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Recommended Practice

Control Center Facilities

ISA-RP60.1 — Control Center Facilities

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Preface

This preface is included for informational purposes and is not part of ISA-RP60.1.

This recommended practice has been prepared as part of the service of the 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, NC 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 U.S.A. users of ISA standards of incorporating suitable references to the SI (and the metric system) in their business and professional dealings with other countries. Toward this end, this Department will endeavor to introduce 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 Institute of Electrical and Electronics Engineers as ANSI/IEEE Std. 268-1982, and future revisions, will be the reference guide for definitions, symbols, abbreviations, and conversion factors.

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This recommended practice is one of a series that constitutes the control center standard ISA-S60. The individual sections provide continuity of presentation, convenience of reference, and flexibility of revision. The complete standard consists of the following sections:

SECTION	TITLE	SCOPE
*dRP60.2	Control Center Design Guide and Terminology	Design methods and terminology used in the specification of control center facilities
RP60.3	Human Engineering of Control Centers	Design concepts accommodating man’s physiological and psychological capabilities
RP60.4	Documentation for Control Centers	Guide to the documentation associated with control center specifications
*dRP60.5	Control Center Graphic Displays	Guide to the use of available graphic display techniques

RP60.6	Nameplates, Labels, and Tags for Control Centers	Guide to the methods of identification of control center equipment and parts
*dRP60.7	Control Center Construction	Guide to control center profiles, fabrication and finish methods, and enclosure selection
RP60.8	Electrical Guide for Control Centers	Design concepts for control center electrical requirements
RP60.9	Piping Guide for Control Centers	Design concepts for control center piping requirements
*dRP60.10	Control Center Inspection and Testing	Guide to the methods of inspection and testing prior to control center acceptance
*dRP60.11	Crating, Shipping, and Handling for Control Centers	Guide to the available methods for center crating, shipping, and handling

* Draft Recommended Practice — For additional information on the status of this document, contact ISA Headquarters.

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Contents

1 Introduction

1.1 Scope

This portion of ISA-RP60 is intended to be used as a guide in the preparation of engineering designs and specifications for control center facilities (see 1.2).

Because of the wide variety of industries using control centers, it is necessary that this recommended practice be general in its coverage. References are made to applicable industry codes and standards and to national codes that are law under the Occupational Safety and Health Act (OSHA). The user is cautioned to consult local and state building and construction codes that may also apply and to comply with the latest revisions of all such codes and standards, particularly in the nuclear power plant industry.

1.2 Definition

A control center facility is a combination of the services, protective enclosures, and environmental treatment necessary for the proper functioning of the control center. Control center facilities could be found in the following:

a) An area within an enclosure that is constructed to protect a control center and its operating personnel. The enclosure might also contain a computer room, motor control center room, instrument/electric shop, laboratory, and personnel facilities such as toilets, lockers, and offices.

b) An unenclosed area located either indoors or outdoors at ground level or in an elevated or subsurface structure.

c) An area in a mobile unit.

d) An area in a prefabricated or skid-mounted enclosure.

2 Site considerations

2.1 Hazards

The following is a list of some hazards that should be considered in locating control center facilities:

- Flammable, corrosive, or toxic liquids that could drain into or around the surrounding area
- Fire exposure from operating units or storage areas
- Entry of toxic and corrosive fumes or explosive dust into the control center facility
- Entry of flammable vapors and gases (see American Petroleum Institute (API) RP500A, RP500B, or RP500C, as applicable, for the classification of areas for the installation of electrical equipment)
- Entry of corrosive or toxic vapors and gases

- Noise
- Radiation exposures or radioactive contamination
- Electromagnetic interference (emi), radio frequency interference (rfi), magnetic interference (mi)
- Vibrations (mechanical and seismic)
- Falling debris, walls, and other obstructions
- Pressure disturbances such as explosion blast waves, hurricane force winds, and tornadoes
- Storms, floods, and wash water
- Underground rivers, caverns, abandoned wells, and mining operations
- Vehicular traffic
- Lack of oxygen due to displacement by inert gases (e,g., Halon, nitrogen, and carbon dioxide)

2.2 Operability

The location of a control center facility normally is dependent upon the amount of operator traffic required between the control center and the process equipment, dictated to a great extent by the type of process. For example, continuous or nonprocess units require less operator traffic than batch operations. Unattended operations may require special considerations.

