Process Industry Practices
Architectural

PIP ARC01015
Architectural and Building Utilities Design Criteria
PURPOSE AND USE OF PROCESS INDUSTRY PRACTICES

In an effort to minimize the cost of process industry facilities, this Practice has been prepared from the technical requirements in the existing standards of major industrial users, contractors, or standards organizations. By harmonizing these technical requirements into a single set of Practices, administrative, application, and engineering costs to both the purchaser and the manufacturer should be reduced. While this Practice is expected to incorporate the majority of requirements of most users, individual applications may involve requirements that will be appended to and take precedence over this Practice. Determinations concerning fitness for purpose and particular matters or application of the Practice to particular project or engineering situations should not be made solely on information contained in these materials. The use of trade names from time to time should not be viewed as an expression of preference but rather recognized as normal usage in the trade. Other brands having the same specifications are equally correct and may be substituted for those named. All Practices or guidelines are intended to be consistent with applicable laws and regulations including OSHA requirements. To the extent these Practices or guidelines should conflict with OSHA or other applicable laws or regulations, such laws or regulations must be followed. Consult an appropriate professional before applying or acting on any material contained in or suggested by the Practice.

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# PIP ARC01015
## Architectural and Building Utilities Design Criteria

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1. Introduction

1.1 Purpose
This Practice provides the architect and the engineer with criteria for building design and building utilities.

1.2 Scope
This Practice describes the minimum requirements for the design of buildings. This Practice is intended to be used in conjunction with PIP ARC01016 - Building Data Sheet, PIP CVC01017 - Plant Site Data Sheet, and PIP STC01015 - Structural Design Criteria.

This Practice does not apply to open or partially enclosed industrial structures.

2. References

Applicable parts of the following Practices, industry codes and standards, and references shall be considered an integral part of this Practice. The edition in effect on the date of contract award shall be used, except as otherwise noted. Short titles are used herein where appropriate.

2.1 Process Industry Practices (PIP)
- PIP ARC01016 - Building Data Sheet
- PIP ARS08111 - Standard Steel Doors and Frames Supplier Specification
- PIP ARS08390 - Blast Resistant Doors, Frames, and Related Hardware Specification
- PIP ARS08710 - Standard Steel Door Hardware Supplier Specification
- PIP ARS13120 - Pre-Engineered Metal Buildings Specification
- PIP CVC01017 - Plant Site Data Sheet
- PIP STC01015 - Structural Design Criteria
- PIP STC01018 - Blast Resistant Building Design Criteria

2.2 Industry Codes and Standards
- Air Movement and Control Association (AMCA)
  - AMCA 511 - Certified Ratings Program – Product Rating Manual for Air Control Devices
- Aluminum Association
  - Aluminum Design Manual
- American Conference of Governmental Industrial Hygienists (ACGIH)
  - Industrial Ventilation: A Manual of Recommended Practice for Design
- American Petroleum Institute (API)
  - API RP 540 - Electrical Installations in Petroleum Processing Plants
• American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE)
  - ASHRAE Handbook - Fundamentals (I-P and SI Editions)
  - ASHRAE Handbook - HVAC Applications (I-P and SI Editions)
  - ASHRAE Handbook - Refrigeration (I-P and SI Editions)
  - ASHRAE 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
  - ASHRAE 62.1 - Ventilation for Acceptable Indoor Air Quality
• American Society of Mechanical Engineers (ASME)
  - ASME A17.1 - Safety Code for Elevators and Escalators
• ASTM International (ASTM)
  - ASTM E1264 - Standard Classification for Acoustical Ceiling Products
  - ASTM F1066 - Standard Specification for Vinyl Composition Floor Tile
  - ASTM F1303 - Standard Specification for Sheet Vinyl Floor Covering with Backing
  - ASTM F1344 - Standard Specification for Rubber Floor Tile
  - ASTM F1700 - Standard Specification for Solid Vinyl Floor Tile
  - ASTM F1860 - Standard Specification for Rubber Sheet Floor Covering with Backing
  - ASTM F1861 - Standard Specification for Resilient Wall Base
  - ASTM F2195 - Standard Specification for Linoleum Floor Tile
• Ceilings and Interior Systems Construction Association (CISCA)
  - Ceiling Systems Handbook
  - Recommended Test Procedures for Access Floors
• Institute of Electrical and Electronic Engineers (IEEE)
  - IEEE 1100 - Recommended Practice for Powering and Grounding Electronic Equipment
• International Code Council (ICC)
  - International Building Code (IBC)
  - International Mechanical Code (IMC)
  - International Plumbing Code (IPC)
• International Society of Automation (ISA)

• National Fire Protection Association (NFPA)
  – NFPA 10 - Standard for Portable Fire Extinguishers
  – NFPA 13 - Standard for the Installation of Sprinkler Systems
  – NFPA 14 - Standard for the Installation of Standpipe and Hose Systems
  – NFPA 45 - Standard on Fire Protection for Laboratories Using Chemicals
  – NFPA 70 - National Electrical Code (NEC)
  – NFPA 72 - National Fire Alarm and Signaling Code
  – NFPA 75 - Standard for the Fire Protection of Information Technology Equipment
  – NFPA 80 - Standard for Fire Doors and Other Opening Protective
  – NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems
  – NFPA 91 - Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids
  – NFPA 232 - Standard for the Protection of Records
  – NFPA 252 - Standard Methods of Fire Tests of Door Assemblies
  – NFPA 496 - Standard for Purged and Pressurized Enclosures for Electrical Equipment
  – NFPA 2001 - Standard on Clean Agent Fire Extinguishing Systems

• National Roofing Contractors Association (NRCA)
  – The NRCA Roofing Manual: Steep-slope Roof Systems
  – The NRCA Roofing Manual: Metal Panel and SPF Roof Systems
  – The NRCA Roofing Manual: Membrane Roof Systems
  – The NRCA Roofing Manual: Architectural Metal Flashing, Condensation Control and Reroofing
  – NRCA Vegetative Roof Systems Manual

• Scientific Equipment and Furniture Association (SEFA)
  – SEFA Desk Reference Manual

• Sheet Metal and Air Conditioning Contractors’ National Association (SMACNA)
  – SMACNA - Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems
  – SMACNA - HVAC Duct Construction Standards - Metal and Flexible

• Steel Deck Institute (SDI)
  – Design Manual for Composite Decks, Form Decks and Roof Decks-No. 31
Telecommunication Industry Association (TIA)
  - TIA-568 - Commercial Building Telecommunications Cabling Standards
  - TIA-569 - Telecommunication Pathways and Spaces
  - TIA-570 - Residential Telecommunications Infrastructure Standard
  - TIA-606 - Administration Standard for Commercial Telecommunications Infrastructure
  - TIA-607 - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

Underwriters Laboratory (UL)
  - UL 10B - Standard for Safety - Fire Tests of Door Assemblies
  - UL 555 - Standard for Safety - Fire Dampers
  - UL 555C - Standard for Safety - Ceiling Dampers
  - UL 1863 - Standard for Safety - Communications-Circuit Accessories

2.3 Government Regulations

U.S. Department of Labor (DOL) / Occupational Safety and Health Administration (OSHA)
  - OSHA 29 CFR Part 1910 - Occupational Safety and Health Standards

U.S. Department of Justice (DOJ) / Americans with Disabilities Act (ADA)
  - 2010 ADA Standards for Accessible Design
  - Guidance on the 2010 ADA Standards for Accessible Design

Federal Communications Commission (FCC)
  - Part 68 - Connection of Terminal Equipment to the Telephone Network, Code of Federal Regulations, Title 47, Telecommunications

3. Definitions

contract documents: Any and all documents, including codes, studies, design drawings, specifications, sketches, practices, and data sheets, that the purchaser or engineer of record has transmitted or otherwise communicated, either by incorporation or reference, and made part of the legal contract agreement or purchase order between the purchaser and the supplier.

owner: The party who has authority through ownership, lease, or other legal agreement over the building or buildings covered by this document.

purchaser: The party who awards the contract to the supplier. The purchaser may be the owner or the owner’s authorized agent.

supplier: The party responsible for providing the design of the building and associated utilities.
4. Requirements

4.1 Building Design

4.1.1 General

4.1.1.1 In addition to local jurisdiction and government requirements, all buildings shall be designed in accordance with IBC and OSHA 29 CFR Part 1910 unless otherwise specified in the purchaser’s PIP ARC01016 Data Sheet or in the contract documents.

