Argonne NATIONAL LABORATORY

FACILITIES DESIGN GUIDE
2016

JSTD-128-W-T001

Approvals and Revision History

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Revision History

Revision	Date	Reason
0	11/9/16	Initial Issue

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List of Acronyms

The following is a list of the acronyms, initialisms, and abbreviations used in this document.

AASHTO	American Association of State Highway and Transportation Officials
ABA	Architectural Barriers Act
ACI	American Concrete Institute
AHU	air handling unit
AISC	American Institute of Steel Construction
Argonne	Argonne National Laboratory
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigeration and Air-Conditioning Engineers
ASTM	American Society for Testing and Materials
AV	audio video
AWWA	American Water Works Association
BAS	building automation system
BICSI	Building Industry Consulting Service International
CDC	Centers for Disease Control and Prevention
CFR	Code of Federal Regulations
CIS	Computing and Information Systems Division
DI	de-ionized
DOE	U.S. Department of Energy
EF	entrance facility
EISA	Energy Independence and Security Act
EMI	electromagnetic interference
EO	Executive Order
EPA	U.S. Environmental Protection Agency
EPAct	Energy Policy Act
ESH	Environment, Safety, and Health
ESQ	Environment, Safety, Health and Quality Assurance Division
FAR	Federal Acquisition Regulations
FEMA	Federal Emergency Management Agency
FMS	Facilities Management and Services Division
GP	guiding principles
GSA	General Services Administration

HPSB	high performance sustainable building
HVAC	heating, ventilation and air conditioning
IAC	Illinois Administrative Code
ICEA	Insulated Cable Engineers Association
IEPA	Illinois Environmental Protection Agency
IES	Illuminating Engineering Society of North America
IDOT	Illinois Department of Transportation
IT	information technology
LAN	local area network
LMS	Laboratory Management System
MBMA	Metal Builder Manufacturers Association
MUA	makeup air unit
MUTCD	Manual on Uniform Traffic Control Devices
NEC	National Electrical Code
NECPA	National Energy Conservation Policy Act
NEPA	National Environmental Policy Act
NETA	InterNational Electrical Testing Association
NFPA	National Fire Protection Association
NIH	National Institutes of Health
NPDES	National Pollution Discharge Elimination System
NRCA	National Roofing Contractors Association
NWM	Nuclear and Waste Management division
OPM	Office of Project Management
OSHA	Occupational Safety and Health Administration
PA	public address
PEMB	pre-engineered metal building
PUE	power usage effectiveness
RCDD	Registered Communications Distribution Designer
RO	reverse osmosis
RTU	rooftop unit
RU	rack unit
SCADA	supervisory control and data acquisition
SME	subject matter expert
SPCC	Spill Prevention, Control, and Countermeasures
SSC	structures, systems, and components

SSWS	Standard Specifications for Water and Sewer Main Construction (Illinois)
SWPPP	Storm Water Pollution Prevention Plan
Telecom	telecommunications
TIA	Telecommunications Industry Association
TPO	thermoplastic polyolefin
TR	telecommunication rooms
UPS	uninterruptible power supply
USDA	United States Department of Agriculture
VCA	Vibration Category A
VFD	variable frequency drives

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1 Introduction

The Facilities Management and Services Division (FMS) of Argonne National Laboratory (Argonne) has primary responsibility for developing and maintaining the site, buildings, and physical plant of the laboratory. This document provides the requirements for facilities-related codes, designs, and items specific to Argonne.

Architects and engineers must create designs according to Argonne's Codes of Record listed in Section 1.2 and the facilities-related Department of Energy (DOE) orders and standards listed in Section 1.1. This guide lists industry standards throughout. Argonne recognizes that new ideas and advances occur in the industry and encourages architects and engineers to communicate with Argonne's designated project manager and subject matter experts (SMEs) if techniques contrary to those listed in this guide would provide better value to Argonne.

Argonne must follow the procurement standards of the Federal Acquisition Regulations (FAR), which require multi-source selection. Except in very limited situations, sole source specifications are not allowed. If a manufacturer preference is listed, it is recommended that alternate sources be listed, and the bids for that portion of the work have exposed pricing.

1.1 DOE Orders and Standards

Argonne is bound by the Argonne National Laboratory Prime Contract. Clause 1.97 (last revised 2/6/09) of the Prime Contract addresses laws, regulations, and DOE directives: "the contractor shall comply with the requirements of applicable Federal, State, and local laws and regulations (including DOE regulations), unless relief has been granted in writing by the appropriate regulatory agency." Also, "The Contractor will perform the work of this Contract in accordance with each of the Contractor Requirements Documents (CRDs) appended to this Contract as 'Appendix I'."

DOE orders and standards relating to facilities design include the following:

- DOE O 420.1C, *Facility Safety*, establishes facility and programmatic safety requirements for DOE and National Nuclear Security Administration (NNSA) for nuclear safety design criteria, fire protection, criticality safety, natural phenomena hazards (NPH) mitigation, and System Engineer Program.
- DOE-STD-1020-2012, *Natural Phenomena Hazards Analysis and Design Criteria for Department of Energy Facilities*, provides guidance for analyzing and designing the facility structures, systems, and components (SSCs) needed to implement the requirements of DOE O 420.1C and to ensure that the SSCs will be able to effectively perform their intended safety functions under the effects of natural phenomena hazards (NPHs).
- DOE-STD-1189-2008, *Integration of Safety into the Design Process*
- DOE-STD-1066-2012, *Fire Protection*

- DOE O 413.3B, *Program and Project Management for the Acquisition of Capital Asset*; this order provides DOE with direction for program and project management when acquiring capital assets with the goal of delivering projects within the original performance baseline, cost and schedule, and fully capable of meeting mission goals.
- DOE O 414.1D, *Quality Assurance*, defines roles and responsibilities for providing quality assurance for DOE products and services.
- DOE O 436.1, *Departmental Sustainability*
- 10 CFR 851, *Worker Safety/Health Program*, outlines the requirements for a worker safety/health program to ensure that DOE contractors and their workers operate a safe workplace.

1.2 Codes and Standards

DOE O 420.1C, *Facility Safety*, is the primary document for establishing facility and programmatic safety requirements for DOE. It requires contractors and Argonne to identify the applicable industry codes and standards, including the International Building Code (IBC), and the applicable DOE requirements and technical standards. The IBC has been adopted as the Code of Record at Argonne National Laboratory. Consider the following IBC primary reference codes as part of the requirements of the IBC:

- 2015 International Building Code
- 2015 International Fire Code
- 2015 International Mechanical Code
- 2015 International Plumbing Code
- NFPA 70, *National Electrical Code*®

NFPA 101, *Life Safety Code*®, is also a Code of Record at Argonne National Laboratory.

Refer to the following chapters for additional secondary codes, standards and/or guides. Whenever a code is listed, it refers to the latest version of the code in place at the time of preliminary design.

1.3 Argonne Procedures

The following list shows the main facilities-related requirements from the Argonne Laboratory Management System (LMS) procedures and policies:

- ESH-9.4, *Electrical Safety Program—Lightning Protection*
- ESH-19.1, *Design Criteria for Facilities—Exit Systems and Life Safety*
- ESH-19.3, *Design Criteria for Facilities—Emergency Lighting Systems*
- LMS-POL-6, *Traffic Safety*

- LMS-PROC-14, *Fixed Ladders*
- LMS-PROC-46, *Clean Air Act and Air Pollution Control Compliance*
- LMS-PROC-115, *Reporting and Responding to Releases of Oil and Hazardous Substances to the Environment*
- LMS-PROC-139, *Emergency Eye Washes and Safety Showers*
- LMS-PROC-210, *Ventilation for Hazard Control*
- LMS-PROC-220, *Trailers and Other Moveable Structures*

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2 Civil and Environmental

2.1 Codes and Standards

2.1.1 Federal/National

- *Energy Independence and Security Act (EISA) Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438, December 2009*
- *Guidance for Federal Agencies on Sustainable Practices for Designed Landscapes*
- *Illinois Native Plant Guide (USDA)*
- Architectural Barriers Act (ABA) *Accessibility Standards*
- *Manual on Uniform Traffic Control Devices (MUTCD)*
- EO 11312, *Invasive Species*
- EO 13690, *Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input* (which revises EO 11988, *Floodplain Management*)

