# LANL Tailored Standards Manual (TSM)

## STD-342-600

*Design Input Constants and Baseline Equipment/System Requirements*
*for use with*
*Selected Projects within the Limitations Listed Herein*

## TABLE OF CONTENTS

## REVISION RECORD

| Rev | Date | Description | POC | OIC |
|---|---|---|---|---|
| 0 | 5/27/21 | Initial issue. | Tobin Oruch, *ES-FE* | Jim Streit, *ES-DO* |
| 1 | 12/23/22 | Revised cost to under $50M from $20M and applicability to “commercial construction” concept. Updated and expanded throughout including systems engineering. Incorporated VARs 10526 GN restrooms and 10564 on TIP development. | Tobin Oruch, *ES-FE* | Michael Richardson, *ES-DO* |

# CHAPTER 1 GENERAL

## 1.0 LIMITATIONS ON USE OF THIS DOCUMENT

A. This document may be used in lieu of the complete LANL Engineering Standards (including LANL Engineering Standards Manual [ESM], STD-342-100) under these conditions:

1. Total project cost under $50M[1],
2. ML-4
3. Conventional, commercial construction[2], and
4. Written approval of Engineering Services Division Leader (e.g., through a formal Alternate Method).

B. Comply with the LANL Engineering Standards Manual (ESM) STD-342-100, LANL Master Specifications STD-342-200, and LANL Standard Drawings and Details STD-342-400 for only those portions specifically invoked by this document.

*Guidance: This document contains the minimum acceptable requirements; however, users may elect to exceed them, including following aspects of the LANL Engineering Standards that are not invoked by reference. In any case, the full Standards are available for additional context and guidance at engstandards.lanl.gov.*

C. LANL personnel: This document does not reduce any program- or administrative-type requirements applicable to LANL in the LANL Standards (ESM examples: IBC Program, Welding/NDE, Commissioning, and Pressure Safety, including project engineer actions, review, and inspections; LANL Master Specifications examples: STR notifications to authorities and inspectors).

## 2.0 DEFINITIONS AND ACRONYMS

See Appendix A of this document.

## 3.0 CONVENTIONS IN THIS DOCUMENT

A. This document includes minimal guidance; italics (or a clear heading) indicates guidance. Reference titles are also italics.

B. Reference to chapters is generally to those within this document; if to LANL's Engineering Standards Manual (ESM), they will note "ESM."



[1] $50M is on a per-building (total project cost of a building) basis. Thus, should eligible buildings under $50M each be part of a larger (line item) project, they may also use the TSM; however, if a single RCD covers both under- and over-$50M buildings, then the TSM should not be used (and full standards [ESM, all specs, etc.] shall be followed to avoid a mixed/confusing standards set.
[2] LANL "conventional commercial construction" is when (1) the facility and associated operations will have no Standard Industrial Hazards (SIHs) that exceed the thresholds in Figure A-1 of DOE-HDBK-1163-2020, *Integration of Hazards Analyses*, and (2) the facility grades as IBC Table 1604.5 Risk Category I or II.

## 4.0 APPLICABLE CODE OF FEDERAL REGULATIONS AND LAWS

Follow all applicable CFRs and laws including but not limited to:

A. 10 CFR 433, Energy Efficiency Standards for the Design and Construction of New Federal Commercial and Multi-Family High-Rise Residential Buildings

B. 10 CFR 436, Subpart A, Methodology and Procedures for Life Cycle Cost Analysis

C. 10 CFR 851, Worker Safety and Health Program

D. 10 CFR 1910, Occupational Safety and Health Standards

E. 10 CFR 1926, Safety and Health Regulations for Construction

## 5.0 REQUIRED DOE ORDERS AND STANDARDS (OTHERS APPEAR THROUGHOUT)

A. DOE O 414.1D, Chg. 2, *Quality Assurance* (Contractor Requirements Document CRD only)

B. DOE O 420.1C, Chg. 3, *Facility Safety* (only CRD's Chapters II–Fire Protection and Chapter IV–Natural Phenomena Hazards Mitigation)

C. DOE-STD-1020-2016, Natural Phenomena Hazards Analysis and Design Criteria for DOE Facilities

D. DOE-STD-1066-2016, *Fire Protection*

E. NA-SD-430.1, *Real Property Asset Management* (CRD only)

## 6.0 NEW MEXICO LAWS AND REGULATIONS

A. Comply with all New Mexico laws and regulations for design and construction.

## 7.0 CODES AND STANDARDS

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On or about February 1st, 2023, LANL is adopting the 2021 edition of selected ICC-codes; Projects with a code of record (CoR) date after that point shall apply the 2021 editions for the following codes referenced within this document*: International Building Code (IBC), International Existing Building Code (IEBC), International Fire Code (IFC).* Questions regarding code and standard year compliance should be directed to the ESM discipline chapter point of contact (POC).

