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Recommended Practice

Electrical Guide for Control Centers

ISA-RP60.8-1978, Electrical Guide for Control Centers

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Preface

This Preface is included for information purposes and is not part of RP60.08.

This Standard has been prepared as a part of the service of ISA toward a goal of uniformity in the field of instrumentation. To be of real value, this document should not be static, but should be subject to periodic review. Toward this end, the Society welcomes all comments and criticisms, and asks that they be addressed to the Secretary, Standards and Practices Board, ISA, 67 Alexander Drive, P.O. Box 12277, Research Triangle Park, North Carolina 27709, Telephone (919) 549-8411, e-mail: standards@isa.org.

The ISA Standards and Practices Department is aware of the growing need for attention to the metric system of units in general, and the International System of Units (SI) in particular, in the preparation of instrumentation standards. The Department is further aware of the benefits to USA users of ISA Standards of incorporating suitable references to the SI (and the metric system) in their business and professional dealings with other countries. Towards this end this Department will endeavor to introduce SI and SI-acceptable metric units in all new and revised standards to the greatest extent possible. *The Metric Practice Guide,* which has been published by the American Society for Testing and Materials as ANSI designation Z210.1 (ASTM E380-76, IEEE Std. 268-1975), and future revisions, will be the reference guide for definitions, symbols, abbreviations, and conversion factors. ISA S60 is an overall set of recommended practices being compiled by the ISA Control Centers Committee. RP60.8 is the first of this series to be issued.

SECTION	TITLE
RP60.1	Control Center (C.C.) Facilities
RP60.2	C.C. Design Guide and Terminology
RP60.3	Human Engineering for Control Centers
RP60.4	Documentation for Control Centers
RP60.5	Control Center Graphic Displays
RP60.6	Nameplates, Labels, Tags and Terminal Identification
RP60.7	Control Center Constructions
RP60.8	Electrical Guide for Control Centers
RP60.9	Piping Guide for Control Centers
RP60.10	Control Center Inspection and Testing
RP60.11	Crating, Shipping and Handling for C.C.

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Contents

1 Scope

This Section of ISA-RP60 is intended to assist the design engineer in establishing the electrical requirements of a control center; it is also intended to comply with the provisions of the National Electrical Code. What follows are the practices normally used by architects, engineers, user organizations and control center manufacturers. Special considerations which may apply to particular devices or circuits are not taken into account in this section.

2 General

2.1 Application

This Section of ISA-RP60 applies to the inter-connection wiring between devices within a control center, or between control centers. It does not apply to the internal wiring of an instrument or device, nor to the wiring between the control center and field-mounted instruments.

2.2 Compliance

All wiring recommendations in this Standard are intended to comply with the National Electrical Code. Compliance with other applicable local or industry codes requires specific reference in the control center specification. General references to these codes should be avoided.

2.3 Wiring

2.3.1 Power wiring

Each device requiring control center power shall be wired so that when wires are removed from any one device, power will not be disrupted to any other device. It is recommended that no voltages greater than 125 Vdc or 120 Vac be used. If higher voltages are required, refer to color coding below. Provisions should be made for power wire segregation and identification to insure personnel safety.

The recommended minimum size for power wiring up to 15 A is #14 stranded copper conductor, 600 V, 60 C with thermo-plastic insulation. Different insulation material should be considered if the insulation has to be self-extinguishing or nontoxic. Refer to Table 310-13 "Conductor Application and Insulations" of the National Electrical Code, latest revision for particular provisions. Where power is 150 W or less and run to each instrument through a separate fuse or circuit breaker, the wire size can be reduced to #16 or #18. Refer to Article 310 — "Conductors for General Wiring" in the National Electrical Code, latest revision for currents greater than 15A.