2.1.2 State

- *IDOT Bureau of Design and Environmental Manual: Part II - Project Development; Part IV - Roadway Design Elements; Part VI - Other Highway Design Elements*
- *Illinois Standard Specifications for Water and Sewer Main Construction (SSWS)*
- *Illinois Urban Manual*
- *IDOT Standard Specifications for Road and Bridge Construction*, latest edition

2.1.3 Trade Standards

- *American Society of Civil Engineers (ASCE) Standard Guidelines for the Design (45-05), Installation (46-05), and Operation (47-05) of Urban Stormwater Systems; ASCE 60 Sanitary Sewer Design*
- American Water Works Association (AWWA) standards
- *American Association of State Highway and Transportation Officials (AASHTO)—Policy on Geometric Design of Highways and Streets (Green Book); Roadside Design Guide; Roadway Lighting Design Guide (AASHTO)*
- *Illuminating Engineering Society of North America (IES) Lighting*

2.1.4 Argonne National Laboratory

- LMS-POL-6, *Traffic Safety*
- LMS PROC-22, *Safeguarding Protected Personally Identifiable Information*

- LMS PROC-46, *Clean Air Act and Air Pollution Control Compliance*
- LMS PROC-115, *Reporting and Responding to Releases of Oil and Hazardous Substances to the Environment (Section 5)*
- *Excavated Soil Management Plan J512-109-T002*
- *National Pollution Discharge Elimination System (NPDES) Permit #IL0034592*
- *Spill Prevention, Control, and Countermeasures Plan (SPCC)*
- *Storm Water Pollution Prevention Plan (SWPPP) for the Argonne Site (Special Condition #9 of the NPDES Permit)*

2.2 General Requirements

Develop all plans using the North American Datum 1983 (NAD83).

Site Plan Background: Project site plans must use the latest site utility map as the project's background. The designer must verify pertinent background data using available GIS information from the GIS database and on-site field surveys.

All projects must apply the requirements and guidance of the National Environmental Policy Act (NEPA) to environmental review recommendations for projects. Detailed design must not start until the environmental review is complete and approved.

2.3 Roads

Do not locate new crosswalks within 200 feet of an intersection or other crosswalks.

Roads are generally not installed with curb and gutter; FMS must approve their use.

When road shoulders are steep, or permanent objects are located within the clear zone, provide roadway guardrails as recommended by the AASHTO Roadside Design Guide and Argonne.

The radii for all roadway intersections must be a minimum of 30 feet to accommodate truck traffic.

All roadway striping must be thermoplastic where available and compatible with the surface.

Gravel and grass roads (tertiary roads) must be a minimum of 18 feet wide. The profile must have a sufficient gravel subbase in place for future paving.

Roadway lanes must be striped 11 to 12 feet wide with an additional three-foot paved shoulder on each edge of the road unless a separate bike path exists along that road.

Remote service roads (identified by FMS-Engineering) do not require a three-foot paved shoulder. The road lanes must be striped 11 feet wide with a one-foot paved edge.

All lighting poles, guy wires, culvert flared ends, and so on, must be installed at least nine feet from the edge of the asphalt or an improved surface; 12 feet is preferred.

2.4 Sidewalks

Sidewalks must be at least five-feet wide and have a minimum thickness of five inches of concrete that includes wire mesh reinforcing. Provide control joints at no greater spacing than one foot for each inch of thickness. Dowels must be installed at expansion joints and connections to existing sidewalks and buildings. New buildings must have haunches to support the sidewalk at the building entrances.

When sidewalks or paths cross vehicular roads, it must be at a right angle, with an open view of the roadway in all directions.

All sidewalk intersections must have concrete corners added for maintenance support: a triangle shape with minimum 18-inch legs.

Sidewalks crossing shallow utilities must have reinforcing added: minimum #4 reinforcing bar every 15 inches perpendicular to the utility trench.

All intersections between sidewalks and roadways that require detectable warning tile must specify a cast iron tile with a red brick powder coat finish. An acceptable manufacturer is TufTile.

2.5 Parking Lots

Install depressed curbs matching the parking lot slope along the edges of parking lots where there are no sidewalks.

Standard parking stall size must be 9-feet wide by 18-feet deep, striped to the centerline.

Prefer parking lot run-off to sheet flow into adjacent grass areas and/or into bio-swales along the parking area.

Sidewalks must typically not be installed to cross a parking lot.

Parking lot layouts, including curb types, must consider where snow is stored during the winter season.

Parking space striping must be 4 inches wide and thermoplastic material where available and compatible, as well as the following:

- Blue striping or marking indicates parking for vehicles displaying handicap placards or plates. Handicap symbols on the pavement surface are not required.
- White indicates designated parking spaces.
- Yellow hatching or curb painting identifies areas for stopping only for loading and unloading of passengers or freight.
- Red hatching or curb painting identifies areas where no parking, standing, or stopping is allowed.

Do not use wheel stops except in locations where facility damage or safety-related needs arise.

2.6 Underground Utilities

All manhole, catch basin access frames, and lids must be installed at the same elevation as the surrounding finished grade. All concrete tops of vaults and conical tops of manholes and basins must be a minimum 12 inches below grade. Use concrete spacer rings to fill the space between the concrete top and the bottom of the steel frame and cover.

All manhole covers or lids must be properly labeled per the utility system it covers.

Dry utility lines must have warning tape installed 18 inches above the line.

2.7 Sewer Water Systems

The design of storm water collection systems must employ the EISA guidance from Section 438. Argonne calculates that event rainfall intensity for 95th percentile is 1.55 inches. Consider exceptions if events larger than this number could affect buildings.

All sewer system plans must have a grading profile provided in the design documents.

Do not use beehive grates for storm sewers or curb drain inlets.

The inside surfaces of corrugated metal culverts must be coated with bitumen.

Sewer manholes must be a maximum 300 feet apart and closer where intersections occur.

The slope for storm sewers must provide a minimum flow of 3 feet per second (fps) and a maximum of less than 10 fps. The slope for sanitary and laboratory sewers must provide a minimum flow of 2 fps and a maximum of less than 10 fps.

Storm sewer and culvert inlets and outlets must have mountable trash guards built into the system; concrete with galvanized grating is preferred. Exceptions are box culverts and other culverts with a concrete head wall. Culvert outlets and inlets must extend at least nine feet past the edge of the road and driveway improved surface.

Storm water culverts and storm sewers must be at least 12 inches in diameter. In instances with small tributary areas, around buildings, or where clearances prevent compliance storm sewers must be at least 8 inches in diameter.

Utility cuts across improved surfaces should result in a pavement cut one foot wider than the trench before repaving.

2.8 Water Systems

The bedding and initial backfill around water piping must comply with the *Illinois Standard Specifications for Water and Sewer Main Construction*.

All bolted connections for underground water piping must use stainless steel bolts.

The installation of new combined fire and domestic water mains, fire hydrants, and control valves must comply with NFPA 24. This includes design, construction testing, and flushing.

Install fire hydrants more than nine feet and preferably approximately twelve feet from the roadway edge. For more fire hydrant requirements, see Chapter 6.

Connect and ground all metal/ductile iron piping systems for cathodic protection.

Do not place any manhole structures, shut off valves, or hand holes within 15 feet of storm water conveyances, such as ditches and swales, and place them 15 feet from the edge of roadways.

All underground piping must have systems to trace the location of the subject lines.

2.9 Landscaping

Locations: A pattern of ornament to less ornament, higher maintenance to lesser maintenance is desired from close to building to distant from building. Native species are encouraged (using species native to the Argonne site), to blend landscapes into the natural surroundings. A landscape architect may use any species near a building (except those mentioned in the general section). Species must gradually shift to native species, so that distant designs are using 100% native species found in the area.

The following is a list of grass seed mixes to use, per IDOT:

- Type 2A salt-tolerant roadside mix must be used within 10 feet of any road or parking lot
- Types 4 and 4A must be used in wet native areas
- Types 4B and 5B must be used in wetland areas
- Types 5 and 5A must be used for dry native areas
- Type 1 lawn mixture may be used for other regularly mowed areas
- All native seeded areas must be intermixed with native plant plugs

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Do not use species that are invasive, or upon evaluation, have the potential to be invasive. Do not use plants that may hybridize with closely related species in the area and potentially create invasive hybrids.

