APPENDIX 9B
Standard Drawings for Electrical Design
Contents

1. Introduction .................................................................................................................. 1
2. Legend ............................................................................................................................. 1
3. Abbreviations ................................................................................................................. 1
4. Site Plan .......................................................................................................................... 2
5. One-Line Diagrams ....................................................................................................... 2
6. Equipment Elevations .................................................................................................. 3
7. Building Floor Plans .................................................................................................... 3
8. Facility Plans .................................................................................................................. 4
9. Process Plans ................................................................................................................ 4
10. Building Sections ........................................................................................................ 4
11. Installation Details ...................................................................................................... 5
12. Control Diagrams ........................................................................................................ 5
13. Interconnection Diagrams .......................................................................................... 5
14. Cable Block Diagrams ............................................................................................... 5
15. Riser Diagrams .......................................................................................................... 6
16. Other Drawings .......................................................................................................... 6
1. INTRODUCTION

This appendix presents an example set of SPU Standard Drawings for electrical design. Drawings and specifications form the bulk of contract documents. They provide detailed information on quantities, size, dimensions, and relationships. A cardinal rule is to avoid duplicating information in specifications and drawings to avoid the possibility for discrepancies.

The following electrical drawings are available from this appendix:

- **B-1 Electrical Legend and Abbreviations**
- **B-2 Electrical Site Plan**
- **B-3 Electrical One-Line Diagram**
- **B-4 Electrical and HVAC Plan**
- **B-5 Electrical Standard Details**
- **B-6 Electrical Schedule and Details**
- **B-7 Electrical Schedule and Relining**
- **B-8 Electrical Flow Meter and Electrical Plan and Riser Diagram**

2. LEGEND

The legend is a list of the symbols to be used on SPU electrical design drawings (Figure B-1). The symbols are based on National Electrical Manufacturers Association (NEMA), Industrial Control Systems (ICS), and American National Standards Institute (ANSI) Standard Y32. Where a design requires a symbol not on the legend, that symbol should be added to the legend if it is used on more than one sheet of the design. If it is used on only one sheet, it may be described on that sheet. The standard legend symbols should be used wherever practical to reduce confusion and time spent inventing unnecessary new symbols.

3. ABBREVIATIONS

The abbreviations used on the electrical drawings should be listed on the electrical legend sheet. This avoids confusion with similar abbreviations on sheets prepared by other disciplines. All abbreviations used on electrical drawings should be included in the abbreviations list. Unless a word is used often, it should not be abbreviated.
4. **SITE PLAN**

Electrical drawings usually include a plan view of the project site and show (Figure B-2):

- Relative location of buildings and structures
- Exterior raceways and circuits
- Locations of manholes and handholes
- Exterior lighting
- References to the drawings for buildings and structures that need more detail.

Often, large sites require a scale so small that additional site plans at a larger scale are required to show detail. The single site plan should always be provided, but when the scale of the overall site plan is less than 1 inch = 30 feet, detailed site plans at a larger scale should be provided.

Detailed site plans should always be at the same scale used for process equipment layout, if possible (i.e. 1 inch = 20 feet or larger). The detailed site plans should be used to show all equipment wiring and general lighting. The overall site plan should be used to highlight the locations of switchgear, MCCs, transformers, and the duct bank system, including all manhole and handhole locations. The overall site plan can also be used as a key to the detailed site plans and detailed plans for buildings and structures. For projects with extensive duct banks, it will be necessary to show duct bank and manhole/handhole sections with conduit arrangement on a separate detail drawing.

5. **ONE-LINE DIAGRAMS**

One- or single-line diagrams are a symbolic representation of the major electrical components of the project and their interconnection (Figure B-3). The following information is typically included on one-line diagrams:

1. Power sources, including voltage and available short circuit current
2. Power ratings, voltages, impedances, connections, and grounding methods of all transformers
3. Protective relay types and sensing connections
4. Frame rating, trip rating, and special features of overcurrent and short circuit protection devices
5. Size and type of motor control devices
6. Voltage, enclosure, short circuit, and main bus ampacity ratings of switchgear assemblies, switchboards, MCCs (MCCs), and distribution panelboards
7. Instrumentation, including instrument transformers, instrument switches, voltmeter, and ammeter, with appropriate ratios and ranges
8. Type and location of surge arresters and capacitors
9. Identification of all loads
10. Identification of all distribution system equipment
11. Key interlock systems
12. Function lines to show interaction between components in the system, such as protective device trip functions and restraints.

When an electrical distribution system is too large to be shown on a single drawing, the major components and feeders should be shown on a single drawing. Additional one-line diagrams should be provided for individual MCCs, as required, to show all the loads supplied from them.