2.3.1.1 Color coding of ac power wiring

1) 120 Vac, 2 wire, single phase:

   Phase—Φ1 or L1, black

   Neutral—N or L2, white

2) 120/240 Vac or 120/208 Vac, 3 wire, single phase with neutral:

   Phase 1—Φ1 or L1, black

Phase 2—Φ2 or L2, red

Neutral—N, white

3) 240 Vac, 2 wire, single phase:

Φ1 or L1, black

Φ2 or L2, red

4) Any 3-phase circuit regardless of voltage:

Phase 1—Φ1 or L1, black

Phase 2—Φ2 or L2, red

Phase 3—Φ3 or L3, blue

Neutral in 4-wire system—N, white

5) Interlock control circuits wired from an external power source:

yellow

6) Case ground wire, if insulated—green or green with one or more yellow stripes.

2.3.1.2 Color coding of dc power wiring

Due to numerous voltage levels and existing standards, it is recommended that distinctive colors be used which do not conflict with other colors being used.

2.3.1.3 Circuit protection

In addition to circuit protection requirements of the National Electrical Code, special circuit considerations must be given. In particular, the solution to the problem of the failure of any device in a system which will cause loss of power for that system or other systems.

2.3.2 Grounding

Each device requiring power should be grounded to the control center by mounting to effect a conducting path or by a ground wire. Ground wire size should be no less than the supply conductor wire size. To determine wire size for grounding of control center to earth ground, refer to Table 250-95 — "Size of Equipment Grounding Conductors for Grounding Raceway and Equipment" of the National Electrical Code, latest revision.

2.3.3 Control wiring

Control wiring is considered distinct from power or signal wiring. This type involves wiring of push buttons, pilot lights, selector switches, relay logic, timers and programming devices. Recommendations for wire sizes, fusing and color codes may be found in the Joint Industrial Council Electrical Standards for General Purpose Machine Tools EGP-1-67.

2.3.4 Signal wiring

Normal usage for signal wiring is #18 AWG stranded copper conductor. The recommended minimum wire size is #24 AWG, which should be used in a multiconductor cable or be twisted pair. For Class 1, 2 or 3 wiring, refer to Article 725 — "Class 1, 2 and 3 Remote-Control, Signalling, and Power Limited Circuits" of the National Electrical Code, latest revision. Pulse type or low level signals may require twisted pair, shielded, or twisted pair and shielding wiring.

Wire type, signal grounding requirements, and shield requirements should be based on instrument manufacturer's recommendations. Wire carrying measurement signals associated with thermocouples, resistance thermometers, pH instruments and other low level signals are

best run directly to the instrument without intermediate terminations. Isolated routing should be provided in the control center for running these wires.

To avoid inductive pickup, power wiring or control wiring should have maximum possible separation from signal wiring. A practical distance is not less than 150 mm (6 in.). If the power wiring has to cross the signal wiring, the crossing should be as close to a right angle as possible.

For intrinsically safe signal wiring, refer to ANSI/ISA RP12.6 "Installation of Intrinsically Safe Instrument Systems in Class I Hazardous Locations."

2.3.5 Wire identification

All wiring is normally identified at both ends by suitable wire markers or color codes in accordance with the user's design documentation. See ISA-RP60.6 — "Nameplates, Labels, Tags and Terminal Identification" for marker materials and other details.

2.4 Terminations

2.4.1 Terminal blocks

Each terminal block and its terminals should be identified, as suggested in ISA-RP60.6 — "Nameplates, Labels, Tags and Terminal Identification." Provisions should be made for spare terminations; the recommended minimum is ten percent. Normal practice is twenty percent.

Recommendations for minimum terminal block spacing are as follows:

(See Figure 1)

Depth of terminal box if used, 100 mm (4 in.). For control center wiring, 65 mm (2.5 in.) between terminal block and sidewall, 90 mm (3.5 in.) between parallel terminal blocks. For field wiring, 100 mm (4 in.) between terminal block and sidewall, 130 mm (5 in.) between terminal blocks.

