

APPENDIX H

Panel and Wiring Diagram Guidance

1.0	SCHEMATIC (ELEMENTARY) DIAGRAMS.....	2
2.0	WIRING (CONNECTION/INTERCONNECTION) DIAGRAMS	3
3.0	PANEL LAYOUT (COMPONENT ARRANGEMENT) DIAGRAMS	4
4.0	REFERENCES	5

RECORD OF REVISIONS

Rev	Date	Description	POC	OIC
0	5/18/05	Initial issue.	Mel Burnett, <i>ENG-DECS</i>	Gurinder Grewal, <i>ENG-CE</i>
1	10/27/06	Administrative changes only. Organization and contract reference updates from LANS transition. IMP and ISD number changes based on new Conduct of Engineering IMP 341. Master Spec number/title updates. Other administrative changes.	Mike Clemmons, <i>FM&E-DES</i>	Kirk Christensen, <i>CENG</i>

PLEASE CONTACT THE I&C STANDARDS POC
for upkeep, interpretation, and variance issues

Section D3060/F1050 App H	Instrumentation & Controls POC/Committee
---------------------------	--

1.0 SCHEMATIC (ELEMENTARY) DIAGRAMS

- A. Refer to ESM Chapter 8, Section 4 to determine when schematic diagrams are required.
- B. Schematic diagrams shall show the electrical connections and functions of a specific circuit arrangement to facilitate tracing of the circuit without regard to the physical size, shape, or relative position of the component device or parts. This diagram shall be prepared in a way that makes the operation of the components easy to understand (e.g., functional grouping of relays, auxiliary contacts, indicating lights, annunciators, control switches, etc. on schematic). The schematic diagram shall be arranged in a “ladder” configuration, with the left vertical line identified as the control circuit power if AC or positive if DC and the right vertical line the operating coil common (neutral if AC or negative if DC). Control devices shall be shown on horizontal rungs between the vertical lines.¹
- C. Schematic diagrams shall be developed for both motor control circuits and other control circuits not specific to motor control. These other types of control circuits include circuits with control devices such as annunciators, PLC and/or DCS inputs and outputs, interlocks, solenoids, etc. See ESM Example Drawings E-6050 or E-6075 as applicable for example of control schematic and minimum content required.²
- D. Identify items shown on the schematics. Numbers shall be assigned sequentially on the schematic diagram in a systematic manner, beginning with 1. Preferably start at the upper left corner of the schematic and proceed from left to right and top to bottom. Graphical symbols used for control devices shown on the schematic shall be in accordance with LANL Drafting Standards Manual, Section 306 and Appendix F, Electrical Symbols. Nonstandard symbols used on the drawings shall be identified as such on the drawing legend sheet.
- E. Represent all components shown on the schematics in their de-energized (shelf) state.³
- F. All terminals shall be shown on the schematic drawing, including those in terminal (junction) boxes. The terminals shall be labeled and in accordance with Appendix H, Section 2.0.D.3. See ESM Example Drawing E-6050.
- G. Provide a sequence of operations on the schematic drawings. This sequence of operations provides a description of the electrical operation associated with the circuit.⁴
- H. Show the power source (e.g., 12 VDC, 24 VDC, 120 VAC) that provides power to the components for the control circuit shown on the schematic. The power source shall be identified by component ID (panel and circuit number or power supply ID), and shall include voltage level.⁵

¹ NFPA 79-1997, Electrical Standard for Industrial Machinery, Section 4.2.

² NFPA 79-1997, Section 4.2 and Appendix D, Figure D.1, D.5, D.6, and D.7.

³ NFPA 79-1997, Section 4.2 and Industry Standards (e.g., Air-conditioning and Refrigeration Institute Standard ARI 130-88, Standard for Graphic Electrical/Electronic Symbols for Air Conditioning and Refrigerating Equipment, Section 6.1).

⁴ NFPA 79-1997, Section 4.1 and Appendix D, Figure D.3.

⁵ LIR [402-600-01.1](#), Electrical Safety, Sections 7.2 & 7.3. Providing power sources allows for the easy determination for isolation of the control circuit for maintenance/operations lock and tag.

- I. Show fuses that protect the control circuit represented by the schematics. The fuse ampacity shall be noted adjacent to the fuse.⁶
- J. For equipment or systems supplied as a complete package, the vendor that assembles the package shall supply control circuit diagrams. This shall be required by the project specific procurement or construction specification.