4.1.1.2 Buildings shall be designed in accordance with 2010 ADA Standards for Accessible Design where required by law.

Comment: The supplier can refer to the Guidance on the 2010 ADA Standards for Accessible Design for more information.

Comment: Buildings “inside the fence” may be exempted from 2010 ADA Standards for Accessible Design if the plant safety requirements state that only able-bodied personnel are allowed in the plant, with approval of the Authority Having Jurisdiction (AHJ).

4.1.1.3 Buildings shall be designed using the information provided in purchaser’s PIP CVC01017 Data Sheet.

4.1.1.4 Buildings shall be designed for all energy conservation codes required by national, state, and local government regulations.

4.1.1.5 Buildings designated by the owner to be used as a temporary safe haven and/or shelter in place shall meet all applicable requirements of this Practice and any additional requirements of the owner specified in the contract documents.

4.1.2 Means of Egress

4.1.2.1 Buildings shall be provided with means of egress in accordance with the applicable building codes and 2010 ADA Standards for Accessible Design if applicable based on use and occupancy.

4.1.2.2 Industrial occupancies shall be in accordance with the egress requirements of IBC.

4.1.3 Foundation and Structure

4.1.3.1 The foundation and structure of a building shall also be designed in accordance with PIP STC01015.

4.1.3.2 Buildings required to be blast resistant shall also be designed in accordance with PIP STC01018.

4.1.4 Materials and Methods of Construction

4.1.4.1 Each building shall be designed with materials and methods of construction appropriate for its occupancy.

4.1.4.2 The type of construction shall be in accordance with requirements of governing building codes.
4.1.5 Pre-Engineered Metal Buildings

Pre-engineered metal buildings shall be in accordance with PIP ARS13120.

4.2 Products

4.2.1 General

Unless the contract documents or applicable governing jurisdictions specify more stringent requirements, products for buildings shall be designed in accordance with this Practice.

4.2.2 Concrete

Concrete design shall be in accordance with IBC and PIP STC01015.

4.2.3 Masonry

Masonry design shall be in accordance with IBC and PIP STC01015.

4.2.4 Metals

4.2.4.1 Steel design shall be in accordance with IBC and PIP STC01015.

4.2.4.2 Floor and roof decks shall be in accordance with SDI Design Manual for Composite Decks, Form Decks and Roof Decks – No. 31.

4.2.4.3 Aluminum design shall be in accordance with the Aluminum Association’s Aluminum Design Manual.

4.2.5 Woods

4.2.5.1 Wood design using allowable stress design shall be in accordance with IBC.

4.2.5.2 Structural lumber shall be grade No. 2 or better.

4.2.5.3 Non-structural lumber shall be grade No. 3 or better.

4.2.6 Gypsum Board Assemblies

4.2.6.1 Interior walls shall be regular-type gypsum board on minimum 22-gage steel stud framing.

4.2.6.2 Type X gypsum board shall be used where fire-resistance-rated assemblies are required.

4.2.6.3 Cement backing board shall be used where tile finish is scheduled.

4.2.6.4 Unless otherwise specified in the contract documents, core thickness of all gypsum board shall be 5/8” (16 mm).

4.2.6.5 Gypsum board assemblies shall be taped, floated, and sanded.

4.2.6.6 For gypsum board assemblies with fire-resistance ratings, materials and construction shall be provided that are identical to those tested in assembly in accordance with ASTM E119 by an independent testing and inspecting agency that is acceptable to authorities having jurisdiction, such as UL 263.

4.2.6.7 Furr-outs shall be gypsum board on steel stud framing.
4.2.6.8 Unless otherwise specified in the contract documents, gypsum board walls shall have a latex enamel painted finish.

4.2.7 Ceilings

4.2.7.1 Suspended acoustical ceiling installation shall be in accordance with CISCA’s Ceiling Systems Handbook.

4.2.7.2 Suspended ceiling acoustical panels shall be in accordance with the following requirements:
   a. ASTM E1264 classifications as designated by types, patterns, acoustical ratings, and light reflectance.
   b. If required for fire rated assemblies, panels shall be fire resistance rated.
   c. If specified in the contract documents, panels shall be moisture resistant and/or scrubbable.

4.2.7.3 Metal suspension system for acoustical panel ceiling shall be standard direct-hung metal suspension systems. Suspension system shall be fire resistance rated if required for fire rated assemblies.

4.2.8 Flooring

4.2.8.1 Solid vinyl floor tile shall be in accordance with ASTM F1700.

4.2.8.2 Vinyl composition floor tile shall be in accordance with ASTM F1066.

4.2.8.3 Rubber floor tile shall be in accordance with ASTM F1344.

4.2.8.4 Vinyl sheet floor covering shall be in accordance with ASTM F1303.

4.2.8.5 Rubber sheet floor covering shall be in accordance with ASTM F1860.

4.2.8.6 Linoleum floor tile shall be in accordance with ASTM F2195.

4.2.8.7 Resilient wall base shall be rubber or vinyl as specified in the contract documents and shall be in accordance with ASTM F1861.

4.2.8.8 Access floor systems shall be in accordance with Section 4.2.12.2 of this Practice.

4.2.9 Thermal and Moisture Protection

4.2.9.1 Insulation

   1. Insulation shall have a flame-spread rating of less than 25 and shall not be exposed to potential fire areas.
   2. Insulation shall be used for separation between roof decks and the roofing membranes.
   3. Insulation shall be provided in exterior walls and roofs, and in walls separating conditioned/non-conditioned areas or zones of differing temperature requirements.
4. Unless otherwise specified in the contract documents, R values shall be in accordance with energy conservation codes required by national, state, and local government regulations and the local environmental conditions but shall not be less than R-11 for walls and R-19 for roofs.

4.2.9.2 Roofing Systems

1. Roofing systems shall be designed in accordance with the appropriate NRCA Roofing Manual(s). NRCA Roofing Manuals are as follows.
   
a. The NRCA Roofing Manual: Steep-slope Roof Systems
b. The NRCA Roofing Manual: Metal Panel and SPF Roof Systems
c. The NRCA Roofing Manual: Membrane Roof Systems
d. The NRCA Roofing Manual: Architectural Metal Flashing, Condensation Control and Reroofing
e. NRCA Vegetative Roof Systems Manual

2. Low-slope roofs shall have a minimum slope of 1/4 inch per foot (21 mm/m).

3. Overflow relief openings shall pass through the parapet where applicable in accordance with SMACNA Architectural Sheet Metal Manual.

4. The roof structure shall be designed for ponding up to the height of the relief openings and with consideration to the deflected shape under the full load.

5. If equipment or piping is placed on a building roof, appropriate supports shall be provided in accordance with NRCA Roofing Manuals to hold them above the roof and a suitable walking or working surface shall be provided to prevent damage to the roofing.

6. Exposed sides of working area and walkway within 6.0 ft (1800 mm) of edge of roof shall be protected with standard safety devices or railings.

7. Equipment shall be mounted a minimum of 8 inches (200 mm) above the roofline to allow for efficient maintenance and repair of the roofing material.

8. Equipment supports shall not be constructed of wood.


4.2.10 Fire Resistance

Buildings shall be designed for fire resistance in accordance with IBC.
4.2.11 Doors and Windows

4.2.11.1 Standard steel doors and frames shall be in accordance with PIP ARS08111.

4.2.11.2 Door hardware shall be in accordance with PIP ARS08710.

4.2.11.3 Unless otherwise specified in the contract documents, overhead coiling doors larger than 64 ft\(^2\) (6 m\(^2\)) shall be motorized. The side rails shall be made from structural steel. Rails made from cold-rolled shapes are not acceptable.

4.2.11.4 Fire-rated doors shall be in accordance with NFPA 252, NFPA 80, and UL 10B.

4.2.11.5 Blast-resistant doors shall be in accordance with PIP STC01018 and PIP ARS08390, and shall be provided with automatic door closers.

4.2.11.6 Unless otherwise specified by the owner and permitted by applicable fire safety and building codes, windows shall not be permitted in buildings within 200 ft (60 m) of hazardous process facilities.

4.2.12 Specialties

4.2.12.1 Exterior Louvers

1. Louvers shall be all-welded construction with drainable blades to minimize water penetration while maintaining a high free area.

2. Louvers shall be designed with a frame that includes a jamb gutter, a recessed drip lip at the head, and an extended water stop on the back of the sill and insect screens where required.

3. Louvers shall be in accordance with AMCA 511 and shall bear the AMCA-certified rating seal for both air performance and water penetration.