Do not use plastic landscape edging. Consider concrete or curb style edging that is flush with the adjacent landscaped surfaces.

Avoid generic seed mixes. Native seed installations perform best when the nativity of the seed is within 100 miles of the Argonne site; therefore, source seeds mixes from local vendors, with the species mix specified.

Native seed mixes and flora are considered on a project-by-project basis.

Do not plant trees within 10 feet of underground utilities.

Locate trees or shrubs which produce fruit so that the fruit does not drop on pedestrian sidewalks.

All projects that demolish trees must install new trees to replace the lost trees to the greatest extent possible. All exterior projects must install trees where practical in the immediate area of the project.

2.10 Outdoor Lighting

Accomplish lighting control using photo cells.

Argonne's standard light level is 0.4 foot-candle (fc) average for parking lots, crosswalks, and intersections, with a minimum of 0.12 fc. The uniformity ratio (average/minimum) must not exceed 6 fc.

Provide street light and sidewalk lighting at high risk areas: areas where roads intersect with other roads and sidewalks or other areas of high volume pedestrian or vehicular traffic.

Photometric studies by a professional engineer are required for any parking lot and street lighting changes.

The pole style for street lighting varies depending on installation or location and the FMS Office of Project Management (FMS-OPM) must review and approve the style. Maximum pole height is 20 feet.

Lighting must illuminate the pavement surface and not cause excessive spillover onto adjacent areas.

2.11 Environmental

Provide gate valves on all trench drains used in the loading dock areas of new buildings which handle bulk deliveries of chemicals (including diesel fuel). Equip buildings that receive incidental amounts of chemicals with a spill kit at the loading dock (a gate valve is not required).

Chlorinated water used for conditioning new water mains must not discharge to storm water. Chlorinated water must discharge into the laboratory sewer system; or, if the laboratory sewer is not available, dechlorinate the water before discharging into the sanitary sewer system.

Remove construction spoils (clay and topsoil) from the Argonne site unless they can be immediately re-used on site. Re-use excavated soils on the project to the extent practicable.

Building drains for cooling towers must discharge to the lab sewer system, not to the storm sewer system, and not to the sanitary sewer unless no other options are available.

Construction projects must follow Argonne specifications for erosion and sediment control. Use settling basins as the preferred method of removing suspended solids from storm water, along with conventional silt fence or excelsior logs.

Obtain the appropriate permits and permissions as follows:

- For all projects with one or more acres of land disturbance, the construction contractor must complete a SWPPP for submittal to Argonne. Argonne will review and submit to the IEPA to obtain the NPDES storm water permit for the project.
- The Permit Program for U.S. Army Corps of Engineers construction in or near jurisdictional wetlands: In general, construction activities must maintain a 30 foot vegetated buffer between the activities and a wetland. If construction takes place within the delineated boundary of a wetland, Corps permitting is required. Recent Corps and EPA definitions of *adjacency* with regard to wetlands result in most Argonne wetlands as being jurisdictional and therefore subject to Corps permitting. A trained ecologist must delineate the wetland before construction, to determine the buffer.

- All proposed laboratory and sanitary wastewater sewer systems connecting to Argonne's wastewater treatment plants must submit the appropriate permit application forms to IEPA and receive IEPA approval for the proposed systems before starting construction. These requirements come from Section 35 of the Illinois Administrative Code Part 309, Subpart B. Appropriate IEPA forms to submit to IEPA include, but are not limited to the following:
  - WPC-PS-1, *Application for Permit or Construction Approval*
  - Schedule A/B, *Private Sewer Connection or Sewer Extension*
  - Schedule P, *Erosion Control*

Coordinate these submittals with the Argonne water pollution SME.

All new construction designs, regardless of square footage, must consider and implement, if feasible, on-site management of storm water by green infrastructure and low-impact development. For projects that must submit an SWPPP to the IEPA (see previous), the document must discuss post-construction green infrastructure.

Keep all waste containers, oil containers, and cylinders under shelter if stored outside. Label all containers.

Do not dispose of wastewater generated during projects inside buildings through identified building storm drains.

2.12 Signage

Argonne's FMS-OPM department must review and approve plans for any non-regulatory (that is, building and guidance) sign. FMS-Engineering must approve plans for MUTCD standard road signage.

3 Architectural

3.1 Codes and Standards

- 29 CFR 1910, *General Industry Standards*
- 29 CFR 1926, *Construction Industry Regulations*
- Architectural Barriers Act (ABA) *Accessibility Standards*
- IECC, *International Energy Conservation Code*
- Illinois Administrative Code (IAC), Title 35, *Environmental Protection*
- 2015 International Building Code
- ANSI/ASHRAE/IES Standard 90.1-2013, *Energy Standard for Buildings Except Low-Rise Residential Buildings*
- The National Roofing Contractors Association (NRCA) Roofing Manual: *Architectural Metal Flashing, Condensation Control & Re-Roofing, 2010*
- The National Roofing Contractors Association (NRCA) Roofing Manual: *Membrane Roofing Systems, 2011*

3.2 Design Criteria

Entry doors to laboratory and office buildings must contain push button controls to automatically activate the door for handicap accessibility.

Design criteria for exits, exit systems, and related exit equipment follows the ESH-19.1, *Design Criteria for Facilities—Exit Systems and Life Safety*.

Guardrail systems for fall protection must comply with 29 CFR OSHA 1926.502.

Fixed ladders must comply with 29 CFR OSHA1910.27 and must be inspected according to LMS-PROC-14, *Fixed Ladders*.

Use cool roofs whenever practicable. Design and install a low-sloped roof with a minimum three-year aged solar reflectance of 0.55 and a minimum three-year aged thermal emittance of 0.75 (per the Cool Roof Rating Council program) or with a minimum three-year aged solar reflectance index (SRI) of 64 (per ASTM E 1980-11). Steep-sloped roofs (pitch exceeding 2:12) must have a 3-year aged SRI of 29 or higher.

Cool roofs on low slope surfaces should be single-ply roofing membranes made of 60 mm-thick thermoplastic polyolefin (TPO) over an R-30 insulation layer. All new roofing systems should be fully adhered or mechanically fastened systems. The new roof systems should be analyzed for moisture control. Ballasted systems are not allowed. Ballasted systems may be reused only when making small changes to existing roof systems.

The appropriate U.S. Government average for space use is 200 usable square feet per person, according to General Services Administration (GSA) guidelines. Do not let the average discourage efficient space use below 200 usable square feet per person, for such functions where efficiency is possible.

Windows must comply with the IECC or ANSI/ASHRAE/IES Standard 90.1. The IECC sets U-factor and SHGC requirements and fenestration area limits. Regardless of the chosen compliance path, fenestration must not exceed mandatory air leakage limits. The IECC requires replacement windows to comply with the requirements set for new construction. The requirements apply when replacing either a full window or just the sash and glazing.

3.3 General

Architectural and industrial maintenance coatings must follow Title 35 of the IAC, Part 223, Subpart C.

Restroom fixtures must be hands-free. Towel dispensers must contain roll towels. Trash cans recessed in the wall are discouraged. Sanitary napkin dispensers are required in women's restrooms.

Door hardware must meet the specifications of Argonne National Laboratory's *Door Hardware Specification*, Section 08 70 00, current version.

Unless 42 inch parapet walls or guardrails are provided, new or replaced roof membrane systems must have fall protection anchors installed.

Follow these suggested guidelines for room identification:

- Measure the building lengthwise and divide it into four or five foot sections, called *modules*. The modules govern the actual number of the rooms. The room number derives even, odd from the first full module contained within its wall (for example, 101 and 103). The opposite side of the corridor is 102, 104, and so on.
- Whenever a building has multiple corridors, letter the corridors clockwise: A, B, C, and so on. The letters then help to identify the location of the room (for example, A101). A room within a room usually takes on a letter suffix for identification, (for example A101A).

