submittals.

2. Submittal data shall be bound in an 8-1/2 inches by 11 inches folder or binder with a table of contents listing items in order of specification section and paragraph number. An electronic copy shall also be provided.

3. Submittals shall consist of detailed shop drawings, specifications, catalog "cuts" and data sheets containing physical and dimensioned information, performance data, electrical characteristics, materials used in fabrication, material finish and those which are excluded. Submittals shall clearly and specifically indicate which products are selected. In addition, seismic data regarding installation and seismic certification shall be included where applicable.

4. Contractor agrees that shop drawing submittals are not change orders; that the purpose of shop drawing submittals by the Contractor is to demonstrate that the Contractor understands the design concept, that he demonstrates his understanding by indicating which equipment and material he intends to furnish and install and by detailing the fabrication and installation methods he intends to use.

B. Substitutions

1. No substitutions shall be made in the materials submitted and approved without a re-submittal and prior approval of the Project Engineer.

C. Shop Drawings and Materials List:
1. Submit material list, shop drawings and product descriptive literature as specified for review. Quantity and procedure for submittals shall be as specified by the owner.

2. Material list shall not include items where no specific manufacturer is shown in the specifications.

3. Purpose of review of submittals is for check of general compliance with information given in contract documents. Each review and/or addition of notations and comments does not relieve Contractor from compliance with requirements of project contract documents.

4. Contractor shall be responsible for confirming and correlating all quantities and dimensions, selecting fabrication processes and techniques of construction.

D. Operating and Maintenance Manuals:

1. Submit three (3) sets and an electronic copy of Operating and Maintenance Manuals of equipment with recommended spare parts.

2. For specific requirements, see the Sections in which the equipment is specified.

1.15 DELIVERY, STORAGE, AND HANDLING

A. Materials shall be new and shall be delivered to the job site in the original packaging.

B. Deliver, store, and handle materials in a manner to prevent damage.

C. Protect equipment from weather and dampness.

PART 2 -PRODUCTS

2.1 LOW VOLTAGE DRY-TYPE TRANSFORMER:

A. See FDG 26 22 13.

B. Self-cooled by natural convection, indoor, dry type UL listed. Autotransformers are not acceptable.

C. 480 V delta primary, 120/208 V, 3-phase, four (4) wire. KVA size shall be shown on the drawings.

D. Ratings shall be indicated on the drawings and shall be for continuous duty without the use of cooling fans.
E. Temperature rise shall not exceed 150°C with limiting temperature in accordance with NEMA standards.

F. Core and coil assemblies:
   1. Rigidly braced to withstand the stresses caused by short circuit currents and rough handling during shipping.
   2. Cores shall be grain oriented, non-aging, silicon steel.
   3. Coils shall be continuous windings without splices except for taps.
   4. Coil loss and core loss shall be optimum for efficient operation.
   5. Coil windings shall have end filters or tie downs for maximum strength.

G. All transformers rated 30 KVA and larger shall have at least two (2) 2.5 percent full capacity taps above and two (2) 2.5 percent full capacity taps below normal rated primary voltage.

H. Core assemblies shall be grounded to their enclosures by adequate, flexible, ground straps.

I. Enclosures:
   1. Enclosures shall be not less than code gauge steel.
   2. Temperature rise at hottest spot shall conform to NEMA standards.
   3. Ventilation openings shall prevent accidental access to live components.
   4. Metal shall be thoroughly cleaned and painted at the factory with primer and the manufacturer's standard finish.

J. Standard NEMA features and accessories, including ground pad, lifting provisions, and nameplate with the wiring diagram and sound level indicated on it shall be provided.

2.2 IDENTIFYING DEVICES

A. Nameplates: Nameplates shall be engraved laminated, 1 inch x 3-1/2 inch, for permanent identification of all panelboards, transformers, switchboards, motor starters, and cabinet enclosed apparatus. Color shall be black with white letters for normal powered equipment and red with white letters for emergency powered equipment.

B. Wire and Terminal Markers: Wire and terminal markers shall be self-adhering, pre-printed cloth or vinyl. All wires shall be labeled at every splice or termination.
2.3 FOR ALL OTHER PRODUCTS, REFER TO INDIVIDUAL FACILITIES DESIGN GUIDE SECTIONS.

PART 3 -EXECUTION

3.1 WORKMANSHIP AND CONTRACTORS QUALIFICATIONS:

A. Only quality workmanship meeting industry’s standards will be accepted. Haphazard or poor installation practice will result in rejection of work.

B. Provide foremen to be in charge of this work at all times. Per California Law apprentices must be supervised. Provide a 1:1 ratio of journeymen to apprentices.

3.2 COORDINATION:

A. Coordinate work with other trades to avoid conflict and to provide correct rough-in and connection for equipment furnished under trades that require electrical connections. Inform Contractor of other trades of the required access to and clearances around electrical equipment to maintain serviceability and code compliance.