4.2.12.2 Access Floors

1. Panels and support systems shall be in accordance with CISCA-Recommended Test Procedures for Access Floors.

2. Floor panels shall have a Class “A” flame-spread rating when tested without floor covering in accordance with ASTM E84. Floor panel covering shall be as specified on the purchaser’s PIP ARC01016 Data Sheet.

3. Unless otherwise specified on the purchaser’s PIP ARC01016 Data Sheet, floor height shall be 24 inches (600 mm) above subfloor.

4. The supporting system shall be as follows:
   a. A commercial heavy duty, bolted grid system
   b. Free from vibration squeaks
c. Designed to support the equipment that is to be located on the access flooring system
d. Resistant to seismic loads in accordance with purchaser’s PIP CVC01017 Data Sheet.

5. The floor system shall support the following minimum loads:
   a. Static: 1000 lb (4.5 kN), concentrated
   b. Dynamic:
      (1) 1000 lb (4.5 kN) rolling load for 3-inches diameter by 1-13/16-inches wide (75-mm diameter by 46 mm) with 10 passes
      (2) 500 lb (2.25 kN) for 6-inches diameter by 1-1/2-inches wide (150-mm diameter by 38 mm) with 10,000 passes
   c. Impact load: 250 lb (1.12 kN)

6. The entire flooring system shall be electrically grounded.

4.2.12.3 Toilet Compartments and Urinal Screens

1. Materials shall be commercial heavy duty, non-permeable, corrosion and stain resistant.
2. Compartment doors shall be a minimum of 24 inches (600 mm) wide, 36 inches (900 mm) on ADA accessible compartments
3. Each compartment shall be provided with a coat hook, toilet tissue dispenser, sanitary napkin disposal (women only) and door latch. Accessible stalls shall be provided with grab bars.
4. Screw and bolt heads shall match accessory finish and shall be vandal-resistant.

4.2.12.4 Restrooms

1. Restrooms shall be provided with soap dispensers, paper towel dispensers, waste receptacle, mirrors, and a shelf for personal items.
2. Restrooms without toilet compartments shall be provided with additional accessories as described in Section 4.2.12.3 of this Practice for toilet compartments.
3. Materials shall be commercial, heavy duty, and corrosion resistant.
4. Anchors shall be concealed and shall be made of nonferrous metal or stainless steel.

4.2.12.5 Laboratory Casework

1. All casework, work-surfaces and service fixture construction and performance characteristics shall be in accordance with applicable parts of the SEFA Desk Reference Manual.
2. Countertops shall be constructed to resist chemicals, moisture, physical abuse, and acid splatters and shall be resistant to damage from heavy instruments and abrasive cleaners.

3. Casework components shall withstand the following minimum loads without damage to the components or to the casework operation:
   a. Base unit load capacity 500 plf (7.3 kN/m)
   b. Suspended units 300 plf (4.4 kN/m)
   c. Drawers in cabinets 150 lb (0.7 kN)
   d. Utility tables (four-leg) 300 lb (1.4 kN)
   e. Hanging wall cases 300 lb (1.4 kN)
   f. Capacity for shelves of units 150 lb (0.7 kN)

4. Casework shall be of flush construction with the surface of doors, and drawers and panel faces shall be flush with the cabinet fronts, ends, and rails.

5. Base cabinets with double swinging doors shall provide full access to the interior without center vertical post.

6. Drawers shall be rated for 150-lb (0.7-kN) load capacity at full extension.

7. Drawers shall be sound-deadened, and all corners shall be fitted smoothly.

4.2.12.6 Laboratory Fume Hoods

Fume hoods shall be in accordance with applicable parts of the SEFA Desk Reference Manual and NFPA 45.

4.2.13 Conveying Systems

Elevators, escalators, and dumbwaiters shall be designed in accordance with ASME A17.1.

4.3 Building Utilities

4.3.1 Heating, Ventilation, and Air Conditioning (HVAC)

4.3.1.1 Design Criteria

1. Climatic Conditions
   a. Unless site specific design temperatures are specified on purchaser’s PIP CVC01017 Data Sheet, climatic condition values shall be in accordance with the ASHRAE Handbook - Fundamentals.
   b. For all HVAC systems, cooling load shall be calculated with the summer design dry bulb (0.4%) and mean coincident wet bulb temperatures, and the supply air requirements shall be determined at these temperatures.
   c. For HVAC systems that have more than 20% outside air make-up, in addition to the cooling load calculations
performed in accordance with Section 4.3.1.1.1.b of this Practice, the cooling load shall also be calculated at the design wet bulb (0.4%) and mean coincident dry bulb temperature to determine which set of conditions results in larger HVAC system capacity. The resultant larger HVAC system capacity shall be used as the cooling capacity of the refrigeration system. The airside capacity shall be as determined from Section 4.3.1.1.1.b of this Practice.

d. For the selection of air-cooled packaged units, air-cooled condensers, and air-cooled condensing units, the summer design dry bulb (0.4%) temperature shall be used.

c. Heating load shall be calculated using the 99.6% heating dry bulb temperature.

2. Indoor Design Conditions

a. Unless otherwise specified in the contract documents, the minimum indoor conditions used for the design of HVAC systems for various occupancies shall be in accordance with Table 1 of this Practice.

b. Design conditions for other occupancies shall be based on rooms listed in Table 1 of this Practice, having similar functions.

c. HVAC systems shall be capable of maintaining dry bulb and relative humidity within the performance range given in Table 1 of this Practice and shall be designed based on ASHRAE Handbook - Fundamentals, applicable health and safety codes, and equipment manufacturers’ requirements.

d. Fresh air requirements for each space shall be based on ASHRAE 62.1

4.3.1.2 Load Calculation

1. General Requirements

a. HVAC load calculations shall be in accordance with the ASHRAE Handbook - Fundamentals methods and shall include a minimum of 5% but not greater than 10% excess capacity (sensible, latent, or heating) as safety factors.

b. Residential method, preferably total equivalent temperature differential with time averaging (TETD/TA), shall be used only for residential application.

c. Overall building cooling and heating loads shall be calculated. Zoning, exposure, and building mass shall be considered in heating and cooling calculations.

d. The air-conditioning system shall provide comfortable conditions in all rooms throughout the operating period in accordance with Table 1 of this Practice.
e. Each zone, portion of a zone, and room with different load profiles, orientations, or sensible loads shall be calculated.

f. A separate block load for each air-handling system shall also be calculated.

2. Cooling Loads
   a. Cooling load calculations shall consider all sensible and latent heat sources.

   b. Sensible cooling load shall be calculated for building envelope, people, lights, equipment, interior non-conditioned spaces, duct and plenum gains, and outside air that is introduced into the system by air make-up or infiltration.

   c. Latent cooling load shall be calculated for people, outside air, and any process in which moisture is released to the air.

   d. Outside air requirements shall be carefully evaluated for the building pressurization in accordance with NFPA 496.

3. Heating Loads
   a. Heat loads shall include heat losses from building envelope, interior non-conditioned spaces (partitions, ceilings, floors), duct and plenum losses, and outside air that is introduced into the system by make-up air and infiltration.

   b. Final discharge temperatures shall range between 85°F (30ºC) and 110°F (43ºC).

4.3.1.3 System Considerations

1. Zoning
   For buildings with separate interior and perimeter rooms, each room or group of rooms (except for unoccupied spaces) having a distinctive load profile shall have individual temperature control.

2. Air System Design
   a. Air distribution systems shall be designed in accordance with ASHRAE Handbook - Fundamentals, “Duct Design” section.

   b. If space conditions permit, supply air ductwork shall be designed for a maximum pressure drop of 0.1 inch wg per 100 ft (0.82 Pa/m).

   c. If space conditions permit, return, general exhaust, and outside air duct shall be sized for a maximum pressure drop of 0.08 inch wg per 100 feet (0.65 Pa/m).

   d. Non-general exhaust duct sizing criteria shall be in accordance with ACGIH - Industrial Ventilation: A Manual of Recommended Practice for Design.
e. All ductwork and fittings shall be fabricated in accordance with the *SMACNA - HVAC Duct Construction Standards Metal and Flexible* and in accordance with the static pressure expected to be encountered in the system.

f. Flexible duct shall not be used for return or exhaust systems.

g. If flexible ducts are used in the supply air system, the ducts shall not exceed 8.0 ft (2400 mm) in length.

h. Manufacturer’s standard diffusers, registers, and grilles shall be used.

i. A volume damper shall be provided in each branch duct serving a separate zone or room. Splitter dampers shall not be used for duct branch take-offs.

j. Volume dampers shall be provided ahead of flexible duct serving supply air grilles, registers, and diffusers.

k. Outside air intakes shall be designed and located to minimize dust intrusion.

l. Outside air intakes shall not be less than 10 ft (3000 mm) from an appliance vent outlet, a vent opening, or a plumbing drainage system or discharge outlet of an exhaust fan unless the outlet is 5 ft (1500 mm) above the outside air intake.

m. If practical, return air shall be drawn through a sealed ceiling plenum.

n. If cable trays are located inside the ceiling plenum, a ducted return air system rather than plenum-rated cables shall be evaluated.

o. If building is pressurized in accordance with *NFPA 496*, the air-conditioning equipment rooms shall not be used as return air plenums.

p. Outside air intake ducts shall have combustible gas and fire/smoke detectors to detect the presence of flammable gas/vapors and/or smoke in buildings in NEC-classified areas.

