

APPENDIX 9D

SPU Electrical Design Checklist

I. INTRODUCTION

This appendix presents a SPU checklist and a typical sequence for electrical design.

2. ELECTRICAL DESIGN CHECKLIST

Preliminary Design Phase

Design Activity		✓
1.0 Power Supply and Distribution		
1.1	Identify electric utility, usually Seattle City Light (SCL), and obtain contact name, address, and telephone number. For facilities outside the SCL service area contact Puget Sound Energy (PSE). Make initial contact to establish general service requirements, service voltage, and basis for cost of service. Determine scope of work required to provide service to the site.	<input type="checkbox"/>
1.2	Establish the need for stand-by power source.	<input type="checkbox"/>
1.3	For existing facilities where capacity is a concern, arrange for service or feeder data monitoring to determine existing loading.	<input type="checkbox"/>
2.0 Electrical Code Review		
2.1	Identify the authority having jurisdiction (AHJ) for electrical and fire alarm systems.	<input type="checkbox"/>
2.2	Identify any local codes such as noise, light pollution, and energy codes.	<input type="checkbox"/>
2.3	Conduct initial survey of existing system to determine condition, code compliance, capacity, short circuit capacity. Determine scope of potential upgrades.	<input type="checkbox"/>
2.4	Determine if additional ventilation or related changes are needed to meet NFPA 820 requirements in wastewater and combined sewer vaults and pump stations.	<input type="checkbox"/>
2.5	Coordinate with project manager regarding stamping and signing electrical drawings. Ensure engineer in responsible charge is on project team.	<input type="checkbox"/>
3.0 Power and Lighting Concepts		
3.1	Review SPU design standards, standard specifications, and standard details.	<input type="checkbox"/>
3.2	Identify any electrical sustainable development goals for the project.	<input type="checkbox"/>
4.0 Special System Concepts		
4.1	Determine if fire alarm, security, telephone and data, CCTV, or lightning protection systems are required.	<input type="checkbox"/>
5.0 Preliminary Engineering Deliverables		
5.1	Document overall electrical concepts.	<input type="checkbox"/>
5.2	Check project electrical scope, effort, and schedule. Qualify scope as required, and coordinate with project manager.	<input type="checkbox"/>
5.3	Identify design tools to be used on the project.	<input type="checkbox"/>

	<p>In addition to above, provide the following to the QC reviewer: Project specific design checklists modified to indicate items not applicable to the project and any additional project requirements.</p>	<input type="checkbox"/>
--	---	--------------------------

30% Design Phase

Design Activity		✓
1.0 Power Supply and Distribution		
1.1	Coordinate with Electric Utility to determine number of electrical feeds to be provided to the facility, location of power feeds, voltage, billing details (peak usage rates), requirements for reduced voltage starters, metering location and requirements, etc. per DSG Chapter 9, and any document requirements.	<input type="checkbox"/>
1.2	Establish preferred voltages for power distribution and utilization equipment.	<input type="checkbox"/>
1.3	Prepare preliminary electrical system load calculations for sizing service.	<input type="checkbox"/>
1.4	Determine redundancy requirements for power supplies and power distribution.	<input type="checkbox"/>
1.5	Verify the need for onsite standby and/or emergency power; generators and/or UPS; if entire facility isn't supplied, identify the critical loads; determine preliminary size.	<input type="checkbox"/>
1.6	Coordinate with the utility and project I&C engineer to determine modes of generator operation. Verify utility interconnection requirements and any possible need for load shedding.	<input type="checkbox"/>
1.7	Check state air pollutant emission standards to determine if emission study is required for generator (usually depends on size, type, and hours of operation). A study will not be required for most SPU projects since the preferred generator manufacturers design to meet emission standards; verify with manufacturers.	<input type="checkbox"/>
1.8	Check EPA Spill Prevention, Control, and Countermeasure (SPCC) regulations to determine if containment and spill prevention is required for fuel tanks or transformers. Double wall containment is an SPU standard for diesel fuel tanks.	<input type="checkbox"/>
2.0 Electrical Code Review		
2.1	Contact the authority having jurisdiction for electrical and fire alarm systems to confirm applicable codes, standards, and local requirements; requirements for plan review; their preferred level of involvement.	<input type="checkbox"/>
2.2	Perform an electrical code review of existing facilities to identify facilities that do not meet current codes, do not have capacity for new loads, have inadequate short circuit rating, or are in poor condition. Develop a plan to upgrade existing facilities when necessary. Coordinate with other disciplines (e.g., architectural, mechanical) to resolve code compliance issues specific to those disciplines.	<input type="checkbox"/>
2.3	Determine how local codes for noise, light pollution, or energy, if any, will be addressed. Determine how LEED certification, if required, will be addressed.	<input type="checkbox"/>
2.4	Develop a preliminary schedule of hazardous and corrosive locations.	<input type="checkbox"/>
3.0 Power and Lighting Concepts		
3.1	Coordinate with the lead process, mechanical, and HVAC engineers to provide electrical information (hp/load, voltage, phase, constant or adjustable speed, non-critical or critical, regular duty or standby unit) to the Equipment List.	<input type="checkbox"/>
3.2	Determine provisions to be made for future loads, if any.	<input type="checkbox"/>