2.3 Clearances

Consideration should be given to providing sufficient clearance between the control center facility and adjacent structures to ensure access for fire fighting equipment, service vehicles, unloading, and for the proper operation and maintenance of equipment located within. The National Electric Code (National Fire Protection Association, NFPA: 70) specifies clearances required between and around equipment containing electrical devices and wiring.

3 Construction

3.1 Foundations and supports

Foundations and footings required for support of control centers may include formed reinforced concrete, piling, masonry, and structural steel. Piling may be cast, poured, or timber type.

3.1.1 Soil tests

Weight and load concentration data should be developed and any necessary soil tests should be made before proceeding with structural design.

The nature and number of soil tests, method of sampling, and format of reports may be dictated by local inspecting authorities and/or by local testing laboratory experience. Where local authorities do not govern and the owner has no policy in this field, the following references are suggested:

- Building Officials Conference of America, Inc. (BOCA), Basic Building Code

  Section 725.0 - Bearing Value of Soils

  Section 726.0 - Borings and Test

  Section 727.0 - Soil Test Procedure

- Southern Standard Building Code

  Section 1302 - Footings and Foundations

- Uniform Building Code Standards

  Standard 29-1 - Soils Classification

  Standard 29-2 - Expansion Index Text

  Standard 70-1 - Moisture/Density Relations of Soils

  Standard 70-2 - In-place Density of Soils

3.1.2 Load checks

Foundations and footings normally present no extraordinary structural design problems.

The design dead load should include weights of the actual building materials used, including partitions, and the weights of installed equipment (e.g., plumbing, heating, and air conditioning systems).

Live loads include snow loading and loads due to the occupancy. Other loads to be considered are:

a) seismic loads;

b) soil lateral load, allowing for hydrostatic pressure;

c) wind loading, walls and roof;

d) impact loads, such as from elevators or vehicles; and

e) installed dead loads (e.g., control centers, electrical switchgear, auxiliary power equipment, battery banks, tubing, cable, cable trays, and raceways).

3.1.3 Seismic considerations

Refer to The National Building Code — Appendix J; the latest Uniform Building Code, Section 2312; and Section 10 of the Code of Federal Regulations (CFR), Part 50, for detail design parameters for earthquake-resistant construction and seismic zone maps of the United States. Also refer to Institute of Electrical and Electronic Engineers (IEEE) Standards 323 and 344.

3.1.4 Severity of weather

Foundations should extend below the frost line depth except when the foundation is on bedrock, on pilings, or on other structures that penetrate the frost line. Areas of permafrost require special consideration. Frost lines may reach depths in excess of six feet.

3.2 Floors

3.2.1 Types

3.2.1.1 Slab

A reinforced concrete slab is fireproof, resistant to shock, durable, strong, relatively inexpensive, and easy to maintain. Concrete slab floors are generally 5 to 6 inches (125 to 150 mm) thick when at grade. The loading strength is dependent upon slab thickness and type and spacing of reinforcing wire or rod.

3.2.1.2 Raised

Raised floors are commonly known as computer floors, which consist of square sections supported at the corners by adjustable jacks or along the sides with angle frames. The sections are prefabricated plates that are usually surfaced with a tile material and are easily supported above a slab floor. This type of floor is often used where large quantities of wire and cable must interconnect several control centers within a facility with field terminals or other equipment. In addition, this type of floor allows for flexibility in rearranging floor-mounted equipment without a major impact.

The space between the slab and removable plates can also be used effectively as an air conditioning distribution or return plenum. There may be special wiring restrictions when this space is so used.