- Each basement and floor level within a facility has an alphanumeric name. For example, A001 indicates the room is located in the basement within module A, B101 indicates the room is located on the first floor within module B, C201 indicates the room is located on the second floor within module C, and so on.

For occupied buildings, provide a tornado refuge area, not a storm shelter or a safe room. Size the tornado refuge according to FEMA 361 Appendix B, *Safe Room Assessment and Design Tools.* Design and designate it according to FEMA P-431, *Tornado Protection, Selecting Refuge Areas in Buildings*. Refuge areas must be interior locations ideally, with short-span roof systems, reinforced masonry walls, and no glass openings. Although technically a refuge area, you can use the commonly understood terminology of *shelter* or *tornado shelter* for interior signage.

3.4 General Consideration

All new overhead doors must have enclosed sprocket wheels and chains.

Endeavor to use low or no VOC paint.

Drinking fountains must contain a water bottle refilling station.

Fire strobes and emergency lights must be white in color.

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4 Structural

4.1 Codes and Standards

- 2015 International Building Code
- ACI 318, *Building Code Requirements for Reinforced Concrete*
- ACI 530, *Building Code Requirements for Masonry Structures*
- AISC 360, *Specifications for Structural Steel Buildings* (including "Commentary")
- ASCE 7, *Minimum Design Loads for Buildings and Other Structures*

4.2 Design Criteria

Floor live loads are as follows:

- Office Space: 100 psf
- Laboratories: 125 psf minimum
- Mechanical, electrical, and plumbing (MEP) spaces larger than 250 sf: 150 psf minimum

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Frame drift limitations:

- Story drift
  - Wind Loading: H/500 or ½"
  - Seismic Loading: H/300 or ½"
- Total building drift
  - Wind Loading: H/400
  - Seismic Loading: H/250

Note that, when used for occupied buildings or buildings containing sensitive equipment, pre-engineered metal building (PEMB) systems are not exempt from the requirements in this section and cannot use lower requirements found in the Metal Builder Manufacturers Association (MBMA) manual.

Vibration Criteria:

- Evaluate vibration per AISC Design Guide 11.
- Develop requirements for low vibration laboratories in consultation with a vibration consultant.
- Laboratories must meet a minimum of Vibration Category A (VCA) of a 150lb individual at 75 paces per minute for all new lab space unless the project requires more rigid criteria.

4.3 General Requirements

Structural configuration adaptability: All framing systems must have a reasonable level of adaptability incorporated in the design to account for future use of the structure.

Prefer one-way systems for cast-in-place concrete slabs in laboratory floors over two-way systems. If a two-way system is used, it must be designed to allow for penetrations by future utilities in useful locations that are clearly documented in the structural drawings.

4.4 Miscellaneous Metals

Specifically identify miscellaneous metals not specified as part of the building structure (such as ladders, ornamental metals, roof anchors, railings, and so on).

Ladders must meet all OSHA and ANSI standards.

Exterior miscellaneous metals that are ferrous must be galvanized or coated with an epoxy-based paint system with compatible primer.

5 Plumbing

5.1 Codes and Standards

- 2015 International Plumbing Code
- ANSI Z358.1, *Standard for Emergency Eyewash and Shower Equipment*
- ASHRAE 90.1, *Energy Standard for Buildings Except Low-Rise Residential Buildings*

5.2 Design Criteria

- Water closet gallons per flush (GPF): 1.28
- Urinal gallons per flush (GPF): 0.125
- Lavatory flow rate, in gallons per minute (GPM): 0.5
- Sink flow rate (GPM): 1.5

5.3 General Requirements

Provide backflow preventers (double detector check valves for fire protection systems) where a laboratory water system splits from the domestic water system.

If both a shower and eye wash are required, use only a combination shower/eye wash unit, so that the same person can use the components simultaneously. If engineering limitations exist, request variance for alternatives (LMS-PROC-139, *Emergency Eyewashes and Safety Showers*).

- *Prudent Practices in the Laboratory-Handling and Disposal of Chemicals*, National Research Council, National Academy Press, Washington, D.C. Available from ESQ Industrial Hygiene group.
- CDC/NIH, 5th edition, *Biosafety in Microbiological and Biomedical Laboratories*.

Mechanical press connections and soldering are acceptable joining methods for copper piping.

Power sump pumps, sewage ejector pumps, and associated controls from an emergency power panel. If the installed systems are duplex, only one pump must be powered from an emergency power panel.

Faucets must have replaceable cartridges instead of needing to replace a diaphragm yearly.

Flagg pipe is found in older buildings on some domestic potable water systems. When connecting to existing flagg piping, make connections using a flagg adapter and transition to copper pipe.

All back flow, main drain, fire protection test stands, and floor drains must drain to the laboratory sewer system. If it is not practical to access the laboratory sewer system, get Argonne approval to use the sanitary system. Never use the storm drain system for these purposes.

Label all piping per Argonne standards:

Pipe Service	Lettering Color	Background Color
Condensate Drain	Black	Yellow
Domestic Cold Water	White	Green
Domestic Hot Water	Black	Yellow
Domestic Hot Water Circulating	Black	Yellow
Sanitary Sewer	Black	Yellow
Lab Cold Water	Black	Yellow
Lab Hot Water	Black	Yellow
Lab Hot Water Circulating	Black	Yellow
Vent	Black	Yellow
Storm Sewer (Primary and Secondary)	White	Green
Lab Sewer	Black	Yellow
Secondary Waste	Black	Yellow
Lab Vent	Black	Yellow
Tempered Water	Black	Yellow
Tempered Water Return	Black	Yellow

6 Fire Protection

6.1 Codes and Standards

DOE-O 420.1C (Section 2.2.1) provides the building code and all NFPA standards that apply to constructing or operating DOE facilities and structures. The basic NFPA fire protection codes typically included in all new facilities at Argonne include the following:

- NFPA 13, *Installation of Sprinkler Systems*
- NFPA 24, *Private Fire Service Mains*
- NFPA 30, *Flammable and Combustible Liquids Code*
- NFPA 45, *Fire Protection for Laboratories using Chemicals*
- NFPA 55, *Compressed gasses and Cryogenic Fluids Code*
- NFPA 72, *National Fire Alarm and Signaling Code*
- NFPA 101, *Life Safety Code*
- NFPA 801, *Facilities Handling Radioactive Materials*

Other NFPA codes might apply depending on the operation and design of new facilities or structures. Identify these other applicable codes in the preliminary design or scoping stage. Whenever NFPA codes and the IBC code conflict, the more conservative requirement applies.

6.2 Design Criteria

Design all spaces for a minimum classification of Ordinary Hazard Group 1.

6.3 General Requirements

For wet sprinkler pipe, use the following type of black steel pipes:

- For sizes two inches and below, use schedule 40 pipe with screwed or flanged joints
- For sizes above two inches, use schedule 10 pipe with mechanically coupled grooved joints

Mechanical fittings for schedule 10 sprinkler pipe must use roll grooves rather than cut grooves.

Use control valves of the rising stem OS&Y type. Do not use butterfly valves inside buildings.

Fire Department connections must be of the five inch STORZ type.

Hydrants must be greater than 40 feet and less than 300 feet from all exterior ground floor building surfaces.

Sprinkler design must allow a minimum safety margin of 10%, but never less than 10 psi.

Sprinkler control valves must not include tamper switches, as Argonne uses the lock and chain allowance.

Fire hydrants must be manufactured by Waterous, Clow, or Mueller, or other approved equal.

7 HVAC and Refrigeration

7.1 Codes and Standards

- ASHRAE 15, *Safety Standard for Refrigeration Systems and Designation and Classification of Refrigerants*
- ASHRAE 55, *Thermal Environmental Conditions for Human Occupancy*
- ASHRAE 62, *Standards for Ventilation and Indoor Air Quality*
- ASHRAE 90.1, *Energy Standard for Buildings Except Low-Rise Residential Buildings*
- ASME B31.3, *Process Piping Design*
- ASME B31.9, *Building Services Piping*
- LMS-PROC-210, *Ventilation for Hazard Control*
- Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), *Duct Construction Standards*

7.2 Design Criteria

Indoor Design Temperature

- Occupied:
  - Cooling: 74°F dry bulb (DB), relative humidity <60%
  - Heating: 72°F DB
- Unoccupied:
  - Maximum: 80°F DB
  - Minimum: 60°F DB

Outdoor Design Temperature (for laboratory and critical spaces)

- Cooling: 95°F DB / 78°F wet bulb (WB)
- Heating: -15°F DB

Outdoor Design Temperature (for all other areas)

- Cooling: 95°F DB / 75°F WB
- Heating: -10°F DB

Site Utility Information

- Chilled Water
  - Supply temperature: 44°F
  - Return temperature: 56°F

Steam and Condensate

- Steam supply: 190 psig saturated steam at building entrance
- Steam condensate return: 40 psig and below

7.3 HVAC

Changes or extensions to an existing system need a thorough analysis to understand the effect on the original system, and to determine the capacity available for expansion.