3.3	Develop the concept for the location of electrical equipment (i.e., indoors versus outdoors, close to major loads, location of service disconnect and utility metering, location of pad-mounted equipment, etc).	<input type="checkbox"/>
3.4	Determine the number of motor control centers (MCCs) to be provided, location of MCCs, and equipment to be powered out of each MCC.	<input type="checkbox"/>
	30% Design Phase	<input type="checkbox"/>
3.5	Prepare reasonable, but conservative, preliminary electrical equipment room/space layouts. Determine the space required for electrical equipment, I&C equipment, security/access control panels, fire alarm panels, and HVAC panels in the electrical room; egress; and whether electrical rooms should be air conditioned.	<input type="checkbox"/>
3.6	Coordinate with I&C discipline to determine where control system components will be installed and component sizes. Be conservative on space estimates.	<input type="checkbox"/>
3.7	Coordinate the overall control philosophy with I&C including standards for local control switch operation and location.	<input type="checkbox"/>
3.8	Review SPU electrical equipment standards for types and installation requirements.	<input type="checkbox"/>
4.0 Special System Concepts		
4.1	Prepare reasonable, but conservative, preliminary communication room/space layouts. Determine the space required for communication equipment, security system equipment, and UPS.	<input type="checkbox"/>
4.2	Define/document requirements and concepts for special systems.	<input type="checkbox"/>
	4.2.1 – Telephone (e.g., incoming service location, scope of supply).	<input type="checkbox"/>
	4.2.2 – Data highway (e.g., control system).	<input type="checkbox"/>
	4.2.3 – Data highway (e.g., LAN, office automation).	<input type="checkbox"/>
	4.2.4 – Fire alarm system.	<input type="checkbox"/>
	4.2.6 – Security system (coordinate with Vulnerability Assessment).	<input type="checkbox"/>
	4.2.7 – Closed-circuit television (CCTV) system.	<input type="checkbox"/>
5.0 Drawings		
5.1	Prepare a preliminary overall one-line diagram for the facilities.	<input type="checkbox"/>
6.0 Specifications		
6.1	Prepare preliminary specification list.	<input type="checkbox"/>
7.0 30% Design Deliverables		
7.1	Document design approach and criteria in Basis of Electrical Design Memorandum.	<input type="checkbox"/>
7.2	Check project electrical scope and schedule. Coordinate with project manager.	<input type="checkbox"/>
7.3	In addition to the above, provide the following to the QC reviewer:	<input type="checkbox"/>
	Preliminary service load calculation and one-line	<input type="checkbox"/>
	Equipment List	<input type="checkbox"/>
	Preliminary specifications list	<input type="checkbox"/>

60% Design Phase

1.0 Power Supply and Distribution		
1.1	Update electrical system load calculation and perform short circuit calculations for service and main distribution equipment. .	<input type="checkbox"/>
1.2	Submit load calculations and one-line diagrams to electric utility for review. Coordinate all service/metering requirements with electrical utility. Write letter documenting requirements.	<input type="checkbox"/>
1.3	Finalize generator size.	<input type="checkbox"/>
2.0 Electrical Code Review		
2.1	Verify compliance with electrical code requirements.	<input type="checkbox"/>
2.2	For wastewater facilities update area classifications in accordance with NFPA. Coordinate with process/mechanical and HVAC.	<input type="checkbox"/>
3.0 One-Line Diagrams		
3.1	Verify equipment motor sizes and other loads with lead process, mechanical, and HVAC engineers.	<input type="checkbox"/>
3.2	Finalize overall one-line diagram.	<input type="checkbox"/>
3.3	Prepare preliminary one-line diagrams for each facility.	<input type="checkbox"/>
4.0 Site Electrical		
4.1	Locate and identify outdoor electrical equipment, such as transformers, engine generator, and switchgear. Coordinate locations with site/ civil discipline.	<input type="checkbox"/>
4.2	Lay out duct bank system, including major runs, manholes and handholes. Coordinate with site/civil disciplines for site piping and other utilities.	<input type="checkbox"/>
5.0 Preliminary Process Plans		
5.1	Confirm electrical equipment dimensions and layout with vendors, if required.	<input type="checkbox"/>
5.2	Finalize size of electrical rooms and update layout of the major electrical equipment located in each electrical room.	<input type="checkbox"/>
5.3	Locate major input/output (I/O) termination locations, terminal junction boxes (TJBs), and control panels.	<input type="checkbox"/>
5.4	Identify rights-of-way and routing methods for electrical conduit and trays.	<input type="checkbox"/>
5.5	Determine equipment requiring uninterruptible power supplies (UPS) and locations of UPS equipment.	<input type="checkbox"/>
5.6	Verify division of responsibility with HVAC design (starter, disconnect, power and control responsibilities) and I&C design (disconnect, power, and control requirements).	<input type="checkbox"/>
5.7	Check for physical conflicts with structural, mechanical, and other electrical components. Check door opening and clearances.	<input type="checkbox"/>
6.0 Lighting Design		
6.1	Develop detailed lighting concepts; select luminaire types in conjunction with architect.	<input type="checkbox"/>
6.2	Do preliminary lighting layouts and initial lighting calculations.	<input type="checkbox"/>
6.3	Prepare preliminary site lighting layout.	<input type="checkbox"/>