B. Verify equipment dimensions and requirements with provisions specified under this Section. Check actual job conditions before fabricating work. Report and resolve any discrepancy to prevent rework.

3.3 MANUFACTURER’S INSTRUCTIONS:

A. A copy of manufacturer’s recommendations shall at all times be kept in the job superintendent’s office and shall be available to Stanford’s representative.

B. Follow manufacturer’s instructions where they cover points not specifically indicated on drawings and specifications. Obtain clarification from the Architect before starting work.

3.4 SERVICE DISCONNECTION AND INTERRUPTION

A. Service Disconnection

1. All circuits and controls to be disconnected shall be traced as directed by the Project Manager to ensure that vital services to other areas are not interrupted.

B. Service Interruption

1. All service interruptions shall be scheduled through the Project Manager by providing notice five (5) working days in advance.
2. Submit MOP (Method of Procedures) to the Project Manager for review & approval prior to work.

C.

3.5 CUTTING AND PATCHING:

A. All cutting and patching required for work of this division is included under other divisions of this specification. Coordination with General Contractor and other trades is imperative. Ensure materials do not contain asbestos.

3.6 MOTOR CONTROL CENTER, SWITCHBOARD AND PANELBOARD INSTALLATION

A. General:

1. Equipment cabinets, motor control centers, etc., shall be anchored and braced to withstand seismic forces, calculated in accordance with the UBC, Section 2314. Transformers suspended on hangers shall be provided with appropriate seismic restraint.
2. Interior wiring shall be bundled and clamped using specified plastic wire wraps.
3. Nameplates, legend plates, and panel directories shall be installed.

3.7 TRANSFORMER INSTALLATION

A. General:

1. Primary shall be connected to minimum value taps during construction period and prior to initial building start-up.
2. Voltage readings shall be made and tap connections adjusted to nominal voltage during final construction review and prior to building occupancy.
3. Transformers shall be installed on vibration pads designed to suppress the transformer vibrations. Pads shall be selected and arranged in accordance with the weights of the transformers.
4. Conduit connections that will prevent transmission of the transformer vibrations to the conduit system shall be installed.
5. Transformers installed against a wall shall have readily accessible primary and secondary terminals.

3.8 PROTECTION

A. General:

1. Conduits, junction boxes, outlet boxes, and other openings shall be kept closed to prevent entry of foreign matter. Fixtures, equipment,
and apparatus shall be covered and protected against dirt, paint, water, chemical or mechanical damage, before and during the construction period. Damaged fixtures, apparatus, or equipment shall be restored to original condition prior to final acceptance, including restoration of damaged shop coats of paint. Brightly finished surfaces and similar items shall be protected until in service. No rust or damage will be permitted.

3.9 WORKMANSHIP

A. General:

1. Preparation, handling, and installation shall be in accordance with manufacturer's written instructions and technical data particular to the product specified and/or approved, except as otherwise specified.
2. Work shall be furnished and placed in coordination and cooperation with other trades.
3. Work shall conform to the National Electrical Contractor's Association Standard of Installation for general installation practice.

3.10 ELECTRICAL TESTING

A. General: Refer to FDG 26 08 00 Electrical Systems Acceptance Testing

B. Work Included:

1. All wire, cable, equipment, and systems installed or connected under electrical contract shall be tested to assure proper installation, setting, connection, and functioning in accordance with the drawings, specifications, and the manufacturer's recommendations. The intent herein is that field testing be extensive and complete as specified, to provide assurance of correct installation and operation of equipment.
2. All tests and inspections recommended by the equipment manufacturer shall be included, whether required by these specifications or not, unless specifically waived by the Project Engineer.
3. Tests shall include but are not limited to the following:
   a. All wiring: Free of shorts and unintentional grounds.
   b. Molded case breakers 150 A and larger: Time and instantaneous tripping, physical condition, contact resistance, insulation resistance.
   c. Power circuit breakers: Calibration to time/current curves, physical condition, contact resistance, insulation resistance.
d. Grounding system: Ground resistance (impedance), ground integrity.
e. High voltage cable: As specified in Underground Power Distribution section.
f. Motor Controls: Proper overload sensing, insulation resistance.
g. Ground fault system: Neutral free of improper grounds, pickup, coordination, zone interlocking.
h. Protective relays: Pick-up, timing, insulation resistance, physical condition.
i. Switchboards, panelboards, unit substations, bus duct, etc.: Insulation resistance, physical condition, proper torque on connections.

3.11 ACCEPTANCE DEMONSTRATION:

A. Upon completion of the work, at a time to be designated by Stanford, the Contractor shall demonstrate to Stanford the operation of the electrical installation, including any special items installed by the Contractor or installed under his supervision.

END OF SECTION