Raised floors are available to support various loads and should be sized carefully for present and future expected loads. A means of distributing concentrated loads should be used when moving control centers and other equipment into place. Loads exceeding reasonable limits should be set directly on the slab floor. See precautions listed in 3.2.1.4 for trenches.

3.2.1.3 Plate

Carbon steel floor plate or grating set on structural members is generally used to support control centers located in open structures above grade. Corrosion and safety considerations may dictate special surface finishes for this type of floor.

3.2.1.4 Trenched

One method for bottom entry of cable and tubing is the trenched floor. This normally consists of formed recesses in a slab floor, the recesses located strategically under the control center sections. Access can be either from outside the facility or from an adjacent termination room. Design problems with this approach include providing sufficient trenching and adequate cover for future needs. When using trenched or raised floors, precautions should be taken to prevent the accumulation of flammable and toxic vapors and liquids in the recessed space and to prevent the entry of animal life. Appropriate combustible gas detectors, toxic gas detectors, and fire extinguishing and fire suppression systems (e.g., Halon) should be considered for trenched or raised floor installations.

3.2.1.5 Combination

Design considerations may dictate a combination of the above types of floors where present and future needs for wiring indicate a limited area of raised floor combined with, for example, a slab floor.

3.2.2 Floor surfaces

A floor material is used to control static charges, dust, and moisture and to provide a non-slip, attractive appearance. Bare concrete floors in particular remain porous and tend to retain moisture and generate dust.

3.2.2.1 A good concrete sealer may provide an adequate, serviceable floor surface for many applications.

3.2.2.2 Tile and carpeting may be used but require significant care and maintenance. Carpeting provides a nonslip surface, but careful consideration must be given to its potential for accumulating dust and static electrical charges and the possibility of its emitting toxic fumes in the event of fire.

3.2.2.3 Concrete floors with painted surfaces offer low resistance to wear.

3.3 Protective structures

3.3.1 Reference material

The following are reference materials for U.S. areas:

- The National Building Code — Appendix K
- Uniform Building Code — Chapter 23
- Southern Standard Building Code — Section 1205

3.3.1.1 Rain and snow

Masonry walls in areas of high rainfall should be adequately sealed. Transition areas, such as wall to roof and door openings, should utilize vertical lapping to prevent water entry. These principles will be of value in every area; however, extended roof projections are adequate in many cases. Ground water buildup is a problem best handled by sufficient floor line elevation in preference to special lower wall treatment. Where required, other methods should be employed to ensure a dry facility.

In some geographical areas, snow loading must be considered in roof design. Recommended snow loading design factors can be found in the various building codes.

3.3.1.2 Fire

Buildings in a potential area of fire exposure should utilize noncombustible materials for structure and furnishings and be equipped with fire doors.

3.3.1.3 Blast waves and fragments

a) Moderate exposure — Exterior walls and roofs should be designed for overpressure in the range of 0.5 psi (3.44 kPa) static loading or 3 to 5 psi (20.7 to 34.5 kPa) dynamic-type loading. A separately supported roof should be used with curtain walls. If blastproof windows or vision panels facing the exposure are required, they should be made of nonfragmenting material and be no larger than 10 inches by 10 inches (254 mm by 254 mm). Interior walls should be resistant to 0.5 psi (3.44 kPa) static overpressure.

b) Serious exposure — Exterior walls and roofs should be designed for overpressure of approximately 3 psi (20.7 kPa) static loading or 10 to 15 psi (68.9 to 103.44 kPa) dynamic-type loading. Additional loading resulting from a larger potential blast or from required proximity of the facility to the source of the blast normally requires the use of reinforced concrete, or equivalent construction, with no windows. Special consideration should be given to the design and location of exterior doors.

3.3.2 Seismic effects

The design of structures that are located in earthquake-prone areas is subject to special considerations. Appropriate design parameters are included in the referenced building codes.