7.0 Specifications		
7.1	Prepare preliminary major electrical equipment specifications that require manufacturer review and input.	<input type="checkbox"/>
7.2	Review other discipline specifications including process equipment, mechanical equipment, and I&C.	<input type="checkbox"/>
8.0 60% Design Deliverables		
8.1	Preliminary Drawings.	<input type="checkbox"/>
8.2	Drawing list.	<input type="checkbox"/>
8.3	Specifications list.	<input type="checkbox"/>
8.4	Check project electrical scope and schedule. Coordinate with project manager.	<input type="checkbox"/>
8.5	In addition to the above, provide the following to the QC reviewer:	<input type="checkbox"/>
	Calculations to date	<input type="checkbox"/>
	Signed 30% Checklist, unsigned 60% Checklist.	<input type="checkbox"/>
90% Design Phase		
1.0 Power Supply and Distribution		
1.1	Update electrical system calculations. Perform remaining required calculations such as voltage drop and motor starting voltage dip. Populate and size circuit breaker panels.	<input type="checkbox"/>
1.2	Size feeders, circuits, and raceway per code. Populate conductor and raceway schedule, if used.	<input type="checkbox"/>
1.3	Finalize utility coordination.	<input type="checkbox"/>
2.0 Electrical Code Review		
2.1	Resolve any outstanding issues with the Authority Having Jurisdiction.	<input type="checkbox"/>
2.2	Specify or call out hazardous and corrosive locations on drawings. Review material selection for corrosive locations and consultate with the corrosion engineer and or manufacturers when in doubt.	<input type="checkbox"/>
3.0 Lighting Design		
3.1	Complete lighting calculations	<input type="checkbox"/>
4.0 Drawings		
4.1	Finalize the following electrical drawings in accordance with DSG Chapter 9 Appendix B:	<input type="checkbox"/>
	Electrical Legend and Abbreviations	<input type="checkbox"/>
	Site Plan(s)	<input type="checkbox"/>
	One-Line Diagram(s)	<input type="checkbox"/>
	Control Diagrams	<input type="checkbox"/>
	Demolition Plans (if required)	<input type="checkbox"/>
	Process Plans	<input type="checkbox"/>
	Facility Plans	<input type="checkbox"/>