When designing for heating or cooling:

- **Heating**: Designs generally must use the site's central steam system. In buildings too distant from the steam supply, or unsuitable for connection to the system, use electric heat.
- **Cooling**: Designs generally must use the site's central chilled water system. In buildings too distant from the chilled water supply, or unsuitable for connection to the system, use condensing units or separate chiller systems.

Obtain approval from Argonne before designing any auxiliary systems.

Humidification is not provided to make buildings comfortable. Provide humidifiers to meet laboratory requirements.

Compressed air is generally available as a building-specific utility at 90 psig.

Do not locate equipment on a roof. You must obtain approval from Argonne before designing roof-mounted equipment.

Equipment cooling with domestic water is prohibited.

Process cooling directly from site chilled water is prohibited. Isolate process cooling from site chilled water via a heat exchanger.

Filtration for air handling units must meet MERV 13 ratings.

Insulate all cold or hot ductwork and equipment for energy efficiency and to reduce condensation sweating.

Provide manufacturer's recommended minimum clearance around all mechanical equipment, piping, valves, fittings, and accessory items. Provide minimum clearance to access, maintain, and remove or replace equipment if no recommendation exists.

Incorporate energy conservation into system designs, such as variable air volume distribution systems and variable frequency drives (VFD) for fans and pumps.

Commission all systems before turning them over to Argonne.

7.4 HVAC Piping

The following rules apply to HVAC piping:

- Insulate all cold or hot piping for energy efficiency and to reduce condensation.
- Install cooling and heating control valves with manual bypasses.
- Incorporate provisions for disassembly into the piping design.
- Label all piping per Argonne standards:

Pipe Service	Lettering Color	Background Color
Steam supply*	Black	Yellow
Steam condensate return	Black	Yellow
Heating water supply/return	Black	Yellow
Chilled water supply/return	White	Green
Heat recovery supply/return	White	Green
Process chilled water supply/return	White	Green
Pure water supply/return	White	Blue
Condensate drain	Black	Yellow
Compressed air*	Black	Yellow
Refrigerant relief vent	Black	Yellow
Laboratory gases	White	Black

* Labels must identify pressure of fluid

7.5 Laboratory Exhaust Systems

Negatively pressurize labs to surrounding areas unless directed otherwise by Argonne. Design air movement to flow from clean areas to less clean areas.

Follow the design guides in LMS-PROC-210, *Ventilation for Hazard Control* (Table C.1-1), for ventilating fume hoods, gas cylinder storage cabinets, glove boxes, and biosafety cabinets.

Exhaust system materials must be suitable for the chemicals and materials being used.

Provide emergency power on any local exhaust systems, including makeup air, as needed, where loss of normal power may release contaminants resulting in unsafe exposure to personnel or significant loss of facilities.

All laboratory chemical hoods must have an air flow monitor and alarm system capable of detecting when face velocity drops 15 fpm below set flow rate and warning operators about the malfunction.

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8 Electrical

8.1 Codes and Standards

- ANSI/IEEE C2, *National Electrical Safety Code (NESC)*
- ASHRAE 90.1, *Energy Standard for Buildings Except Low-Rise Residential Buildings*
- ICEA, Insulated Cable Engineers Association
- NETA, InterNational Electrical Testing Association
- NFPA 70, *National Electrical Code*
- NFPA 70E, *Standard for Electrical Safety in the Work Place*
- NFPA 72, *National Fire Alarm and Signaling Code*
- NFPA 110, *Standard for Emergency and Standby Power Systems*
- NFPA 780, *Standard for Lightning Protection*
- ESH-9.4, Electrical Safety—Lightning Protection
- ESH-19.3, Design Criteria for Facilities—Emergency Lighting Systems

8.2 Basic Design Criteria

Design electrical systems to use redundancy and serviceability of equipment to avoid unnecessary outages.

Use two separately-derived power sources with an acceptable transferring scheme or a main-tie-main configuration for facilities that cannot experience prolonged power outages.

Include the following design calculations with all electrical designs:

- Equipment amperage ratings
- All electrical loads
- Emergency and required standby power
- Short circuit analysis
- Voltage drops

Electrical designs must include the following studies, drawings, and diagrams:

- Provide studies for arc flash and overcurrent device coordination, and provide labeling per NFPA 70E
- Include one-line diagrams with all acronyms identified and defined
- Supply riser diagrams

- Determine and supply electrical space planning diagrams
- Develop and provide usage and consumption rates for systems such as generators, transformers and critical systems

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Receptacles controlled by lighting controllers or occupancy sensors should be green in color and pad printed with controlled symbol per NEC.

8.3 General Requirements

All contractors and installers must provide proof of recent certifications (within the past two years) from approved manufacturers to install all project-specific electrical equipment and components.

All electrical installations require third-party testing and commissioning using NETA and ANSI standards, and must follow a plan for inspection, testing, and commissioning.

Load and phase balancing is required when installing all electrical equipment.

Contractors must document the torque measurements of all lugs, bus work, and electrical terminations, and follow these requirements:

- Use a valid and calibrated device designed for torqueing
- Have Argonne staff witness and approve all torque measurements (this is essential)

Use 100% copper (Cu) for all conductors and bus details. Do not use any other type of material, such as aluminum (Al).

Consider using variable frequency drives (VFD) with disconnect and bypass switches for all critical systems, and wherever deemed appropriate.

Use hinged access doors for all commercial grade and equipment panel boards.

Use built-in lock-out tag-out devices for all 480-volt, commercial-grade panel boards.

Verify conduit and wire color-coding with the Argonne representative and with existing building conditions. Many facilities use red/blue/black for A/B/C phase coding of wire. For new facilities and buildings, use commercial, color standard for 480v and 208v. However, for existing buildings use red/blue/black for phases A/B/C. Label phase from left to right and top to bottom A/B/C.

Use color-coded conduits throughout all projects. Verify the use and color with Argonne.

Electrical products, parts, and components used throughout all projects must bear an official, certified UL label. It is imperative that all manufacturers provide the proper documentation to prove that they comply with and meet UL requirements.

8.4 Low Voltage Requirements

Low voltage electrical systems are electrical systems with a voltage rating of 1000 volts and below. The following list provides the requirements for low voltage systems.

Use panel boards with the following:

- Main circuit breakers or disconnecting means within sight (preferred panel boards are Schneider Electric)
- Voltage test station ports (preferred type: GracePort product r-3mt)

Use 480-volt switch gear panels with thermal viewing ports.

Use a ground-monitoring system with alarm contact systems for all delta-connected 480v equipment.

Use transfer switches with draw-out, bypass-isolation (preferred type Russ Electric).

Use the following for low voltage (1000V) cable:

- 100% copper stranded THHN/THWN-2
- Underground in duct bank type RHW-2

For any electrical installation or retrofit at 1000V and below, consider using ETAP software for all arc flash and coordination studies. Give the program file to the appropriate Argonne staff.

8.5 Utility Voltage Requirements

Utility voltage electrical systems are electrical systems of 1000 volts and above. This section provides the requirements for utility voltage systems.

Overhead 13.2kV and below distribution must use ComEd systems standards for pole installations.

Main power cables installed in the utility infrastructure must be single conductor, MV-105, 133% EPR, copper, class B concentric stranded, and PVC jacketed.

Use class 1, cold shrink, or hot shrink voltage terminations and splices.

During the original design, or when removing or adding cable to underground duct banks, perform thermal and ampacity calculations to determine the spacing or conductor load capacity for underground conduit.