(1) If the detector detects greater than 10% of the lower flammable limit, an alarm shall occur.

(2) If the detector detects greater than 25% of the lower flammable limit, the air intake blowers shall shut down and the outside air intake damper shall close automatically.

(3) If the blowers shut down, dampers shall automatically close.
3. Control Systems
   a. HVAC control systems shall be designed and installed using commercially available equipment and techniques to control temperature and, if required, humidity, pressure, and air quality in accordance with ASHRAE 90551 or ASHRAE 90552 as applicable.
   b. All thermostats shall be manually adjustable over the operating range and have time/date setbacks or be tied to an energy management system.
   c. Fire dampers shall be installed in accordance with NFPA 101.
   d. Unless the building is always manned, HVAC units shall automatically shut down in accordance with NFPA 90A and NFPA 101 if fire alarm system is activated.
   e. If the building is always manned (e.g., control building), a manual shutdown switch shall be provided.

4. Piping and Coils
   a. The location of air-conditioning equipment components shall account for piping and equipment pressure drop, area classification, and equipment clearance requirements.
   b. Access space shall be provided for the removal of any coil or other equipment component, in accordance with equipment manufacturer’s recommendation.
   c. Multiple compressor refrigerant piping shall be interconnected in accordance with manufacturer’s recommendations.
   d. For any split condenser/compressor or compressor/evaporator unit separated by more than 10 ft (3000 mm), refrigerant lines shall be sized in accordance with ASHRAE Handbook - Refrigeration, “Refrigerant Line Sizing” section.
   e. Coils may require corrosion protective coatings based on local air quality conditions.

5. Humidity Control
   a. If humidification is required, humidifiers shall be steam- or ultrasonic-type humidifiers and have water blowdown capability to minimize solids buildup.
   b. A high-limit duct humidistat shall be used to limit moisture carryover and condensation in the duct.
   c. Normal humidity control shall be accomplished by a return air or space humidistat.
d. High humidity control shall be accomplished by use of the cooling coil. The humidistat shall override the thermostat and cooling with re-heating as required to maintain space temperature.

6. Ventilation and Exhaust
   
   a. All enclosed portions of buildings customarily used by occupants shall be provided with fresh ventilation air.

   b. The minimum amount of outside air shall either equal 10 percent of supply air in excess of all exhaust air or equal the ventilation air requirements in accordance with ASHRAE 62.1, whichever is greater.

   c. The toilet, locker, and shower rooms shall be provided with a mechanically operated exhaust system capable of providing as a minimum the ventilation requirements in accordance with ASHRAE 62.1. The system shall exhaust directly to the outside, and the point of discharge shall be at least 5 ft (1500 mm) from any openable window or door and 3 ft (900 mm) above and 10 ft (3000 mm) away from any air intake unless superceded by ASHRAE 62.1.

   d. Occupied, non-air-conditioned enclosed spaces shall have mechanically forced ventilation.
      
      (1) The ventilation airflow rate shall be established to ensure that space temperature does not exceed the ambient outdoor temperature by more than 10°F (5.5°C).

      (2) Outside air intakes shall be designed to minimize dust intrusion.

   e. Buildings or portions thereof where flammable or toxic materials are used shall be designed for the required ventilation rate in accordance with ACGIH - Industrial Ventilation: A Manual of Recommended Practice for Design. Exhaust ventilation shall be taken from a point at or near the floor level for gases heavier than air and from near the ceiling level for gases lighter than air.

   f. Ventilation for special applications shall be in accordance with ACGIH - Industrial Ventilation: A Manual of Recommended Practice for Design.

   g. Automotive-type garages, where vehicles operate under their own power, shall either have a mechanical exhaust system or have permanent openings to the outside in accordance with IBC and ASHRAE 62.1.

7. Noise

   HVAC-related background sound for an occupied room shall be in accordance with the guideline criteria specified in ASHRAE Handbook - HVAC Applications.
4.3.1.4 Special Applications

1. Chemical Laboratories

   a. Design and operation of HVAC systems in chemical laboratories shall be in accordance with the following codes and standards:

      (1) ASHRAE 62.1
      (2) ASHRAE Handbook - HVAC Applications
      (3) ACGIH - Industrial Ventilation: A Manual of Recommended Practice for Design
      (4) NFPA 45
      (5) NFPA 90A
      (6) NFPA 91
      (7) ASHRAE 110

   b. Air from laboratory work areas shall be continuously discharged to the outdoors, and the area shall be maintained at a negative pressure relative to the adjacent areas.

   c. Air from laboratory work areas shall not be recirculated.

   d. Ductwork, hoods, fans, drives, and other system components shall be designed and selected in accordance with fire, explosion, corrosion, and acid-resistant requirements.

   e. Automatic fire dampers shall not be used in laboratory hood exhaust systems.

   f. Fire detection and alarm systems shall not be interlocked to automatically shut down laboratory hood exhaust fans.

   g. Fume hood exhaust shall be designed in accordance with the IMC and ACGIH - Industrial Ventilation: A Manual of Recommended Practice for Design.

   h. Airflow indicators shall be installed on new laboratory hoods or on existing laboratory hoods, if modified, in accordance with NFPA 45.

2. Essential Operating Facilities

   a. Essential operating facilities include rack rooms, computer rooms, control rooms, communication equipment rooms, and any other buildings housing electrical equipment and control systems that are vital in the production, processing, and transportation of the process. Office buildings, maintenance facilities, dining halls, etc., are not typically essential operating facilities.
b. For pressurized buildings, the maximum amount of outside air supplied to pressurize the building during normal operation with all doors and windows closed shall be used in HVAC load calculations.

c. 100% capacity of cooling and heating standby systems shall be provided.

d. For buildings located in Class I, Division 2 electrical areas, the HVAC system, alarms, and controls shall be designed to prevent the entry of flammable vapors or gases in accordance with NFPA 496, in the section titled “Pressurized Control Rooms.”

e. Outside air for pressurization shall take into account all air exhausted from the space, including all exhaust fans as if operating on a continual basis, even if all exhaust fans do not operate continuously.

f. HVAC equipment in hazardous areas shall be suitable for operation in the area classification in which the equipment is located.

g. Outside air for pressurization of buildings in classified areas shall be taken from an unclassified area.

h. For pressurized buildings, the exterior envelope shall be designed to be as air tight as practical. Air-locked vestibules shall be provided at the building entrance doors.

i. A 100% standby fan shall be provided for buildings with pressurization systems.

3. Battery Rooms

a. Battery rooms shall be ventilated to the outside of the building at a minimum rate of one air change every 3 hours, unless a higher exhaust airflow rate is required because of the discharge of cooling air that cannot be recycled from the room.

b. Air shall not be recycled from battery rooms.

c. For batteries located inside the electric/UPS rooms, if analysis reveals that H₂ evolution is less than 2% of the room volume while charging, a once-through air system shall not be required; however, a local exhaust system over the battery area shall be provided.

d. The bottom of the supply air outlet into the battery room shall not be higher than 6 inches (150 mm) above the floor.

e. The exhaust opening shall be in the ceiling or its upper edge and shall be flush with the ceiling if the exhaust opening is in a wall.
f. Air inlets and outlets shall be located to provide effective cross ventilation over the batteries.

g. Batteries with liquid medium shall be placed in an area with full spill containment.

h. Battery supports/racks shall meet the seismic design requirements of IBC.

4. Chemical Filtration

a. In all buildings containing electronic equipment, the concentration of corrosive gases shall be limited to the G1 environmental classification level shown in Table 2 of this Practice.

b. If it is confirmed that the concentration of corrosive gases in the local plant environment exceeds the G1 classification level, chemical filters shall be provided that limit to the G1 classification level the concentration of gases inside the rooms containing the electronic equipment.

c. Unless otherwise specified in the purchaser’s PIP ARC01016 Data Sheet, activated charcoal shall be used.