6. **EQUIPMENT ELEVATIONS**

Two-dimensional drawings of switchboards and MCCs should show the general arrangement of components of the assemblies. The elevation drawings are usually nonscale drawings. However, their intent is to determine general space requirements for the assembly, so they need to be laid out using the dimensions of the equipment being specified. The front elevations typically show main service and feeder circuit protective devices, metering, branch circuit protective devices and controllers, terminal board compartments, and future designated space requirements. One problem with equipment elevation drawings is that the final equipment elevation provided by the manufacturer will likely differ from the electrical design engineer’s elevation because suppliers vary. It is possible to eliminate these elevations if the electrical design engineer ensures adequate space is provided for the equipment.

7. **BUILDING FLOOR PLANS**

Two types of building floor plans are used to depict the electrical requirements for buildings and enclosed structures: the facility plan and the process plan. Although the entire electrical design can be shown on a single drawing when facility and process requirements are minimal, it is often preferable to separate floor plans by the kind of work involved. This design method makes floor plans less crowded and easier to read.

The electrical building floor plans show the general location of equipment to be wired and connected under the electrical specifications, as well as the necessary conductors and raceways associated with the work. Symbols used on the drawings are usually not to scale but, by definition, tell the contractor how a particular device is to be connected to the electrical system.

Several different techniques may be used for "home run" designations and for defining conductor and conduit requirements. In some cases, the conductor and conduit requirements are called out by the symbol used (as defined in the legend). In others, the specific requirements are shown on the drawings. In still other cases, a code is used. The code definition can be either a small circuit callout list located on the drawing or a more complete circuit and raceway schedule for the entire project. The circuit codes and circuit names must be developed for each specific project. See Figure B-4 for a building floor plan for electrical.
8. FACILITY PLANS

Facility plans show lighting, general purpose outlets, special system equipment, connections to HVAC equipment, and miscellaneous power requirements directly related to a building or structure. The plans identify and locate luminaire types and special purpose outlets and power connections and locate general purpose outlets. All conduit and conductor requirements associated with this equipment are shown on the plans. All panelboards and equipment from which the above luminaires, outlets, and power connections receive their power supply should be shown on the drawings, or the drawings that show them must be referenced. See Figure B-4 for a facility plan for electrical.

Note: For offices, administration buildings, and other similar facilities, it may be necessary to add a third set of floor plans to show only special systems.

9. PROCESS PLANS

All electrical equipment and control devices and electrical connections to process equipment, equipment control panels, and instrumentation are shown on the process plans. Electrical process plans should be prepared using the mechanical process equipment plans as a base. The process equipment should be screened so that the electrical equipment, connections, and circuits stand out on the drawings. There are several ways to present process plans, depending on project complexity:

- **Home runs.** Process equipment and devices are shown, along with home runs indicating wiring requirements similar to facility plans.

- **Locations only.** When a separate raceway schedule is produced, the process plans may show only equipment locations. When this approach is used, it is important to show the pullboxes and other nodes that are listed in the raceway schedule.

- **Complete single-line routing.** Some projects may require that all conduits be shown their full length in single-line form. This can become very difficult where large numbers of conduits intersect or converge. Blow-ups of these areas will be required.

Whatever type of presentation is used, it is the electrical design engineer’s responsibility to ensure that conduits can be routed in the spaced available. It is often advisable to show electrical "rights-of-way" on the process plans to reserve adequate space for conduits. Even though actual conduits are not shown on the process plans, the electrical design engineer must consider physical limits and develop a concept for raceway routing and installation. Additional blow-ups and details may be required to convey the design concept to the contractor.

10. BUILDING SECTIONS

For process facilities, it is often helpful to develop one or more building sections that show typical raceway routings and equipment locations.
11. INSTALLATION DETAILS

Installation details illustrate specific requirements an electrical design engineer has in mind for construction, installation, or connection of equipment or materials that are better shown by a drawing than by wordy specifications. Many installation details are provided in the standard drawing package and should be used whenever possible. If the design engineer encounters a unique situation that requires a special detail, they should prepare a new detail using materials equivalent to those used in the standard detail and then have the detail reviewed for constructability and compatibility. The details to be used should always be referenced on the plan drawings by either notes or symbols. Where possible, details should include notes to indicate the area and/or circumstances where they apply. See Figures B-5 and B-6 for electrical standard details and partial plans and details.

12. CONTROL DIAGRAMS

The electrical control diagram is a schematic for an equipment supplier and contractor and shows how a system is controlled. The presentation of electrical control schematics varies widely from project to project. For water and wastewater facilities, control diagrams generally are for motor starters installed as part of an electrical system. Control diagrams or schematics for other equipment, such as I&C panels, are then included with I&C drawings. For more detailed designs, all control diagrams may be combined and presented in a common format. In some cases, these more detailed control diagrams will not be fully prepared at the time of bid. In such cases it may be necessary to prepare typical motor control diagrams so that the bidders can accurately estimate the cost of the motor starters.