If terminals are mounted on standoffs, wires can be routed behind the terminal blocks which make connections and wire markers more accessible.

Typical wire connections used at screw type terminal blocks are spade and ring lugs. Another type of terminal block utilizes compression fittings which accept striped wire. The ring lug and compression fitting terminal block are recommended for applications involving vibration.

Preferably, not more than two conductors should be terminated at each terminal connection. If two wire sizes must be terminated in a single compression type fitting, refer to terminal block manufacturer for the maximum difference between wire sizes.

2.4.2 Wiring between control centers

Interconnection between control center sections, which will be separated for shipment, should be adequately prepared for convenient reassembly. Wire of adequate length for final connection should be disconnected, and pulled back in sections for shipment.

Possible ways of handling the interconnecting wiring are:

1) Wiring of each section brought to terminal blocks in that section. Jumper wires used between terminal blocks of both sections.

2) Wiring in one section, say section B, brought to terminal blocks in the section. Wires from other sections, say A and C, are brought directly to section B terminal blocks. For shipping, wires from A and C are removed from the terminal blocks in B and coiled back to their respective sections.

3) As in (1) and (2) but use multi-wire connectors instead of terminal blocks.

2.4.3 Cable connectors

Cables with multi-pin connectors are an acceptable form of interwiring control centers. The connectors can be mounted on special channels made by the connector manufacturer or control center supplier.

Suitable wire and cable identification should be provided as in 2.3.5. Also, the connector should be labeled. Use live female connector whenever circuit voltages could endanger personnel.

2.5 Sizing conduit and electrical metallic tubing

Consult Chapter 9—"Tables and Examples" of the National Electrical Code, latest revision, to determine the maximum number of conductors in conduit or electrical metallic tubing if it is installed for the internal control center wiring.

3 General purpose open wiring

3.1 General application

General purpose open wiring — wiring carried in raceways, or bundled and open.

3.2 Raceway

Wires should be run in vented non-combustible or self-extinguishing non-metallic raceway. Metallic wireways are also acceptable.

3.3 Open wiring

Where the use of raceways is not practical, wires should be run open, bundled and bound with suitable cable ties at regular intervals not exceeding 300 mm (12 in.). All wires within a bundle should be run parallel to one another. Bundles should have a uniform appearance, a circular cross section, and be securely fastened to the control center framework.

3.4 Safety

Consideration should be given to live parts of terminal blocks, pilot lights and switches which may affect personnel safety or circuit integrity. If the control center itself does not constitute an acceptable enclosure, these live parts should be covered or enclosed with a housing. Where wires are to be run to a housing from either an open bundle or from raceway, the housing should be fitted with a suitable insulating bushing or grommet.

3.5 Working space

Where working space is required within a control center, Article 110-16 — "Working Space About Electric Equipment (600 Volts or less, Nominal)" of the National Electrical Code, latest revision should be observed.

4 General purpose enclosed wiring

4.1 General application

Enclosed general purpose wiring — all wiring and terminals are enclosed.

4.2 Enclosed wiring

All wiring should be run enclosed in electrical metallic tubing, flexible conduit with plastic covering or sheet metal wireway. Sharp edges, burrs, rough surfaces, or threads with which wire insulation may come in contact should be removed from conduit fitting, wireway, or any other parts.

Electrical metallic tubing, flexible conduit or raceway should be securely fastened to the control center. Pull boxes should be provided with pilot holes, plugs or knockouts for conduits.

5 Hazardous location Class I, Division 2 open wiring

5.1 General application

Used when control center is made of components for which general purpose enclosures are acceptable under Article 501-3 (b-1, 2, 3) of the National Electrical Code, latest revision. In order to comply with the National Electrical Code, the control center construction must be considered a single general purpose enclosure. An example is a totally enclosed cabinet, including bottom and hinged, non-removable doors with locks.