Use concrete duct banks (colored with red dye) for all underground utility cable installations.

Use rigid galvanized steel conduit for all utility applications. PVC conduit is acceptable in concrete duct banks.

Install tracer wire on all duct banks along with marker tape identifying the voltage.

Argonne Nuclear and Waste Management (NWM) staff must dispose of oil-filled transformers.

Argonne recommends that new or retrofitted installations use Schweitzer Engineering Laboratories protection and control relays.

S&C is the preferred manufacturer for overhead and underground distribution equipment.

Connect any utility infrastructure equipment capable of network communication to the Schneider Electric ION SCADA on campus.

For any electrical installation or retrofit in the electric utilities infrastructure, use SKM software to perform all arc flash and coordination. Provide the required program file to the Argonne Utilities department.

8.6 Generator Requirements

Submit a complete set of instructions (including operating manuals, schematics, and setup instructions) to Argonne FMS staff after installing and testing the emergency generator.

Install emergency generator units less than 1118 kW (1500 hp) to avoid complex permitting issues.

Consider installing a generator tap box connection for all critical systems and building.

Generators require the use of diesel fuel with minimum 24-hour runtime.

Consider using walk-in enclosures with OSHA stairs, interior and exterior lighting, convenience outlets, space heating, and a ventilation fan for generator sizes 250KW and above.

Consider the following for all generator installations:

- Block heaters
- Battery charger
- Battery monitor
- Fuel polisher
- Load bank connection
- Remote alarm monitoring
- Remote fuel monitoring
- Fuel filling station or port
- Manual fuel by-pass valve
- Shut-off valves on all coolant and fuel hoses
- Positive crank ventilation system
- Interstitial alarms
- Water alarms
- High/low alarms

Use a main disconnect or output breaker mounted on the Genset skid for all designs.

Include the following on identification labels for a generator, engine, or stator:

- Model
- Serial number
- Manufacturer
- Type
- Available voltages
- Available fault current
- Amperage
- KW, KVA, PF, and HZ

8.7 Grounding Requirements

Follow the recommendations of the National Electrical Code (NEC) for grounding system equipment.

Use exothermic welding methods for all underground grounding connections.

Grounding conductors must have enough capacity to carry reasonable abnormal currents and be large enough to withstand injury.

Make interconnections between system neutral and the non-current-carrying metal parts of equipment per NEC recommendations.

Use a grounded resistance of no more than 5 ohms.

Connect main substation ground directly to site ground grid using exothermic connections or other approved means.

Connect all building equipment, transformer secondary grounds, and building steel to ground grid using exothermic connections or other approved means.

Provide ground test wells for selected grounding rods with adequate clearance and accessibility.

Provide equipment grounding conductor in all receptacle conduits and raceways.

8.8 Indoor Lighting Requirements

Interior lighting must conform to the Illuminating Engineering Society of North America (IES) Lighting Handbook recommendations.

Following these lighting technologies:

- Primary technology—light-emitting diode (LED): tubes, bulbs, or fixtures
- Secondary technology—fluorescent (some T8, some T5 tubes)
- Others—limited halogen, limited high-pressure sodium (HPS), limited metal halide (MH)
- Eliminate whenever possible—CFL, incandescent, halogen, T12 fluorescent, 8-foot fluorescent tubes with high output ballasts

Use the following light bulb tube sizes: 2 feet, 3 feet, 4 feet, and U-bend.

Exit signs must be LED unless otherwise noted or specified by Argonne.

The recommended light bulb types are: A-lamp (40/60/75/100W equivalent), MR16, 4-pin vertical and horizontal (CFL replacement), BR30, PAR30, and PAR38.

Request clarification from Argonne regarding interior lighting color and temperature.

Retrofit projects for interior lighting must meet the following criteria:

- Eliminate T12 F32W tubes by using 12W LED tube and electronic ballast.
- For office rehab projects; replace entire fixture if replacing the ceiling grid. Retrofit fixture with LED tubes unless otherwise specified.
- Adjust fixture lumen output for recommended foot-candles per Argonne directions.

8.9 Exterior and Outdoor Lighting Requirements

Design exterior lighting in parking lots, intersections, driveway entrances and crosswalks (areas of conflict) with the following considerations:

- An average of 0.4 fc with a minimum of 0.12 fc. A uniformity ratio (avg/min) not to exceed 6 fc (refer to Argonne lighting standard).
- Lighting must illuminate the pavement surface and not cause excessive spillover into adjacent areas.
- Photometric studies by a professional engineer are required for any parking lot and street lighting changes.
- The pole style for street lighting varies depending on installation or locations and Argonne must review the style. Maximum pole height is 20 feet.

Exterior lighting temperatures must meet the following criteria:

- Primary technology—light emitting diode (LED): tubes, bulbs and fixtures
- Eliminate wherever possible—CFL, incandescent, halogen, HPS, MH, LPS
- Provide 4000K color temperature unless directed otherwise by Argonne for specific applications
- Follow International Dark-Sky Association guidelines to minimize or eliminate light pollution by using fixtures that incorporate shielding and light cutoff measures
- Retrofit projects shall use the Lunera MH replacement (4000K) or fixtures approved by Argonne

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9 Instrumentation

9.1 Codes and Standards

- ANSI/ASHRAE Standard 135, *BACnet®—A Data Communication Protocol for Building Automation and Control Networks,* including all amendments
- ASHRAE 90.1, *Energy Standard for Buildings Except Low-Rise Residential Buildings*
- IECC, *International Energy Conservation Code*

9.2 Building Automation System (BAS)

BACnet is required for all building automation system (BAS) networking. LONWorks, Modbus, or proprietary protocols are not allowed.

JCI Metasys is the preferred building automation system. For new buildings or installations into buildings that do not have a BAS, additional vendors such as Honeywell and Siemens should be listed as acceptable vendors, but pricing for the BAS and its integration with the existing system should be exposed so that Argonne can evaluate which system to use.

Large packaged equipment (chillers, boilers, rooftop units, and so on) must have a data connection integrated to the BAS which includes electrical demand consumption information. Critical control signals (start/stop, speed, reference, alarm, and so on) must be directly hardwired.

Variable frequency drives (VFDs) must have BACnet data connection integrated to the BAS that includes electrical demand and consumption information. Critical control signals (start/stop, speed, reference, alarm, and so on) must be directly hardwired. The BAS must integrate with all comfort heating, cooling, and airside systems and have full control and monitoring capability.

BAS power must be from an emergency power panel where equipment controlled by the BAS is also powered from an emergency power panel. Include a local battery backup system or UPS that will support the load for a minimum of ten minutes and provide power transfer ride-through capabilities.

9.3 Lighting Controls

Lighting controls must be per ASHRAE 90.1 and IECC requirements. Non-proprietary devices and systems are preferred.

BAS control and monitoring of exterior and public area lighting is preferred.

Centralized or networked lighting control systems are not required. If used, connect them to the BAS for full control and monitoring.

9.4 Building Systems and Large Equipment

All systems and large equipment must integrate into either an existing data acquisition system or into a large scale energy management system. If monitored, the monitoring must include electrical demand and consumption information, and any other energy sources (fuel, steam, hot water, chilled water, and so on).

Configure systems, where feasible, so that integrating new systems, performing maintenance, or expanding systems does not require a large scale building or system shutdown.

Systems and equipment include (but are not limited to):

- Comfort cooling systems and equipment
- Chillers
- Boilers
- Packaged air handling equipment (rooftop units [RTUs], air handling units [AHUs], makeup air units [MUAs], and so on)
- Laboratory exhaust systems
- Packaged hydronic equipment (pump skids, reverse osmosis [RO] systems, de-ionized [DI] systems, and so on)
- Electrical power distribution
- Electrical standby power (generator, transfer switch, UPS, and so on)
- Elevator and other conveying equipment

9.5 Electrical

Connect electrical meters to the existing electrical supervisory control and data acquisition SCADA system and, at a minimum, report instantaneous and peak values for each of the following measurements: amperes (A), voltage (V), power demand (kW), and power consumption (kWh).

Provide power quality metering for building services, data centers, large experiments, and similar applications.

Meter building services using revenue grade meters.