5. Dust Filters

a. Dust filters shall be equipped with pre-filters and final filters.

b. The pre-filters shall have a minimum of 25% efficiency, and the final filters shall provide a minimum of 85% dust spot efficiency, in accordance with ASHRAE 52.2.

c. The selected filters shall be easily available locally.

6. Insulation

a. All supply and return air ducts, located outdoors or exposed to unconditioned air, shall be insulated.

b. Insulation shall not be required for return air ducts in a ceiling space if both sides of the ceiling space are exposed to conditioned air, and if the ceiling space is not used as a return air plenum.

c. Supply air ducts in return air plenums shall be insulated.

d. Supply air ducts in conditioned space and return air ducts in return air plenums shall be insulated.

e. Internal duct lining shall not be permitted except in the following cases:

   (1) For acoustically sensitive areas.

   (2) For terminal boxes and air-handling units if protective coating is required to prevent erosion.
f. Refrigerant suction lines shall be insulated from the evaporator to the compressor.

g. Condensate line shall be insulated from the unit to the drain location.

7. Dampers

a. Each branch duct serving a separate zone or room shall have a volume damper.

b. Branch duct dampers shall be sheet metal opposed blade type, using pivot and rod, with locking quadrant damper.

c. Fire dampers shall bear the UL label.

d. Fire dampers shall be securely mounted in a rated fire separation wall, ceiling, or floor, such that ducts can break away without lessening fire separation rating.

e. Fire and smoke dampers shall be manufactured in accordance with UL 555 or UL 555C and installed in accordance with SMACNA - Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems.

f. For HVAC systems, inspection doors shall be provided to allow access to all fire dampers.

g. Combination smoke/fire dampers shall be in accordance with all requirements for smoke damper fire alarm closure and fire damper latching.

4.3.1.5 Installation

1. All air handlers, refrigeration condenser units, pumps, and any equipment mounted outside a building, shall be mounted on a concrete housekeeping pad, at a minimum of 4 inches (100 mm) above the floor or pavement or 6 inches (150 mm) above surrounding unpaved areas.

2. Access doors shall be provided to every valve, damper, or mechanical device that requires periodic inspection or adjustment.

3. Access doors for fire dampers shall be positioned so that dampers can be reset and fusible links can be replaced.

4. Unless otherwise specified by the equipment manufacturer, a minimum 3-ft (900-mm) clearance shall be provided on each side of equipment with removable panels or controls.

5. Adequate space shall be provided for coil removal.

6. All HVAC equipment shall be properly grounded in accordance with NFPA 70 (NEC).
<table>
<thead>
<tr>
<th>Room Name</th>
<th>Room Functions Description</th>
<th>Thermostat-Setting Temp. (dB)</th>
<th>% Relative Humidity</th>
<th>Pressure Relative to Atmosphere</th>
<th>Air Quality</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery Rooms</td>
<td>Contain battery systems. Not normally occupied.</td>
<td>77°F (26°C) summer 72°F (22°C)</td>
<td>N/A</td>
<td>Negative pressure to the rest of the building</td>
<td>As req’d for gas removal</td>
<td>These rooms are sometimes classified for electrical installations (i.e., Class I, Division 2).</td>
</tr>
<tr>
<td>Break Rooms</td>
<td>Typically house a sink, microwave, or other kitchen-type appliance. Typically have table(s) and chairs for people to sit and eat. Break rooms may or may not also have vending machines. Occasionally occupied.</td>
<td>75°F (24°C) summer 72°F (22°C)</td>
<td>50% ± 10%</td>
<td>+0.05&quot; (12.5 Pa)</td>
<td>ASHRAE 62.1</td>
<td></td>
</tr>
<tr>
<td>Change Rooms</td>
<td>Areas for personnel to change clothes and may include lockers and lavatories. They may be part of or adjacent to restrooms or shower rooms. Occasionally occupied.</td>
<td>75°F (24°C) summer 72°F (22°C)</td>
<td>50% ± 10%</td>
<td>Negative pressure to the rest of the building</td>
<td>ASHRAE 62.1</td>
<td></td>
</tr>
<tr>
<td>Coffee/Vending Rooms</td>
<td>Contain vending machines and/or coffee machines. May also have microwaves. These rooms are distinguished from break rooms in that they do not typically have tables, chairs, or sinks. Not normally occupied.</td>
<td>75°F (24°C) summer 72°F (22°C)</td>
<td>50% ± 10%</td>
<td>+0.05&quot; (12.5 Pa)</td>
<td>ASHRAE 62.1</td>
<td></td>
</tr>
<tr>
<td>Communications Closets</td>
<td>Contain communications equipment, cable terminations, and associated cross-connect cable/wiring. Not normally occupied.</td>
<td>75°F (24°C) summer 72°F (22°C)</td>
<td>50% ± 10%</td>
<td>+0.10&quot; (25 Pa)</td>
<td>N/A</td>
<td>See Notes 3 and 4 for additional requirements.</td>
</tr>
<tr>
<td>Communications Computer Rooms</td>
<td>Contain programming applications, electronic equipment such as servers, switches, hubs, and routers. Occasionally occupied.</td>
<td>75°F (24°C) summer 72°F (22°C)</td>
<td>50% ± 10%</td>
<td>+0.10&quot; (25 Pa)</td>
<td>ISA 71.04</td>
<td>See Note 4 for additional requirements.</td>
</tr>
<tr>
<td>Communications Equipment Rooms</td>
<td>Contain programming applications and electronic equipment such as servers, switches, hubs, and routers. Occasionally occupied.</td>
<td>75°F (24°C) summer 72°F (22°C)</td>
<td>50% ± 10%</td>
<td>+0.10&quot; (25 Pa)</td>
<td>ISA 71.04</td>
<td>See Note 4 for additional requirements.</td>
</tr>
<tr>
<td>Computer Rooms</td>
<td>Mainly houses computers and associated equipment. May be considered either normally or not normally occupied, depending on the project specific use.</td>
<td>75°F (24°C) summer 72°F (22°C)</td>
<td>50% ± 10%</td>
<td>+0.10&quot; (25 Pa)</td>
<td>ISA 71.04</td>
<td>See Note 3 for additional requirements.</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Room Name</th>
<th>Room Functions Description</th>
<th>Thermostat-Setting Temp. (°F (°C))</th>
<th>% Relative Humidity</th>
<th>Pressure Relative to Atmosphere</th>
<th>Air Quality</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conference Rooms or Auditorium</td>
<td>Occasionally occupied. If occupied, these spaces may have a lower square foot per person average than do normally occupied spaces.</td>
<td>75°F (24°C) summer 72°F (22°C) winter</td>
<td>50% ± 10%</td>
<td>+0.05&quot; (12.5 Pa)</td>
<td>ASHRAE 62.1</td>
<td></td>
</tr>
<tr>
<td>Control Rooms</td>
<td>Contain control consoles. Normally occupied.</td>
<td>75°F (24°C) summer 72°F (22°C) winter</td>
<td>50% ± 10%</td>
<td>+0.10&quot; (25 Pa)</td>
<td>ISA 71.04</td>
<td></td>
</tr>
<tr>
<td>Copy/Fax Rooms</td>
<td>Separate walled-in rooms for housing copy and/or fax machines. Not normally occupied. For HVAC design purposes, any normally occupied space listed as a copy/fax room should be treated as an office space.</td>
<td>75°F (24°C) summer 72°F (22°C) winter</td>
<td>50% ± 10%</td>
<td>+0.05&quot; (12.5 Pa)</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Electrical/Telephone/Radio Rooms</td>
<td>Specifically for housing electrical, telephone, or radio equipment. Distinguished from mechanical room because they specifically house electrical/telephone/radio equipment. Not normally occupied.</td>
<td>80°F (26°C) summer 50°F (10°C) winter or as required by equipment manufacturer</td>
<td>50% ± 10% or as required by equipment manufacturer</td>
<td>+0.05&quot; (12.5 Pa)</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>HVAC/Mechanical Rooms</td>
<td>Contain HVAC equipment and/or other types of equipment such as pumps, water heaters, electrical equipment, etc. Not normally occupied.</td>
<td>80°F (26°C) 50°F (10°C)</td>
<td>N/A</td>
<td>+0.05&quot; (12.5 Pa)</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>I/O Rooms</td>
<td>Contain I/O equipment. Not normally occupied.</td>
<td>75°F (24°C) summer 72°F (22°C) winter</td>
<td>50% ± 10%</td>
<td>+0.10&quot; (25 Pa)</td>
<td>ISA 71.04</td>
<td></td>
</tr>
<tr>
<td>Janitor’s Room</td>
<td>Contain service sinks and provide storage for various cleaning supplies. Not normally occupied.</td>
<td>80°F (26°C) summer 50°F (10°C) winter</td>
<td>50% ± 10%</td>
<td>Negative pressure to the rest of the building</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Libraries and Reading Areas</td>
<td>Contain reference books, magazines, papers, or other types of reading materials. They are distinguished from file/record storage because the reading materials are meant to be accessed on a regular basis. Normally occupied.</td>
<td>75°F (24°C) summer 72°F (22°C) winter</td>
<td>50% ± 10%</td>
<td>+0.05&quot; (12.5 Pa)</td>
<td>ASHRAE 62.1</td>
<td></td>
</tr>
</tbody>
</table>