Wiring and terminals need not be in explosion-proof enclosures. Arcing contacts are either hermetically sealed or enclosed in explosion-proof housing with sealed fittings or in circuits which under normal conditions do not release sufficient energy to ignite a specific hazardous atmospheric mixture. Any device operating at auto ignition temperature of flammable material is enclosed in an explosion-proof housing and provided with seals.

5.2 Raceway

Wires should be run in vented non-combustible or self-extinguishing non-metallic raceway. Metallic wireways are also accepted.

5.3 Open wiring

Where the use of raceways is not practical, wires should be run open, bundled and bound with suitable cable ties or equal at regular intervals not to exceed 300 mm (12 in.). All wires within a bundle should be run parallel to one another. Bundles should have a uniform appearance, a circular cross section, and be securely fastened to the control center framework.

5.4 Seals

Seals are used at explosion-proof housings containing arcing devices that have been mounted in the control center. They may also be required where the field conduit enters the control center.

Seals should be poured in the field and each will bear a prominent tag or be painted to indicate this fact. Dams for these seals can be put in place prior to shipment of control center. For proper location and application of seals, refer to Article 501-5 — "Sealing and Drainage" of the National Electrical Code, latest revision.

6 Hazardous location Class I, Division 2 enclosed wiring

6.1 General application

Control center construction must be considered a single general purpose enclosure. An example is an enclosed cabinet including bottom and hinged, non-removable doors with locks. All wiring and terminals are enclosed. Arcing contacts are either hermetically sealed or enclosed in explosion-proof housing with sealed fittings or in circuits which under normal conditions do not release sufficient energy to ignite a specific hazardous atmospheric mixture. Any device operating at auto-ignition temperature of flammable material is enclosed in an explosion-proof housing and provided with seals.

For non-incendive, intrinsically safe system, refer to ANSI/ISA RP12.6 "Installation of Intrinsically Safe Instrument Systems in Class I Hazardous Locations."

6.2 Enclosed wiring

All wiring should be run in accordance with Article 501-4b — "Wiring Methods—Class 1, Division 2" of the National Electrical Code, latest revision.

6.3 Seals

Seals are used at explosion-proof housings containing arcing devices that have been mounted in the control center. They may also be required where the field conduit enters the control center. Seals should be poured in the field and each will bear a prominent tag or be painted to indicate this fact. Dams for these seals can be put in place prior to shipment of control center. For proper location and application of seals, refer to Article 501-5 — "Sealing and Drainage" of the National Electrical Code, latest revision.

7 Hazardous location Class I, Division 1 wiring

7.1 General application

All wiring and terminals are enclosed. Equipment, boxes and fittings are explosion-proof.

7.2 Equipment

Terminals, switches, relays, instruments, meters, etc. shall be provided with an enclosure approved for appropriate Class and Group.

7.3 Wiring

All Wiring must be enclosed in threaded rigid metal conduit or other types approved by the National Electrical Code, explosion-proof boxes, fittings and joints. Threaded joints shall be

made up with at least the number of fully engaged threads required by the Area Classification. Sharp edges, burrs, rough surfaces, or threads with which insulation of conductors may come in contact, should be removed from conduit fittings and other parts.

7.4 Seals

Seals should be poured in the field and each will bear a prominent tag or be painted to indicate this fact. Dams for these seals can be put in place prior to shipment of control center. For proper location and application of seals, refer to Article 501-5 — "Sealing and Drainage" of the National Electrical Code, latest revision.

7.5 Terminal box

Threaded holes with plugs for conduit fittings should be provided in each box for field wiring. Holes should be sized for conduit applicable to the number of existing terminal connections.

7.6 Purging

Where purging is required, ISA-S12.4 — "Instrument Purging for Reduction of Hazardous Area Classification" should be consulted, along with NFPA 496 — "Purge and Pressurized Enclosures for Electrical Equipment."