3.3.3 Dust and fumes

Enclosed control center facilities should be designed to minimize the entry of dust and flammable, toxic, and corrosive fumes, gases, and vapors. Measures normally include filtering and pressurization from a clean outside air source and the use of an airlock. Refer to NFPA 496 and Section 4.4.

3.3.4 Openings

3.3.4.1 Doors

The size of access doors is dependent upon the size of the control centers and other equipment that must pass into the facility. Metal access doors opening outward and equipped with automatic door closers are recommended. At least two exits are required for personnel safety, one being away from the plant.

Various levels of security and selective access to the control center facility may be accomplished by the use of electronic card readers or keypad-type combination locks. Special door considerations include removable transoms, air locks, high mass doors for blast resistance, special gasketed doors for environmental purposes, "panic" hardware for emergency exits, shielded assemblies for radiation areas, sound attenuating doors for high noise areas, self-closing doors for rooms with automatic fire suppression (Halon), and fire isolation doors that are self-closing on temperature rise.

Various levels of security and selective access to the control center facility may be accomplished by the use of electronic card readers or keypad-type combination locks.

3.3.4.2 Windows

Use of windows should be avoided, but, if they are necessary, they should use glass reinforced with wire mesh. The area of each door window is commonly limited to 80 $in.^2$ (516 cm^2). Windows are sometimes limited in protective structures due to various hazards created by explosions or fires. Also see 3.3.1.3 and 3.3.1.4 for additional information. Wire-reinforced glass is recommended for use indoors to limit injury from breakage and for increased security.

Windows and/or skylights may be used to supplement facility lighting. Double-glazed insulation-type windows and tinted windows may be used to limit thermal loss or gain.

3.3.4.3 Other openings

Other openings include those for nonprocess pipes, tubing, conduits, cable trays, ducts, and ventilator fans.

The use of flashing and weatherhoods is the normal method of sealing pipes and ducts through roofs.

Pipe, cable, and tubing entries may be sealed by using bulk filler material around the cables, tubes, and/or trays. For most applications, a final resilient material may be used to seal the entry.

More stringent conditions such as flammable, toxic, and dusty environments, wind-driven rain, integrity of electrical classification, fire, or radiation exposure may require the use of special entry fittings, seals, and trenches. Provisions for prevention of animal and insect entry may also be required.

3.4 Control center bases

Control centers are normally supported off a facility floor or other surface in areas subject to washing by flooding or hosing. Drainage should be away from the control center. Such bases are usually made of concrete or fabricated from a steel channel.

3.4.1 Concrete

A poured concrete curb with a smooth and level top surface may be used as a base for the control center when slab floor construction is used as a finished surface. It is normally shaped and finished to inhibit dirt collection. Anchor bolts should be used to secure the control center in place.

3.4.2 Steel channel

Steel channel can be used to support the control center. Channel can be supplied as an integral part of the control center structure or as a separate support dimensioned to match the supported structure. Steel channel used on outdoor installations should be galvanized or otherwise protected from corrosion. For interior installations, a painted surface selected to match the control center finish is usually adequate.

4 Heating, ventilating, and air conditioning

4.1 General

The life and operation of control equipment is improved by environmental control. Design factors to consider in heating and ventilating control center facilities are weather extremes; area classification; process fluid or dust hazards; occupancy level; heat release of electronic and electrical equipment; and the effect of humidity, airborne particles (e.g., salt), and corrosive gases on electronic or electrical equipment. Reference ISA-SP71.04, Environmental Conditions for Process Measurement and Control Systems: Airborne Contaminants.

Different rooms within the control center facility may have different heat loads and different equipment constraints. This may require zoning of the heating, ventilating, and air conditioning system or separate systems for various rooms.

A testing laboratory may also be included in the control center facility. The testing of flammable samples anywhere in the facility can affect the electrical classification of the entire facility. To avoid this problem, a separate facility is recommended for laboratories where flammable materials will be present. Where this is not practical, these rooms shall have separate HVAC systems, and entry should be possible only from the outside of the building. Care should be taken to isolate the laboratory exhaust gases from the main control center facility's intake.