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Table 1 – HVAC Room Descriptions and Design Criteria (Continued)

<table>
<thead>
<tr>
<th>Room Name</th>
<th>Room Functions Description</th>
<th>Thermostat- Setting Temp. (dB) F° (°C)</th>
<th>% Relative Humidity</th>
<th>Pressure Relative to Atmosphere</th>
<th>Air Quality</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lobbies and Corridors</td>
<td>Typically open areas at the main entrance to a building and may include waiting areas and receptionists desks. Corridors, also known as circulation, are hallways connecting various rooms in a building. Corridors are considered not normally occupied. Lobbies may be considered either normally or not normally occupied.</td>
<td>75°F (24°C) summer 72°F (22°C) winter</td>
<td>50% ± 10%</td>
<td>+0.05&quot; (12.5 Pa)</td>
<td>ASHRAE 62.1</td>
<td></td>
</tr>
<tr>
<td>Offices</td>
<td>Occupied by one or more persons and used for office-type work.</td>
<td>75°F (24°C) summer 72°F (22°C) winter</td>
<td>50% ± 10%</td>
<td>+0.05&quot; (12.5 Pa)</td>
<td>ASHRAE 62.1</td>
<td></td>
</tr>
<tr>
<td>Record/File Rooms</td>
<td>Storage areas for files and records. Not normally occupied. For HVAC design purposes, any normally occupied space listed as a record/file room should be treated as an office space.</td>
<td>75°F (24°C) summer 72°F (22°C) winter</td>
<td>50% ± 10%</td>
<td>+0.05&quot; (12.5 Pa)</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Reproduction</td>
<td>Areas used for plotters, printers, copiers.</td>
<td>75°F (24°C) summer 72°F (22°C) winter</td>
<td>50% ± 10%</td>
<td>+0.05&quot; (12.5 Pa)</td>
<td>ASHRAE 62.1</td>
<td></td>
</tr>
<tr>
<td>Restrooms</td>
<td>Contain one or more of the following: 1. Water closet 2. Urinal 3. Lavatory 4. Bidet Considered occasionally occupied.</td>
<td>75°F (24°C) summer 72°F (22°C) winter</td>
<td>50% ± 10%</td>
<td>Negative pressure to the rest of the building</td>
<td>ASHRAE 62.1</td>
<td></td>
</tr>
<tr>
<td>Shower Rooms</td>
<td>Areas for showering or bathing. They may be part of or adjacent to restrooms and/or change rooms. Considered occasionally occupied.</td>
<td>75°F (24°C) summer 72°F (22°C) winter</td>
<td>50% ± 10%</td>
<td>Negative pressure to the rest of the building</td>
<td>ASHRAE 62.1</td>
<td></td>
</tr>
<tr>
<td>Storage Rooms/ Spaces</td>
<td>Areas for general storage that do not fall into the category of file/record rooms or any other specific type of storage area such as solvent or chemical storage. Not normally occupied.</td>
<td>80°F (26°C) summer 50°F (10°C) winter</td>
<td>50% ± 10%</td>
<td>+0.05&quot; (12.5 Pa)</td>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>

(Continued, next page)
<table>
<thead>
<tr>
<th>Room Name</th>
<th>Room Functions Description</th>
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<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switchgear Rooms/MCC Rooms</td>
<td>Contain all switchgear and MCC equipment such as transformer, breakers, starters, and panel boards. Not normally occupied.</td>
<td>77°F (26°C) summer 72°F (22°C) winter</td>
<td>50% ± 10%</td>
<td>+0.10” (25 Pa)</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>UPS Rooms</td>
<td>Contain UPS equipment and/or battery charger. Not normally occupied.</td>
<td>77°F (26°C) summer 72°F (22°C) winter</td>
<td>50% ± 10%</td>
<td>+0.10” (25 Pa)</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Training Rooms</td>
<td>Areas for training classes and also may be used as meeting rooms. They are distinguished from conference rooms in that these rooms are occupied on a regularly scheduled basis and are considered normally occupied.</td>
<td>75°F (24°C) summer 72°F (22°C) winter</td>
<td>50% ± 10%</td>
<td>+0.05” (12.5 Pa)</td>
<td>ASHRAE 62.1</td>
<td></td>
</tr>
<tr>
<td>Waiting Rooms</td>
<td>Separate walled-in rooms (as distinguished from waiting areas in a lobby). Occasionally occupied.</td>
<td>75°F (24°C) summer 72°F (22°C) winter</td>
<td>50% ± 10%</td>
<td>+0.05” (12.5 Pa)</td>
<td>ASHRAE 62.1</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1. The following definitions apply:
   a. Normally occupied - Any space or room in which a person or persons are assigned to be on a day-to-day basis
   b. Not normally occupied - Any space or room in which a person or persons is not assigned on a day-to-day basis
   c. Occasionally occupied - Any space or room in which a person or persons is not assigned on a day-to-day basis but at times may be fully occupied
2. The number values in this table shall be used unless otherwise specified by the purchaser.
3. Rooms contain non-active equipment; room temperature shall be maintained at 50°F (10°C) to 95°F (35°C), and humidity shall be below 85%.
4. TIA-569
Table 2 – ISA Classification

<table>
<thead>
<tr>
<th>Gas Concentrations (Parts per Billion, by Volume)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>ISA Class G1</td>
</tr>
</tbody>
</table>

Note: ISA environmental classes, relative humidity <50%.

4.3.2 Electrical Work

4.3.2.1 General

1. Unless otherwise specified in the contract documents or by law, all electrical work shall be in accordance with this Practice and local, state, and national codes.

2. Electrical work shall be in accordance with NFPA 70 (NEC) and energy conservation codes required by national, state, and local government regulations.

3. Equipment, apparatus, or material required to be approved shall be approved by a nationally recognized testing laboratory.

4. The electrical hazardous area classification for the buildings shall be shown on the electrical area classification drawings.

4.3.2.2 Lighting

1. Unless otherwise specified in purchaser’s PIP ARC01016 Data Sheet, building exterior electrical lighting and interior electrical lighting shall be provided in accordance with local energy codes.

2. Unless otherwise specified in the purchaser’s PIP ARC01016 Data Sheet, indoor lighting shall be fluorescent, light emitting diode (LED), or high-intensity discharge (HID). Illumination levels shall be in accordance with API RP 540.

3. For occupied buildings, interior lighting shall include egress lighting and exit sign lighting with a secure power supply. A secure power supply shall be a battery charger with a battery or an uninterruptible power supply (UPS) sized for a minimum of 90 minutes.

4. Unless otherwise specified in purchaser’s PIP ARC01016 Data Sheet, lighting for each room shall be separately controlled by a motion-sensor switch located on the wall near each door entering the room or an energy management system.

4.3.2.3 Power

1. Unless otherwise specified in purchaser’s PIP ARC01016 Data Sheet, power source for the building shall be a single 480-volt, 3-phase, 3-wire plus ground, 60-Hertz feeder brought to a point to be designated by the owner. Unless otherwise specified by the owner, this feeder shall not be a service.
2. The building shall be provided with transformers, panelboards, and other equipment as required to distribute power to all building lighting, receptacles, HVAC equipment, and other utility equipment.

3. All equipment shall be located indoors except for transformers larger than 500 kVA.

4. All transformers inside buildings shall be dry type.

5. 120-volt, single phase duplex grounding receptacles supplied from single phase 120-volt, 60-Hertz branch circuits shall be provided in every room in accordance with NFPA 70 (NEC).