Generally, control diagrams should show all devices to be located on the starter or contactor and all field-installed devices. Control logic that is provided in a remotely located control panel should be shown as a terminal connection. All interfaces with remote equipment should be clearly shown, using appropriate symbols, and clearly identified. See Figure B-7 for an electrical control diagram.

13. INTERCONNECTION DIAGRAMS

A more detailed design may require interconnection diagrams for all I&C field wiring. These diagrams typically show the termination information for all field (interconnecting) wiring between panels and equipment. Several formats are used for interconnection diagrams. In some cases, a tabulation called a wire list may be used instead of an actual drawing.

14. CABLE BLOCK DIAGRAMS

Cable block diagrams (CBDs) are a design tool used to define wiring requirements. Generally, CBDs are organized on a loop or equipment basis and show all wiring requirements for that loop. They do not show conduits or routing.
15. **RISER DIAGRAMS**

In SPU and Seattle City Light, riser diagrams are used to show power pole and conduits for service drops. See **Figure B-8** for an electrical flow meter plan and riser diagram.

Riser diagrams are schematic representations, usually in a vertical format, that show communication or fire alarm systems and related devices. For instance, the base of the diagram will start with the main fire alarm panel and have separate upward branches for smoke detectors and strobe devices for each successive floor or room.

16. **OTHER DRAWINGS**

Electrical drawings must be consistent with and reference other related drawings. For example, conduit penetrations through concrete floors must be mentioned on the structural drawings so that the conduits are put in place before a slab is poured. Civil, mechanical, I&C, and structural drawings may all need to be referenced.

The need to reference other discipline drawings makes electrical drawings susceptible to changes by others. It is one reason the electrical design engineer is often last to finish.
<table>
<thead>
<tr>
<th>SYM</th>
<th>TYPE</th>
<th>DESCRIPTION</th>
<th>LAMPS</th>
<th>VOLTS</th>
<th>MOUNTING</th>
<th>MANUFACTURER</th>
<th>POLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>FLOL</td>
<td>Heavy-duty industrial fixture, rigid reflector, constructed of high-quality steel in housing.</td>
<td>3275</td>
<td>120</td>
<td>STEM</td>
<td>LMNA</td>
<td>N/A</td>
</tr>
<tr>
<td>M2</td>
<td>FLOL</td>
<td>Same as Type 1, except with an emergency ballast</td>
<td>3275</td>
<td>120</td>
<td>STEM</td>
<td>LMNA</td>
<td>N/A</td>
</tr>
<tr>
<td>H1</td>
<td>WC</td>
<td>SMD wall-mounted luminaire with one-foot (30 cm) extension and aluminum base, coating, and cell</td>
<td>31W</td>
<td>120</td>
<td>WALL</td>
<td>GE W52351012</td>
<td>N/A</td>
</tr>
<tr>
<td>H2</td>
<td>WC</td>
<td>Same luminaire as H1, with one-foot (30 cm) extension and aluminum base, coating, and cell</td>
<td>150W</td>
<td>120</td>
<td>WALL</td>
<td>GE W520155141012005</td>
<td>N/A</td>
</tr>
<tr>
<td>H3</td>
<td>WC</td>
<td>Same luminaire as H1, with one-foot (30 cm) extension and aluminum base, coating, and cell</td>
<td>250W</td>
<td>120</td>
<td>POLE</td>
<td>LMNA</td>
<td>N/A</td>
</tr>
<tr>
<td>K1</td>
<td>NA</td>
<td>Copper-free aluminum reflector, flexible reflector, stainless steel coated, porcelain lamp socket, rugged for use in class 1, division 1.</td>
<td>300W</td>
<td>120</td>
<td>WALL</td>
<td>CROUSE-HIND/STOP</td>
<td>N/A</td>
</tr>
</tbody>
</table>

**CABLE TERMINATION HANDHELD DETAIL**

1. Provide conductor box at each conductor termination.
2. Provide conductor box with the nomenclature as shown in the wiring diagram.

**GROUNDING BUSBAR DETAILS**

**CONDUIT PENETRATION DETAIL**

**WIRE TAGGING DETAIL**

**FLOAT LEVEL SWITCH & TRANSDUCER MOUNTING DETAIL**

**LIGHTING SCHEDULE AND ELECTRICAL DETAILS**

**SEATTLE PUBLIC UTILITIES DESIGN STANDARDS AND GUIDELINES**

**City of Seattle**

Chuck Clarke, Director

**SEATTLE PUBLIC UTILITIES**

**DESIGN STANDARDS AND GUIDELINES**

**Sherry Clarke, Director**

**SEATTLE PUBLIC UTILITIES**

**DESIGN STANDARDS AND GUIDELINES**