In geographical areas where ambient temperatures could exceed the equipment specifications limitations, standby air conditioning equipment should be considered.

4.2 Mild climate locations

In mild climates where only occasional heating is required and cooling may be accomplished by ventilation only, a once-through system designed to provide a minimum of six air changes per hour is satisfactory. The air flow may be provided either by inlet or exhaust fans.

4.3 Severe climate locations

Where the climate is more severe, dictating the use of automatic heating and air conditioning, a recirculating system with minimal fresh air makeup is more economical. Design of air conditioning or heating capacity should be based on normally expected weather extremes and the load presented by the required fresh air makeup rate. The determination of the required fresh air makeup rate usually depends upon such factors as building leakage rate, number of occupants, and room volume. Special situations such as the ventilation of cooking areas, restrooms, and laboratories may also affect the required rate of fresh air makeup. To control odors and other fumes, the latter areas should receive once-through ventilation. The location of the fresh air intakes should be selected using American Petroleum Institute (API) RP 500A as a guide. In addition, locations of plant vents or other likely sources of process fluid leakage and prevailing wind direction should be considered in selecting the location of the fresh air source.

General ventilation guides factor	**Rate of makeup**
Occupancy level	20-30 ft^3/min per person
(from 0.01 to 0.015 m^3/s)	
Room volume	2-4 changes per hour
Cooking areas	4 changes per hour
Restrooms	4 changes per hour
Laboratories	4 changes per hour

For further information on ventilation design, reference American National Standards Institute ANSI Z4.1-1986, Sanitation in Places of Employment, Minimum Requirements, Section 4.2.1, and American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Handbook, 1985, Fundamentals.

4.4 Locations classified for electrical installations

It is preferred that control center facilities be located outside of hazardous (classified) areas. Facilities placed in areas classified because of external adjacent equipment, however, can be made unclassified by complying with the requirements of the National Fire Protection Association (NFPA) Standard 496, Purged Enclosures for Electrical Equipment. This requires that the room or building be pressurized to greater than 0.1 inch of water (24.9 Pa) and ventilated with clean air drawn from outside the classified area. Loss of pressure below this value is allowable as long as an outward velocity of 60 feet per minute (0.3 m/s) can be maintained through any openings. Generally, pressurizing should be limited to a maximum of 0.4 inch of water (99.5 Pa) because of the difficulty of operating automatic door closers and the "earpopping" effects of sudden door openings when greater pressures are allowed. Pressurized rooms usually use an air recirculation system with automatic temperature and humidity control. The design for the fresh air makeup rate will depend on the factors treated in 4.3. NFPA 496 also references requirements for alarms and interlocks that depend upon the specific electrical classification of the area. For oil- and gas-producing facilities, combustible gas detection equipment installed in accordance with API RP500B, Third Edition, Section 4.8, can be a basis for installing non-explosion-proof equipment in certain buildings that would otherwise require such equipment.

5 Services

5.1 Power

5.1.1 Electrical

Reliable electrical power should be provided in the facility for instruments, controls, and other equipment. In many cases, commercial power is not reliable enough, and uninterruptible power system (UPS) backup systems should be installed. A UPS system helps to protect against the effects of lightning strikes, the start-up of large motors, and electronic motor controls that may introduce large spikes, voltage dips, and noise into the electrical system.

5.1.2 Pneumatic

Air for the proper operation of pneumatic instruments should be supplied by clean and corrosion-resistant pipe to minimize its contamination. The size and schedule of the pipe is dependent upon the air flow and pressure. Refer to ISA-SP7.3, Quality Standard for Instrument Air, and ISA-RP60.9, Piping Guide for Control Centers.

Where nitrogen is used as an emergency instrument air system backup, a low oxygen alarm system is required.