2.0 WIRING (CONNECTION/INTERCONNECTION) DIAGRAMS

- A. Wiring diagrams shall be required for new designs in order to facilitate the assembly of the control panels, or on existing designs when necessary to show proper connection of components. Wiring diagrams shall depict the general physical arrangement of electrical connection and wires between circuit elements in the installation or assembly. They shall show internal connections, but may include external connections that have one termination inside and one outside the assembly.⁷
- B. The wiring diagram shall include the following elements:⁸
 - 1. Physical relationship to circuit elements and their connections,
 - 2. Items identified by reference designations in accordance with NFPA 79,
 - 3. Clearly identified terminal arrangements,
 - 4. Wire numbers for reference, and
 - 5. Wire and termination descriptions
- C. Wire numbers shall be provided on the wiring diagrams and wire markers printed with wire numbers that match the drawings shall be attached at each end of the wire identification purposes (See ESM Examples E-6065 & E-6060).⁹ Wire marker material shall be per LANL Master Specification 26 0553 – Identification for Electrical Systems.
- D. Wire numbers shall comply with the following numbering convention:
 - 1. The address of the terminal the wire is coming from and the address of the terminal the wire is going to will both appear on the wire label, separated by a “/”.
 - 2. The address of the terminal the wire is going to will be placed closest to the terminal on the label.
 - 3. The terminal address shall consist of the Control Panel, a Comma, the Terminal Strip Number, a Dash, and the Terminal Number. (E-6065).

⁶ NFPA 79-1997, Electrical Standard for Industrial Machinery, Appendix D, Figure D.1.

⁷ ASME Y14.24-1999, Types and Applications of Engineering Drawings, Section 12 provides requirements and guidelines on wiring diagram development. This diagram shows the point to point wiring of specific components within an assembly.

⁸ ASME Y14.24-1999, Section 12.

⁹ Labeling of conductors is a long-standing practice at LANL to facilitate trouble-shooting of systems. Reference ESM Chapter 7, Section D5000, Electrical Identification subsection.

- E. Wiring diagrams shall show external connections between separate assemblies and field devices.¹⁰
- F. All terminal strips and field devices shall be shown with wire numbers (see E-6065). Internal wiring not connected to terminal strips shall be shown as separate wires that can be traced from components to component. (Refer to E-6060 and E-6055).
- G. All field wiring entering a control panel shall land on a terminal strip and shall not be wired directly to components in the panel.

3.0 PANEL LAYOUT (COMPONENT ARRANGEMENT) DIAGRAMS

- A. Panel layout drawings shall be developed to locate and identify major components (terminal boards, power supplies, relays, status lights, etc.) in a control panel as well as their component ID. Drawings of this type show the physical layout of the control and termination devices.¹¹ This drawing shall reference a materials list drawing, which calls out model/make and quantity of components. Reference ESM Example Drawing E-6055 and LANL Drafting Standards Manual, Appendix F-3.
- B. Dimensions for specific component locations within the control panel shall be provided, if required.¹² Cases where dimensioning may be required include separation of intrinsically safe and non-intrinsically safe wires/components, component heat generation and heat removal considerations, where space restrictions are known, as required by the component manufacturer, etc.
- C. All components shall be labeled using the component functional identification as referenced in NFPA 79, Electrical Standard for Industrial Machinery, Appendix E Device and Component Descriptions.
- D. Labeling nameplates shall be installed on or adjacent to the component to be identified.¹³ Preferred locations are shown on ESM Example Drawing E-6055. Refer to LANL Master Specification 26 0553- Identification for Electrical Systems, for nameplate materials, size, dimension, etc.

¹⁰ ASME Y14.24-1999, Types and Applications of Engineering Drawings, Section 12.

¹¹ NFPA 79-1997, Electrical Standard for Industrial Machinery, Appendix D, Figure D.2.

¹² NFPA 79-1997, Section 4.1 and Appendix D, Figure D.3.

¹³ IEEE 200, IEEE Standard Reference Designations for Electrical and Electronic Parts and Equipments, Section 8.

4.0 REFERENCES

ASME Y14.24-1999, Types and Applications of Engineering Drawings

IEEE 200-1975, IEEE Standard Reference Designations for Electrical and Electronic Parts and Equipments

IEEE 315-1975, Graphic Symbols for Electrical and Electronic Diagrams

LIR 240-01-01.2, Facility Configuration Management

LIR 402-600-01.1, Electrical Safety

LANL Drafting Standards Manual

NFPA 79-1997, Electrical Standard for Industrial Machinery