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A. Comply with the requirements of construction defined by the applicable Code(s) of Record (CoR) as defined by the project Requirements Criteria Document (RCD) and/or Scope of Work (SoW).

B. Submit listing of design codes and standards committing to follow for LANL review and approval no later than the 15% design maturity point.

C. Structures, systems, and components (SSCs) and equipment shall be designed in accordance with the 2015 International Building Code (IBC) and the codes and standards listed as references in the IBC for the applicable risk category (RC)

structure as modified by ESM Chapter 16 Section IBC-GEN Attachment A LANL Building Code (LBC).

D. Follow all applicable consensus codes and standards.

E. Existing SSC modifications shall follow the 2015 International Existing Building Code (IEBC) as amended by ESM Chapter 16 Section IBC-GEN Attachment B LANL Existing Building Code (LEBC).

F. Deviation from this document requires LANL Standards Program approval per ESM Chapter 1 Section Z10.

## 8.0 SITE SPECIFICS

A. Elevation

1. Nominal = 7,500 ft
2. Range = 6,250 – 7,780 ft (depending on specific location)

B. Latitude: 35.9 deg N, Longitude 106.3 deg W (TA-6 weather station)

C. Barometric Pressure (avg): 11.10 psia (22.65 inches Hg).

D. Air Density (7,500 feet): I-P: 0.057 pounds/cubic foot (0.075 pcf at standard air)

1. S-I: 0.00091 g/cm$^3$ (0.0012 at standard air/sea level)

E. Air Density Ratio: 0.075/0.057 = 1.32 (reciprocal = 0.76)

**Note:** Exceptions to the above (where altitude and the other data must be corrected to actual) are contained in ESM Chapter 1 Section Z10.

## 9.0 COMPLETE DESIGN

A. The design agency is responsible for a complete, coordinated design package; this includes but is not limited to:

1. Drawings or sketches (a) consistent with calculation results, (b) consistent with other discipline drawings, and (c) that are coordinated with the Specifications.
   a. Designs shall document final design inputs (including IEBC Alt Level if applicable) and fire ratings of any walls being penetrated.
   b. Drawings, when required, shall be completed in accordance with the *LANL CAD Standards Manual*, STD-342-300.
2. A CSI-format specification book must be created for the project by combining multiple specification sections.
3. Design package shall be up to date, technically correct, without repetition or conflict internally nor with construction subcontract pro forma (general conditions, etc.) and meeting all imposed and derived design inputs (and any approved changes).

4. Design Agency must perform required internal checking and verification reviews in accordance with their QA plan prior to submitting to LANL reviewers. Externally produced design will be reviewed by LANL in accordance with AP-341-620, *Review and Verification of Design Documents*; Design Agency must resolve comments to satisfy that Administrative Procedure (AP).
5. Submit design deliverables per review schedule provided by LANL.

## 10.0 PROJECT FILES — GENERAL

A. The project shall produce and deliver electronic files that include all information important to the accomplishment of the design for the entire lifecycle of the design, procurement, and construction, testing/startup, and commissioning.

B. Electronic files shall have optical character recognition (OCR) functionality which allows content searching. Non-electronic deliverables are only allowed when electronic is impossible (e.g., samples, mockups, prototypes, spare parts).

C. Document design by a set of calculations, drawings and/or sketches, and design/evaluation criteria commensurate with project scope that demonstrate the design is both safe and cost effective. When the design is complete, there must be a historical record showing how the design progressed and reasons for changes.

D. The project file shall include design review records, submittals, changes, and test and inspection results. It should also include significant written correspondence, summary of significant telephone calls, design and design-evaluation criteria whether furnished by LANL or designer-generated and working notes.

E. The Design Agency is responsible for producing and delivering the complete project file as described above; however, when LANL directs the use of LANL document control services to (1) manage reviews (e.g., of submittals) or (2) maintain official versions of drawings, documents, and/or records, the Design Agency need not maintain duplicative records of these records—and shall not deliver same (to prevent duplication/confusion). See also Project Closeout topic at end of this chapter.

## 11.0 CALCULATIONS

A. Prepare design calculations to document analytical determinations in accordance with the Design Agency's processes. Room numbers, equipment nomenclature, fixture numbers, zone numbers, or any other designations must be consistent with those indicated on the drawings or in the specifications. Calculations must be checked, reviewed, sealed when required, signed, and dated by the designer and the checker, complete in all respects and must reflect the basis for selection of systems and components. For Design Agents who do not have formal calculation procedures acceptable to LANL, calculations must be prepared in accordance with LANL AP-341-605, *Calculations*.