5.2 Lighting

Publications useful in lighting design are American Petroleum Institute API: 540 and the Illuminating Engineers Society (IES) Lighting Handbook. Perimeter lighting for safe access should be at an illumination level of 5 footcandles (53.8 lux) at grade. Energy efficient lamps are recommended. The interior should be illuminated to a minimum level of 40 to 50 footcandles (431 to 538 lux) maintained at 5 feet (1.5 m) above the floor and on the panel section of the control center. The minimum recommended illumination level for the back of control centers is 10 footcandles (108 lux), 3 feet (1 m) above the floor. Special circumstances may require higher levels. Low intensity presentations such as video display tubes (VDT) may require special mounting treatment when using the lighting level indicated above. Adjustable lighting for each operating area may be considered.

5.3 Emergency lighting

It is recommended that control center facility lighting circuits be fed from the emergency power supply system. Emergency lamps, capable of emitting 1 footcandle (10.8 lux) measured at floor level, should be furnished to illuminate egress from the control center facility for life safety. Exit lights must be provided per the applicable codes. Refer to National Electrical Code (NEC), Article 700 and NFPA: 101.

5.4 Grounding

5.4.1 Low level signal grounding

A ground connection should be provided for use as a common signal ground for the various input and control devices such as intrinsically safe systems and computer systems. The signal ground should be insulated and separated from any electrical power ground and should be located as close as possible to the control center. The signal grounding conductor should be equal to or larger than the size of the largest conductor providing power to the control center. Reference NEC Article 250. Reference NFPA Article 504 and ISA-S12.6 for intrinsically safe circuits.

Special grounding requirements are often specified by equipment manufacturers and must be followed to assure manufacturers' warranties.

5.4.2 Lightning protection

Structural steel members should be grounded for lightning protection.

5.4.3 Equipment grounding conductor

Refer to NEC Table 250-95 for equipment grounding.

5.5 Drains

Suitable drains should be provided where required. If flammable or harmful vapors may enter the facility through the drain system (particularly likely during plant upsets, spills, or flooding) suitable water traps should be provided. A separate drain system shall be required.

6 Personnel safety

Consideration should be given to the detection and control of the following potential personnel safety hazards.

6.1 Fire

Fire is normally detected by temperature sensors and smoke detectors that are connected to an alarm system, that is, usually independent of process annunciators. Suitable fire extinguishers, protective clothing, and breathing equipment should be readily available. A permanently installed Halon or other type of extinguishing system may be required.

6.2 Radiation

Radiation is a potentially serious hazard in many industries. The Nuclear Regulatory Commission (NRC) has stringent requirements that relate to the handling of nuclear materials and to the safety of personnel in facilities where radiation is a hazard. Accordingly, the NRC requirements should govern in the design of all facilities where nuclear materials are present.

6.3 Toxic gases and flammable vapors

Facilities with a potential for exposure to toxic gases and/or flammable vapors should have suitable analytical equipment to detect their presence and to sound an alarm. In certain installations, it is normal practice to shut down the control center facility ventilating systems to prevent the entry of the contaminants.

6.4 Noise

Normal industrial practice is to design to the minimum practical level but not greater than a maximum of 65 dBA (A-weighted, per ANSI S1.4) for efficient performance of personnel in the enclosed control center facility.

7 Communications

7.1 Wired

Careful consideration should be given to the routing and installation of wiring for telephones (normal and emergency systems), sound-powered telephones, teletype writers, VDT displays, closed-circuit televisions, public address systems, and other similar equipment to prevent interference with, or interruption of, their operation during emergencies. Allowance for future additions and expansions is recommended.

7.2 Radio

To provide for radio communications, space should be allocated for the installation of equipment such as receivers, repeaters, and transmitters. (In the U.S., the regulations of the Federal Communications Commission (FCC) must be followed. FCC regulations control the height above grade of the transmitting antenna, as well as its distance from the transmitter.)

Consideration should also be given to the effect of the power and frequency of radio transmitter signals from local or remote sources on nearby electronic devices such as transducers, computers, counters, and other sensitive instruments (refer to Scientific Apparatus Manufacturers Association SAMA PMC 33.1, Electromagnetic Susceptibility of Process Control Instrumentation).

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