Meter all 480 volt distribution equipment.

All electronic communicating trip units and circuit breakers must meet the minimum requirements for electrical metering.

Design metering to allow separate measurements of experimental and data center loads. Design metering to allow separate measurements of lighting, HVAC, general power, and other large loads. Readings from multiple meters may be summed to obtain total load measurements.

For data centers, meter IT and facility loads separately for power usage effectiveness (PUE) calculations.

Provide monitoring of status and alarms for the building service's main circuit breakers, feeder circuit breakers in main switchgear and key distribution equipment, generators, transfer switches, UPS, and similar equipment.

All metering and monitoring terminals must have a suitable barrier from line voltage components, for making low voltage connections without de-energizing equipment.

9.6 Chilled Water and Heating Water

Connect HVAC water meters to the BAS and measure BTU/hr and BTU.

At a minimum, meter chilled water and hot water services at the building entrance.

Measure the chiller's efficiency directly, or report it to the BAS via a BACnet MS/TP serial or BACnet IP data connection from the chiller control panel. Measure the boiler's efficiency directly, or report it to the BAS via a BACnet MS/TP serial or BACnet IP data connection from the boiler control panel.

Measure the heat exchanger's efficiency directly, or install a differential pressure sensor to sound an alarm if it detects excess fouling of the heat exchanger.

Submeter large building area loads, such as data centers or other large experimental loads.

Consider using valves with built-in metering for submetering large equipment instead of installing separate meters.

9.7 Steam

Connect steam meters to the BAS and measure lbm/hr and lbm.

Meter steam service at the building entrance.

Measure the heat exchanger's efficiency directly, or install a differential pressure sensor to sound an alarm if it detects excess fouling of the heat exchanger.

Meter condensate return.

9.8 Natural Gas

Connect natural gas meters to the existing water treatment SCADA and measure therms/hr and therms.

Meter natural gas service at the building entrance.

Submeter large loads, such as boilers.

9.9 Potable, Laboratory, and Canal Water

Connect potable, laboratory, and canal water meters to the existing water treatment SCADA and measure gallons per minute (gpm) and gallons (gal).

Meter water services at the building entrance.

Submeter systems or spaces designed for high demand.

10 IT, Networking, Telecom, AV, and Security

10.1 Codes and Standards

- Argonne National Laboratory, Computing and Information Systems Division (CIS) Specifications, Section 27 05 32—Structured Cabling Systems
- ANSI/NECA/BICSI 568-2006, *Standard for Installing Commercial Building Telecommunications Cabling*
- TIA-162-A, *Telecommunications Cabling Guidelines for Wireless Access Points*
- TIA-526-7-A, *Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant*
- TIA-526-14-C, *Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant*
- TIA-568.1-D, *Commercial Building Telecommunications Infrastructure Standard*
- TIA-568-C.2, *Balanced Twisted-Pair Telecommunications Cabling and Components Standards*
- TIA-569-D, *Telecommunications Pathways and Spaces*
- TIA-606-B, *Administration Standard for Telecommunications Infrastructure*
- TIA-607-C, *Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises*

10.2 Solutions Architecture and Governance

It is important to include CIS and FMS in the design process and to set approval checkpoints throughout the design and implementation phases, to verify that things are correctly proposed and implemented.

The appropriate Argonne SME group must meet with the architects, engineers, and contractors to review the design and implementation. Argonne SME groups are as follows:

- CIS Infrastructure Networking
- CIS Infrastructure Telecom
- CIS Audio Video (AV)
- FMS-Safeguard Security and Emergency Services

The Argonne project manager must provide product submittals to the IT group for review and approval before purchasing or installing IT infrastructure.

Provide construction drawings designated for telecommunications, which are separate from electrical drawings (usually designated E-XX).

Entities designing technology systems must have at least one Building Industry Consulting Service International (BICSI) Registered Communications Distribution Designer (RCDD) on staff.

10.3 Networking

Most buildings on the Argonne campus need network connectivity to support building services and occupants. Argonne staff procures and installs network electronic components.

Allocate a minimum of 20 rack units (RU) of adequate space in two-post racks, four-post racks, or network cabinets for networking equipment.

Two-post racks, four-post racks, or network cabinets for networking equipment must be 19 inches in width (inside rail dimension).

Allow a minimum egress of 32 inches (clear space) in front and back of two-post racks, four-post racks, and network cabinets.

When installing brackets indoors for access points to a wireless LAN:

- Provide a minimum of two Cat-6A (or better category) data cables for every access point location of the wireless LAN.
- Provide adequate bracing and support for installing brackets for access points to the wireless LAN.
- Be at least 8 feet above a finished floor.
- Be 24 inches away from lighting fixtures, fire protection sprinklers, PA speakers, or other sources of electromagnetic interference (EMI).

When installing brackets outdoors for access points to a wireless LAN:

- Install at least 15 feet above a finished floor.
- Provide proper bracing to mount at least 8 inches out from exterior of building.
- Install 24 inches away from electrical power lines, lighting fixtures, fire protection sprinklers, PA speakers or other sources of electromagnetic interference (EMI).
- Include proper grounding and bonding.
- Verify all cables are outdoor and UV rated.
- Verify enclosures and liquidtight flexible non-metal conduit (including connectors) are a minimum of NEMA 4x and UV rated.

10.4 Telecommunication Rooms

Telecommunication rooms (TR) are required throughout the facility to support the communications infrastructure. Each facility must have an entrance facility (EF) that connects it to the outside cable plant. Every TR must have structured cabling that ties back to the entrance facility. For more details, refer to the Argonne National Laboratory, CIS Specifications, Section 27 05 32—Structured Cabling Systems.

Telecommunication rooms must meet the following requirements:

- At least one per floor
- Within 90 meters of furthest data cable office or station end
- Minimum room dimensions of 10 feet W × 12 feet L × 10 feet H
- Contains no columns or other building infrastructure systems such as electrical or plumbing

Provide one entrance facility that meets the following requirements:

- On lowest floor of the building, and connecting to the external laboratory cabling conduit system
- Minimum room dimensions of 10 feet W × 15 feet L × 10 feet H; rectangular in shape
- Contains no columns or other building infrastructure systems such as electrical, plumbing, and so on

Provide separate emergency and common power circuits to the rooms.

Provide proper HVAC ventilation and humidity control.

Provide proper two-post racks, four-post racks, and network cabinets.

Provide proper badge proximity reader and keyed door entry.

Provide grounding and bonding.

10.5 Cabling Infrastructure

A cabling infrastructure is required in facilities needing IT infrastructure. This includes the cabling trays, copper and fiber cabling, racks and cabinets, patch panels and fiber shelves, outlets and faceplates, and patch cables. Please refer to the CIS Specifications document listed earlier for more details. The following lists the requirements concerning infrastructure:

- Provide a cable trays system
- Provide outside cable plant integration

- Contractors must be certified by the manufacturer of the cabling being installed
- Contractors must have a minimum of one certified (and current) BICSI-Installer 2 and one certified (and current) BICSI-Technician on staff
- The architect or engineer must specify that the contractor provide manufacture's cabling system warranty with documentation
- Contractor must provide the following in both an electronic and a physical disk version:
  - Documentation certifying Cat-6A cabling testing
  - As-built documentation and drawings
  - Excel file with data jack labeling
- Contractors provide 100% matching of patch cables-to-data jack on both telecommunication rooms and office station areas
- Current copper cabling spec Cat-6A (or better category)
- Current fiber optic riser rated spec (between each telecommunication room and the entrance facility):
  - Multimode: 50 micron laser-optimized (OM4 rated) with minimum 12 strands
  - Single-mode with minimum 12 strands

10.6 Telecommunications

All facilities require at least one analog phone for emergency life safety purposes. Most buildings with occupants require VoIP phones for the office and common areas. Argonne staff procures and installs the phones. Please refer to the CIS Specifications document listed earlier for more details.

10.7 Audio Video (AV) and Conferencing Systems

Most facilities at Argonne require AV and conferencing systems. These systems are generally deployed in meeting and conference rooms, large conference centers, and in the lobby of the facilities. The architect or engineer is responsible for the design of the cabling and mounting infrastructure. The Argonne AV team selects the AV electronic components.