6. Additional receptacles shall be provided for any cord-and-plug-connected building utility equipment.

7. All receptacles shall be grounding type.

8. Ground Fault Circuit Interrupters (GFCI) protected 120 volt receptacles shall be supplied in accordance with NFPA 70 (NEC). Where supplied, the GFCI shall be of the self-testing type.

9. If specified in purchaser’s PIP ARC01016 Data Sheet, Arc-Fault Circuit Interrupters shall be supplied on 120 volt single phase branch circuits in accordance with NFPA 70 (NEC).

4.3.2.4 Grounding

1. Grounding shall be in accordance with NFPA 70 (NEC) requirements.

2. If specified in purchaser’s PIP ARC01016 Data Sheet, special grounding shall be provided.

3. A grounding wire shall be provided with the building power feeder, which shall be bonded to the building grounding system.

4. Proper grounding shall be the primary method of lightning protection.

4.3.2.5 Wiring Methods

1. Unless otherwise specified in the contract documents, interior wiring shall be in electrical metallic tubing (EMT) and flexible metallic tubing.

2. Unless otherwise specified in the contract documents, exterior wiring shall be in rigid galvanized steel conduit and liquid-tight flexible metal conduit.

3. All conductors shall be copper.

4. Wiring in rooms with finished walls and ceilings shall not be exposed.

5. In order to protect both personnel and equipment, buildings with a high density of electronic equipment and/or high occupancy
shall have cables and wiring specified as being low smoke zero halogen (LSZH or LSOH or LS0H or LSFH or OHLS) wire and cable to reduce the amount of toxic and corrosive gas emitted during combustion.

4.3.2.6 Energy Management and Conservation

1. Electrical equipment, apparatus, and lighting shall be energy efficient and shall be in accordance with energy conservation codes required by national, state, and local government regulations.

2. Unless otherwise specified, exterior lights shall be controlled by photocells.

4.3.2.7 Rooms primarily intended for electrical power equipment shall have locks on all doors.

4.3.2.8 Receptacle control switches and electrical equipment shall be readily accessible to all potential occupants of the room in accordance with 2010 ADA Standards for Accessible Design if applicable.

4.3.3 Communications

4.3.3.1. General

1. This communications design criteria section shall be used in conjunction with the following codes and standards:
   a. IEEE 1100
   b. FCC, Part 68
   c. NFPA 70 (NEC)
   d. NFPA 72
   e. NFPA 75
   f. NFPA 232
   g. NFPA 2001
   h. TIA-568
   i. TIA-569
   j. TIA-570
   k. TIA-606
   l. TIA-607
   m. UL 1863
   n. UL 60950-1

2. This section furnishes requirements for communications rooms including the following:
   a. Communications closet
   b. Communications equipment room
c. Communications computer room  
d. Communication entrance facilities and entrance room

3. A communications room may contain the equipment used in multiple communications systems (e.g., telephone, site access, security, hotlines, closed circuit television, bar coding, weather monitoring, etc.).

4. See Figure 1 of this Practice for typical communications room arrangements.

![Figure 1. Typical Communications Room Arrangements](image)

4.3.3.2 Room Descriptions

1. Communications Closets
   a. A communications closet shall contain communications equipment, cable terminations, and associated cross-connect cable/wiring.
   
   b. A communications closet shall serve one floor area of one building.
   
   c. Communications closets for non-active equipment or active equipment will be walk-in.
2. Communications Equipment Rooms  
   a. Communications equipment rooms shall provide space and 
      maintain a suitable operating environment for large 
      communications or computer equipment.  
   b. Communications equipment rooms may serve a building or 
      multiple buildings.  
   c. A communications equipment room may also serve as a 
      communications closet.  
3. Communications Computer Rooms  
   a. Communications computer rooms shall contain 
      programming applications and electronic equipment 
      (e.g., servers, switches, hubs, and routers) that directly effect 
      the business operations.  
   b. Communications computer rooms shall be provided with 
      environmental control and monitoring as required to protect 
      the communications equipment.  
   c. Rooms associated with the communications computer room 
      shall be adjacent to qualified personnel. 
   d. All buildings in a campus shall connect with the 
      communications computer room. 
4. Communications Entrance Facilities  
   a. The communications entrance facility shall consist of the 
      communications service entrance to the building, including 
      the entrance through the building wall, and continuing to the 
      entrance room or space.  
   b. The communications entrance room may be the 
      communications closet, communications equipment room, 
      and in some cases the communications computer room.  
   c. 2-inch (50-mm) conduits shall be used with small diameter 
      0.5-inch (12-mm) cables (e.g., optical fiber and coaxial 
      cable).  
   d. 4-inch (100-mm) conduits shall be used with larger diameter 
      cables (e.g., multi-pair copper cables and innerduct).  
   e. As a minimum, either of the following shall be considered 
      for each entrance point:  
      (1) Two 4-inch (100-mm) conduits with as a minimum one 
          spare 4-inch (100-mm) conduit.  
      (2) Three 2-inch (50-mm) conduits.  
   f. A separate communications closet, or communications 
      equipment room, on the same floor as the entrance facility.
shall be provided for buildings with a communications computer room.

g. Verify requirements for redundant entry/exits of communication lines.

4.3.3.3 Building Facility

1. Buildings shall be served by at least one communications closet or communications equipment room, with a minimum of one communications closet per floor.

2. There is no maximum number of telecommunications closets that may be provided within a building.

3. Communications rooms shall not be shared with other services nor shall these rooms contain non-communications-related equipment.

4. Piping, ductwork, pneumatic tubing, etc., other than for fire suppression systems, shall not pass through communications rooms.

5. All communications rooms shall be fitted with a locking mechanism to prevent the entry of unauthorized personnel.

6. Communications closets and communications equipment rooms shall be located as close as possible to the center of the floor space being served, away from any threat of potential flooding.

7. Communications rooms shall not be below or adjacent to rooms that store or require running water. Locations that are water hazards (e.g., restrooms, break rooms (with sinks), and kitchens) shall be avoided.

8. If a communications closet is at risk of water ingress, a floor drain shall be provided.

9. For buildings that have a computer room, the communications closet or communications equipment room shall be adjacent.

10. For qualifying the communications room location, the following other key factors shall be considered:

   a. Distances from required utilities

   b. Expansion of communications systems

   c. Building access for large equipment

   d. Distance limitations of the cable being installed for service

11. Communications rooms shall not be located where subject to vibration caused by equipment and other heavy machinery.

12. Sources of electromagnetic interference (EMI) shall be 10 ft (3000 mm) away from the communications equipment room and communications computer rooms. Examples of EMI sources
include photocopying equipment, door openers, elevator systems, factory equipment, etc.

4.3.3.4 Room Ancillaries

1. Floor materials for communications rooms shall have antistatic properties. Carpet shall not be permitted.

2. Unless otherwise specified in purchaser’s PIP ARC01016 Data Sheet, communications computer rooms shall have access floors.

3. Windows shall not be provided in communications rooms except as required for cable entry.

4. Communications rooms shall not be shared with other services nor shall these rooms accommodate pass-through of non-communications-related services such as piping, ductwork, pneumatic tubing, etc., except as required to service the room.

5. Lighting
   a. Lighting shall be mounted at 8.5-ft (2600-mm) minimum above finished floor.
   b. Lighting shall not provide radio frequency interference (RFI) that could interfere with the communications equipment.
   c. Light fixture power shall not be from the same electrical distribution panel as that of the communications equipment.
   d. Communications computer areas shall be provided with emergency lighting.

6. Communications closets with active equipment and communications equipment rooms shall have a minimum of two dedicated 120-volt receptacle circuits. For convenience, duplex outlets shall be placed at 6-ft (1800-mm) intervals at a height of 6 inches (150 mm) above the floor and shall be identified and marked.

7. A dedicated power panel, serving power to communications equipment only, shall be installed within the room.

8. If the building has standby power, it shall be designed for the communications equipment room requirements including HVAC.

9. Distribution panels that serve lighting fixtures shall not serve communications equipment.

10. Communications computer rooms shall have a guarded push button at each door that initiates disconnection of power from specified equipment. This equipment includes computer room electronic equipment, servers, switches, hubs, etc. The operation of the push button shall close the fire/smoke dampers on the HVAC system.
11. Electrical power for the communications computer room shall be supplied from a minimum of two dedicated power panels.
   a. One panel shall be for receptacles.
   b. The second panel shall be for the junction boxes in the under-floor area. A minimum of four dedicated 120-volt nominal, single-phase, non-switched, air-conditioning duplex electrical outlet receptacles, each on a separate 20-amp-branch circuit, shall be provided.