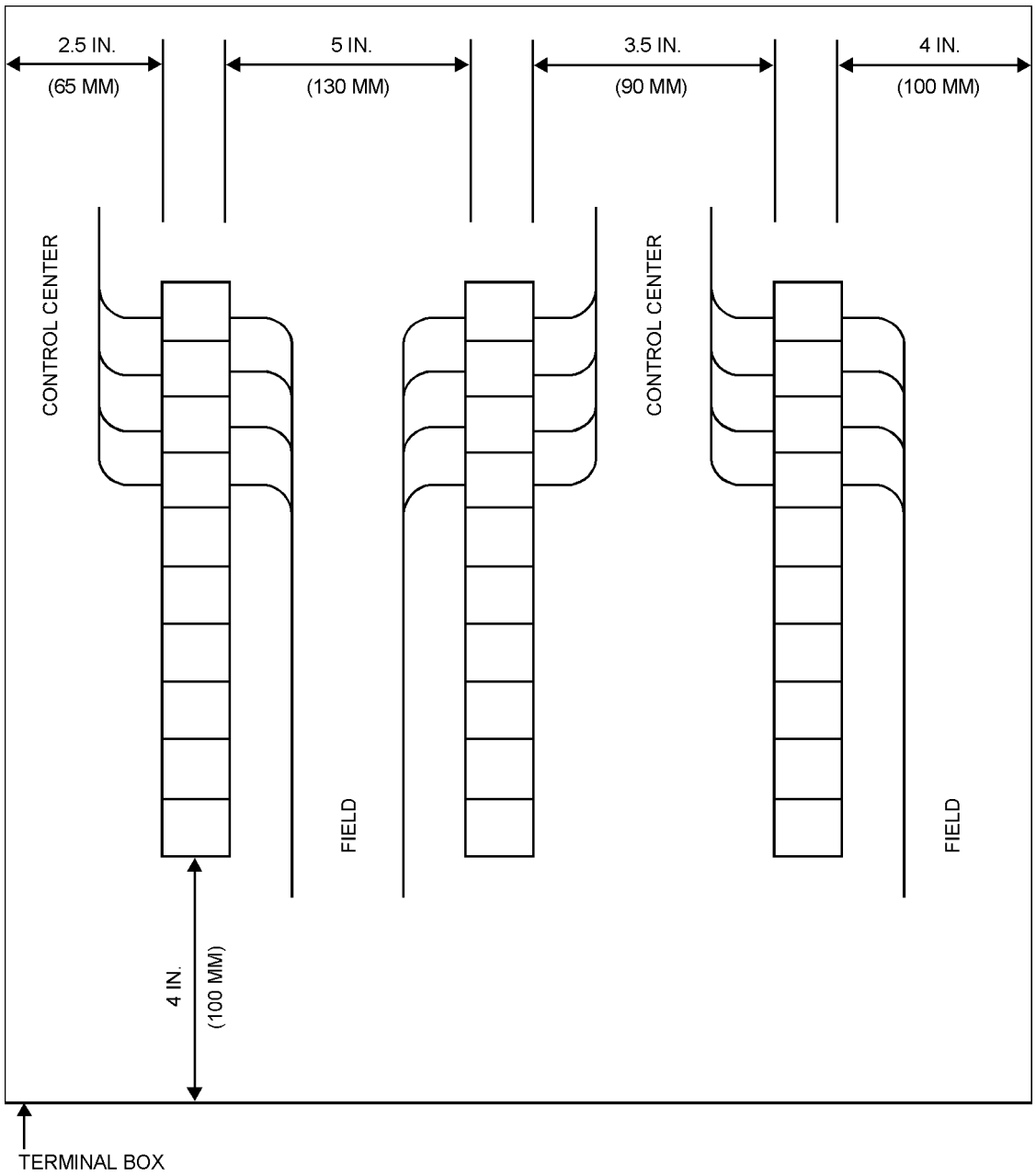

Figure 1 — Terminal block layout (minimum dimensions recommended)

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