Consider AV applications at the beginning of the planning process. Address plans, furniture, usage, and functionality for all meeting spaces early in the design phases. Design large offices, meeting rooms, board rooms, collaboration spaces, and auditoriums for AV systems.

Accompany all wireless presentation devices by either a wall jack or a table connection as a backup.

Power, data, and phone lines must be in proximity to work surfaces adjacent to viewing devices.

Provide one extra network jack for each display device leading back to the closet. Shielded twisted pair, terminated at block. No switch required.

Specify minimum of two extra outlets at all display devices over 32 inches diagonal in size.

10.8 Security (Cameras, Door Access, and Alarms)

Argonne deploys security camera, door access, and alarm systems in all of our facilities. The preferred vendor for door access and alarm systems is DSX. The architect or engineer is responsible for designing the system. Argonne Protection Services is responsible for programming and connecting it to the lab-wide system. The following list provides the security requirements:

- Cameras are of high definition quality and have Power over Ethernet capability.
- Install a network drop to the camera.
- The DSX alarm system is a standalone system that integrates with fiber optics and phone circuits. Alarms sensors need prior approval before implementation.
- The DSX door access system integrates with the network requiring a network drop.
- The proximity readers are pivClass and are dual technology working with 125KHZ and 13.56MHZ cards.

10.9 Public Address System

Argonne has a site-wide public address (PA) system that broadcasts announcements in the campus buildings. Include a design to integrate the PA into the existing system. In some buildings, the PA integrates with the fire alarm system, others have separate amplifiers and speakers.

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11 Sustainability

11.1 Codes and Standards

- ASHRAE 62.1
- ASHRAE 90.1
- DOE O 436.1, *Departmental Sustainability*
- EO 13653, *Preparing the United States for Climate Change*
- EO 13693, *Planning for Federal Sustainability in the Next Decade*
- *Determining Compliance with the Guiding Principles for Sustainable Federal Buildings*, issued by the Council on Environmental Quality in February 2016
- Illinois Energy Conservation Code

11.2 Design Criteria

All construction projects must meet the requirements of DOE O 436.1, *Departmental Sustainability*, and all associated flow-down requirements, such as National Energy Conservation Policy Act (NECPA), Energy Policy Acts (EPActs), and Energy Independence and Security Act (EISA) Section 432.

New construction and major renovations greater than 5,000 gross square feet must meet federal high performance sustainable building (HPSB) criteria. Projects must either comply with the guiding principles (GP) of HPSB or provide documentation proving compliance from using equivalent elements of third-party rating systems for green building (for example, LEED certification). However, you must also meet any part of the guiding principles not fulfilled by elements of the third-party rating system.

For HPSB projects, use the Federal High Performance Sustainable Buildings Checklist in U.S. EPA's ENERGY STAR® portfolio manager to document and track progress towards achieving compliance with the HPSB GPs, which are summarized below:

- GP I: Employ integrated design principles
  - Sustainable locations
  - Integrated design
  - Commissioning
- GP II: Optimize energy performance
  - Energy efficiency
  - Renewable and clean energy
  - Metering
  - Benchmarking

- GP III: Protect and conserve water
  - Indoor water use
  - Outdoor water use
  - Alternative water
  - Stormwater management
- GP IV: Enhance indoor environmental quality
  - Ventilation and thermal comfort
  - Daylighting and lighting controls
  - Indoor air quality
  - Occupant health and wellness
- GP V: Reduce environmental impact of materials
  - Material content and performance
  - Waste diversion and materials management
- GP VI: Assess and consider climate change risks
  - Mission criticality
  - Floodplain considerations
  - Facility design
  - Facility adaptation

Beginning in FY2020, per EO 13693, section 3(h)(i), design all new construction (greater than 5,000 gross square feet) entering the planning process to achieve energy net-zero and, where feasible, water or waste net-zero by FY2030.

11.3 General Requirements

Project teams must track compliance with HPSB guiding principles using the tracking tool from the EPA's ENERGY STAR portfolio manager, communicate progress to Argonne regularly, and submit documentation for HPSB compliance to the Argonne sustainability team before completing the project.

12 Non-Reactor Nuclear Facilities and Accelerator Facilities

12.1 Introduction

The reference documents listed in this section do not necessarily apply to all non-reactor nuclear facilities as defined in 10 CFR 830, *Nuclear Safety Management*, or to all accelerator facilities. To determine applicability, use the hazard categorization process defined in DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports.*

For brevity, this list shows the highest level of codes and standards, and does not include other documents that flow down from the documents listed below.

12.2 Federal Rules

- 10 CFR 708, *DOE Contractor Employee Protection Program*
- 10 CFR 830, *Nuclear Safety Management*
  - Subpart A, *Quality Assurance Requirements*
  - Subpart B, *Safety Basis Requirements*
- 40 CFR 61, *National Emission Standards for Hazardous Air Pollutants*
  - Subpart H, *National Emission Standards for Emissions of Radionuclides other than Radon from DOE Facilities*
- 10 CFR 835, *Occupational Radiation Protection*
  - Subpart K, *Design and Control*

12.3 DOE Orders

- DOE O 414.1D, *Quality Assurance*
- DOE O 420.1C, *Facility Safety*
- DOE O 420.2C, *Safety of Accelerator Facilities*
- DOE O 433.1B, *Maintenance Management Program for DOE Nuclear Facilities*
- DOE O 458.1, *Radiation Protection of the Public and the Environment*

12.4 DOE Standards

- DOE-STD-1020-2012, *Natural Phenomena Hazards Analysis and Design Criteria for Department of Energy Facilities*
- DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*

- DOE-STD-1066-2012, *Fire Protection*
- DOE-STD-1073-2003, *Configuration Management Program*
- DOE-STD-1189-2008, *Integration of Safety into the Design Process*
- DOE-STD-3020-2015, *Specification for HEPA Filters Used by DOE Contractors*
- DOE-STD-3024-2011, *Content of System Design Descriptions*

12.5 DOE Guides and Handbooks

- DOE Guide 414.1-2B, *Quality Assurance Program Guide*
- DOE G 420.1-1A, *Nonreactor Nuclear Safety Design Criteria for use with DOE O 420.1, Facility Safety*
- DOE G 420.2-1A, *Accelerator Facility Safety Implementation Guide for DOE O 420.2C, Safety of Accelerator Facilities*
- DOE G 441.1-1C, *Radiation Protection Programs Guide for Use with Title 10, Code of Federal Regulations, Part 835, Occupational Radiation Protection*
- DOE-HDBK-1132-99, *Design Considerations*
- DOE-HDBK-1169, *DOE Handbook Nuclear Air Cleaning Handbook*
- DOE-HDBK-1215, *Optimizing Radiation Protection of the Public and the Environment for use with DOE O 458.1, ALARA Requirements*

12.6 Other Reference Documents

ACGIH 2096, *Industrial Ventilation: A Manual of Recommended Practices for Design.*

13 Temporary Facilities

13.1 Codes and Standards

- DOE EP-0108, *Standard for Fire Protection/Construction Safety of DOE Electronic Computer/Data Processing Facilities*
- ASCE 7/ANSI A58.1, Section 6, *Wind Loads*
- ASCE 7/ANSI A58.1, Section 7, *Snow Loads*
- ESH 19.3, *Emergency Lighting Systems*
- LMS-PROC-220, *Trailers and Other Movable Structures*
- NEC Article 645
- 29 CFR 1910, *General Industry Standards*
- International Building Code®, Section 1111.0, *Snow Load*

13.2 Design Criteria

For design purposes, the basic wind speed (as derived by the University of California Research Laboratory, pub. 53526 rev 1) is 80 mph. Use exposure C for all calculations.

For office environments, continuously provide 20 cfm (cubic feet per minute) of outside air per person.

Floor load rating must be 40 lbs/sq. ft. for commercial and office uses.

Install fire extinguishers per NFPA 10, *Standard for the Installation of Portable Fire Extinguishers*.

Install emergency lighting per ESH 19.3, *Emergency Lighting Systems*. Exterior night lighting is required above each exterior door.

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Appendix: Subcomittees

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ABOUT ARGONNE NATIONAL LABORATORY

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