12. The standby power for the buildings shall be designed to include the communications computer room equipment and HVAC systems.

4.3.3.5 Room Size

1. Additional communications closets shall be provided for the following cases:
   a. For each 10,000 ft$^2$ (1000 m$^2$) of building area
   b. If a work area is more than 300 ft (90 m) from the closet
   c. If the floor area served exceeds 10,000 ft$^2$ (1000 m$^2$)
2. Walk-in communications closets shall be a minimum of 4 ft, 6 inches deep by 4 ft, 6 inches wide (1350 mm by 1350 mm).
3. Communications closets layouts shall be in accordance with TIA-569.
4. Communications equipment rooms shall be sized for the equipment to be used, including working clearances and future space if required.
5. Communications equipment room size shall be approximately 0.75 ft$^2$ (0.07 m$^2$) for each 100 ft$^2$ (9 m$^2$) of work area, with a minimum size of 150 ft$^2$ (14 m$^2$).
6. Communications computer rooms shall be sized for the equipment to be used. The design shall anticipate future needs and technologies.
7. Adjacent to the communications computer room shall be the support rooms (e.g., recorded media storage, UPS, I/O stations, etc.). See NFPA 75, Appendix A, for a typical example.

4.3.3.6 Communications Closet HVAC

1. A communications closet shall maintain a temperature the same as that of the adjacent office area.
2. Communications closets with active equipment shall maintain continuous HVAC at all times.
3. If the building system cannot ensure the continuous HVAC required, a stand-alone unit shall be provided.
4. The environmental equipment may be located inside the communications closet.

5. Sensors and controls shall be placed 5 ft (1500 mm) above the finished floor, located in the communications closet.

4.3.4 Fire Protection and Safety

4.3.4.1 General

1. Building fire protection systems shall be in accordance with specified codes and/or standards and this document.

2. The design of the systems shall be in accordance with the applicable NFPA standards and this Practice.

4.3.4.2 Standpipes

1. The design, placement, and installation of a standpipe system shall be governed by NFPA 14. The type of standpipe system required is based on building height, area per floor occupancy classification, egress system design, required flow rate and residual pressure, and the distance of the hose connection from the source(s) of water supply.

2. The following describes the types of standpipes that shall be provided and their intended use:

   a. Class I: 2.5-inch (65-mm) hose connections to supply water for use by fire departments and those trained in handling heavy fire stream.

   b. Class II: 1.5-inch (40-mm) hose stations to supply water for use primarily by the building occupants or by the fire department during initial response.

      Comment: Class II is recommended for general requirements.

   c. Class III: 1.5-inch (40-mm) hose stations to supply water for use by building occupants and 2.5-inch (65-mm) hose connections to supply a large volume of water for use by fire departments and those trained in handling heavy fire stream.

4.3.4.3 Automatic Fire Sprinkler Systems

1. Typically, the sprinkler systems shall be wet, dry, or pre-action type, depending on the building contents or environmental conditions.

2. Usually, wet pipe systems shall be used in all cases except as specified in Section 4.3.4.3.3 of this Practice.

3. Typically, if inadvertent water leakage could damage high-value or water sensitive contents, pre-action sprinkler systems shall be used. A dry pipe system is typically used in areas where the system can be exposed to freezing conditions (i.e., outdoors).
4. All sprinkler systems shall be designed and installed in accordance with NFPA 13.

5. Sprinkler systems for laboratories shall have a design density in accordance with NFPA 45.

4.3.4.4 Portable Fire Extinguishers

1. All fire extinguisher type, size, and placement shall be in accordance with NFPA 10. Fire extinguisher type, size, and placement are determined in NFPA 10 based on the type/size of hazard.

2. If wheeled extinguishers are to be installed, consideration shall be given to the mobility within the area in which they are to be used. Doorways, aisles, and corridors shall be wide enough to permit the ready passage of a wheeled fire extinguisher.

4.3.4.5 Clean Agent Fire Extinguishing Systems

1. Fixed fire suppression systems based on an environmentally friendly agent shall be provided for the sub-floor spaces of control rooms, auxiliary rooms, communications rooms, and process control computer rooms.

2. Fixed fire suppression systems shall be designed and installed in accordance with NFPA 2001.

3. Existing Halon 1301 systems may be retained in service until the end of their expected working life.

4.3.4.6 Fire Alarm, Detection, and Control Systems

Building fire alarm detection and control systems shall be provided in accordance with NFPA 72.

4.3.4.7 Gas Detection Systems

1. Building gas detectors shall be provided as required to maintain a safe building environment.

2. The type of gas detector to be used depends on the possible hazards and may include the following:
   a. Combustible gas detectors
   b. Toxic gas detectors
   c. Oxygen analysis

3. If nitrogen is present and/or nitrogen back-up is provided in the area, oxygen analysis shall be provided.

4. If combustible gas and toxic gas detectors are provided, they shall be situated at the fresh air intake of the HVAC system. The HVAC system shall be designed to interlock with these gas-monitoring systems.
4.3.5 Plumbing

4.3.5.1 General

1. The following systems, including associated piping, fittings, valves, hangers and supports, fixtures, equipment, insulation, and other trim, accessories, and related parts shall be in accordance with this Practice:
   a. Sanitary drainage, waste, and vent
   b. Laboratory waste and vent
   c. Distilled water, laboratory gas, air, vacuum, and steam system
   d. Potable hot and cold water
   e. Safety showers and plumbing fixtures
   f. HVAC condensate drainage
   g. Roof drainage system

2. All plumbing design shall be in accordance with the local plumbing code. In the absence of any locally adopted building code, the building plumbing system shall be designed in accordance with IPC and this Practice unless otherwise specified on the purchaser’s PIP ARC01016 Data Sheet.

3. High-temperature equipment and piping, so located as to endanger personnel or create a fire hazard, shall be properly guarded or covered with insulation.

4.3.5.2 Plumbing System Layout and Design

1. The plumbing system shall be laid out by determining proper elevations for all components of the system and using only the minimum number of bends to produce a satisfactorily functioning system.

2. Pipes shall be laid out to fall within partition, wall, or roof cavities. Unless otherwise specified, furring shall not be permitted.

3. Horizontal sanitary drainage piping 3 inches (75 mm) and larger shall be run at a minimum uniform grade of 1/8 inch per ft (3 mm per 300 mm) (i.e., 1% slope). Horizontal sanitary drainage piping smaller than 3 inches (75 mm) shall be run at a minimum uniform grade of ¼ inch per ft (6 mm per 300 mm) (i.e., 2% slope).

4. Any portion of the drainage system installed underground or below a basement or cellar shall not be less than 4 inches (100 mm) in diameter.

5. New pipe shall match slope of existing pipe where new pipe ties into existing pipe.
6. Horizontal water piping shall be run with an adequate pitch in direction of flow to permit complete drainage.

7. Sufficient swing joints, ball joints, expansion loops, and devices shall be provided as necessary for a flexible piping system.

8. Piping shall be independently supported at pumps, coils, tanks, and similar locations so that the equipment does not support the weight of pipe.

9. The drains from drip pans, relief valves, air vents, and similar locations shall be piped to spill over an open sight drain, floor drain, or other acceptable discharge point, and terminated with a plain end unthreaded pipe 6 inches (150 mm) above the drain.

10. Complete dielectric isolation shall be provided between ferrous and nonferrous metals.

11. Plumbing pipes shall not be located inside rooms with major electronic equipment.

4.3.5.3 Floor Drains

1. Floor drains shall be provided in toilet rooms, janitor closets, lockers areas, shower stalls, eyewash/safety showers, equipment rooms, and shop areas.

2. Except for shower stall floor drains which do not require trap primer connections, all other floor drains shall be provided with primer connections.

4.3.5.4 Cleanouts

1. Cleanouts shall be the same size as the pipes but not greater than 4 inches (100 mm).

2. Cleanouts shall be easily accessible.

4.3.5.5 Insulation and Pipe Coating

1. All indoor cold water lines shall be provided with anti-sweat insulation.

2. Underground steel piping shall be coated and wrapped.

3. The following piping shall be insulated:
   a. Domestic hot and cold water piping
   b. Horizontal roof drains and overflow piping subject to condensation

4.3.5.6 Grease and Oil Interceptors

1. Grease interceptors with automatic draw-off shall be provided for drains in areas where food is prepared.

2. Oil interceptors shall be provided for drains in maintenance shops or in similar rooms, near mechanical equipment if potential exists for oil leakage or spillage.