	Grounding Plans	<input type="checkbox"/>
	Hazardous Area Definition Plans and Sections (where needed for clarity)	<input type="checkbox"/>
	Cable Block Diagrams (in lieu of Process Plan wiring information, if desired)	<input type="checkbox"/>
	Riser Diagrams (for telephone, data, fire alarms, security, paging)	<input type="checkbox"/>
	Electrical Schedules	<input type="checkbox"/>
	Standard Details.	<input type="checkbox"/>
5.0 Specifications		
5.1	Finalize electrical and special system specifications.	<input type="checkbox"/>
5.2	Review other discipline specifications including process and mechanical equipment and I&C.	<input type="checkbox"/>
6.0 Design Coordination		
6.1	Check that legend includes all symbols and abbreviations used on drawings.	<input type="checkbox"/>
6.2	Check site plans for the following:	<input type="checkbox"/>
	Conformity and consistency with other site plans including equipment/facility location, names, north arrow, scale	<input type="checkbox"/>
	Physical conflicts with other underground systems, roadways, structures	<input type="checkbox"/>
	Major feeder sizes against the one-line diagram	<input type="checkbox"/>
	Duct bank size adequate for proposed and future circuits	<input type="checkbox"/>
	Coordinate all circuits and raceways entering and leaving facilities with the circuit and raceway schedules.	<input type="checkbox"/>
	All field equipment and devices, including heat trace, have power and control wiring	<input type="checkbox"/>
6.3	Check electrical one-line diagrams for the following:	<input type="checkbox"/>
	Motor hp, voltage, phase, name, and number against equipment specifications and P&IDs.	<input type="checkbox"/>
	Bus ampacity and short circuit rating against the electrical system calculations and equipment specifications	<input type="checkbox"/>
	All electrical distribution equipment (including disconnects) shown, sized, and labeled	<input type="checkbox"/>
6.4	Check motor control diagrams for the following:	<input type="checkbox"/>
	All motors have a control diagram, all diagrams are properly labeled	<input type="checkbox"/>
	Motor features against equipment specifications	<input type="checkbox"/>
	Motor control against P&IDs and HVAC specifications	<input type="checkbox"/>
6.5	Check plans (and Cable Block Diagrams when provided) for the following:	<input type="checkbox"/>
	Process equipment number, location, disconnect requirements, power, and control wiring against P&IDs, specifications, mechanical plans, one-line diagram, and control diagrams	<input type="checkbox"/>
	I&C component number, location, power, and control wiring against P&IDs, specifications, mechanical plans, and control diagrams	<input type="checkbox"/>

	HVAC equipment number, location, disconnect requirements, power, and control wiring against specifications, HVAC plans, one-line diagram, and control diagrams	<input type="checkbox"/>
	Electrical equipment is shown to proper scale and has code required clearance	<input type="checkbox"/>
	Physical conflicts	<input type="checkbox"/>
	Luminaires are accessible for maintenance	<input type="checkbox"/>
	Conduit corridor routing with mechanical and structural designs, especially embedded conduits.	<input type="checkbox"/>
	Coordinate with package system specifications regarding electrical and I&C interfaces.	<input type="checkbox"/>
	Check special system devices are shown appropriately on plans and riser diagrams.	<input type="checkbox"/>
6.6	Check electrical details for the following:	<input type="checkbox"/>
	All details are appropriately referenced on drawings or w/ notes to indicate their use	<input type="checkbox"/>
	All referenced details are included.	<input type="checkbox"/>
6.7	Review all electrical equipment specifications such as motors, motor data sheets, package system electrical and controls, valve and gate actuators, HVAC, I&C, and other equipment with electrical or control requirements by other disciplines.	<input type="checkbox"/>
6.8	Review electrical and special system specifications for completeness and conformance with Owner requirements and preferences	<input type="checkbox"/>
6.9	Check that hazardous and corrosive areas are clearly defined. Verify, where necessary, that equipment is explosion-proof or non-sparking.	<input type="checkbox"/>
6.9	Review and sign-off all electrical calculations.	<input type="checkbox"/>
7.0 Design Fix-Up		
7.1	Adjudicate all QC comments received.	<input type="checkbox"/>
7.2	Respond in writing to all major review comments.	<input type="checkbox"/>
7.3	Incorporate accepted comments and coordinate with other affected leads.	<input type="checkbox"/>
8.0 Project Closeout		
8.1	Purge notebooks of extraneous information and outdated calculations.	<input type="checkbox"/>
8.2	Archive any electronic and hard copy files according to SPU standard practice.	<input type="checkbox"/>
8.3	Provide input to the project post mortem report.	<input type="checkbox"/>

3. TYPICAL ELECTRICAL DESIGN SEQUENCE

(Most items are iterated at least once)

- Start Electrical Design Notebook
- Prepare/Review project definition per Predesign checklist
- Request Loads
- Prepare Basis of Design Memorandum
- Start Equipment List
- Calculate Utility Service Required
- Determine Likely Service Location
- Determine Emergency Power Requirements
- Calculate Genset/Alternate Power Source Size
- Size Electrical Equipment
- Start Panel Schedules
- Determine Environmental Conditions
- Start Environmental Conditions and Materials Application Spreadsheet
- Determine Starting and Control Requirements (adjustable frequency drive [AFD], Softstarter, Devicenet, etc.)
- Select Electrical Equipment
- Start Specifications
- Ascertain Size of Auxiliary Systems Electrical Equipment
- Negotiate Equipment Space and Layout Equipment
- Lay Out Grounding System
- Lay Out Instruments and Control Stations
- Negotiate Possible Conduit Routes
- Start Raceway and Conductor Schedule
- Select and Lay Out Lighting
- Lay Out Receptacles and Switches
- Lay Out Auxiliary System Components (Smoke Detectors, Intrusion Sensors, etc.)
- Add Control Diagrams and Standard Details
- Coordinate Design
- Finalize Specifications