B. Calculations shall be performed, numbered,and approved in a consistent format and shall include, at a minimum, sections for Purpose, Methodology, Acceptance

Criteria, Unverified Assumptions, Assumptions, Limitations, Calculation Inputs, Computer Hardware and Software, Summary and Conclusions, References, and Calculations. Include notes/comments that strengthen the design coherence and communicate intent. Note references (source) for unusual formulas or methods of analysis, including edition of the reference and page number. Clearly label all variables and constants with the appropriate engineering units. Provide copies of tabulated data used.

C. Neatly arrange sketches, input, output, and other material pertinent to the analysis and use 8½ × 11-inch sheets, where practical, and include in the complete analysis presentation.

D. Submit calculations to LANL for review and acceptance as requested or required. This approval does not relieve the designer of any responsibility for correctness and coordination with the drawings and specifications.

E. The calculations will become record calculations for LANL and may be used in the future for modifications.

F. Hand calculations may be scanned by LANL. For this reason, calculations must be printed clearly and with sufficient darkness and contrast to ensure clarity. Index calculations in a logical order and include adequate sketches to allow an engineer to follow and comprehend them easily.

## 12.0 PROJECT DOCUMENT LIST (PDL)

A. Project Document List (PDL): Unless waived by LANL (e.g., IPT), the Design Agency shall produce and deliver an index of all project drawings, calculations, trade study reports, and other documents during the project and finalizing at close-out.

*Guidance: Include design outputs and other deliverables (including revision and date). Projects using LANL's design review tool may employ other means to accomplish document control (and transfer-to-EDRMS functions).*

## 13.0 PROFESSIONAL ENGINEER SEALING (STAMPING)

A. Comply with the New Mexico Engineering and Surveying Practice Act (Chapter 61, Article 23 NMSA 1978) and NMAC 16.39 (especially 16.39.3.12) and the Architectural Act (Article 15 NMSA 1978). Outputs prepared by non-LANL engineers, consultants, and contractors (i.e., Subcontractors) that are involved in the practice of engineering must bear the seal (stamp) and signature of a professional engineer (PE), currently licensed in New Mexico, in responsible charge and directly responsible for the engineering work.

B. PEs shall only practice and seal for those disciplines for which they have qualified as a competency with the NM Licensure Board (which may be reflect on their website in the future). The LANL Site Chief Engineer, Building Official, and ES-EPD discipline leads may waive this requirement based on significant demonstrated experience and competency (via variance or memo to project file).

## 14.0 EQUIPMENT LOCATION/DESIGN

A. Maintenance: Active mechanical, electrical, controls, and similar equipment must be accessible for inspection, service, repair, and replacement without removing permanent construction or necessitating abnormal or unsafe action (e.g., crawling on ducts, piping, conduit, or cable trays).

B. Outside: Select sites carefully when locating equipment on grade. Ensure that factors such as snow accumulation and drift, ice, windy areas, rainwater from roof overhangs, etc., do not affect equipment performance and maintenance. *Avoid locations on the north side of the building.*

C. Roofs: Locate equipment a minimum of 10 feet from the edge of roof or inside face of parapet whenever practicable. If the distance is less than 10 feet, specify a 42-inch-high restraint, e.g., guard rails, parapet, screen wall, etc., to provide fall prevention.

## 15.0 ITEM NUMBERING AND LABELING; PROJECT EQUIPMENT LIST (PEL)

A. Projects must develop an equipment/component listing as a turnover document. LANL transforms the PEL to the Master Equipment List (MEL) for the operating facility.

B. PELs must follow applicable ESM Chapter 1 Section 200 – Item Numbering and Labeling requirements (include all required SSCs, mandated item naming/labeling syntax and names & acronyms for systems and items, use of Upload Workbook, data, etc.) so that PEL-to-MEL manipulation and upload to CMMS is seamless.

C. Design Agency shall initiate the PEL. PEL shall include all items specified by the design with fields populated with all information known at the point of final design completion. The Design Agency shall transmit the PEL to LANL.

D. The Constructor, unless otherwise stated in the Subcontract Documents, is responsible for populating the remainder of the Design Agency-created PEL workbook (Attachment 1: CMMS Upload Workbook [xls]) with the actual SSCs selected and accepted for Engineer of Record (EOR) review as submittals under the related specifications. Once complete the PEL shall be provided as a submittal to the EOR. The LANL FDAR and system engineer or designee will incorporate the worksheet and upload into CMMS MEL.

## 16.0 SPECIFICATIONS (DIV 01)

A. Comply with the provisions of the following LANL Master Specifications (online here):

| | |
|---|---|
| 01 1117 | *Work by Owner–Self Perform*[3] |
| 01 2500 | *Substitution Procedures* |
| 01 3300 | *Submittal Procedures*[4] |

[3] Generally needed since LANL will do tie-ins, final security work, etc.
[4] Interpret LMS 01 3300 statement "all submittals required by all the LANL Master Specifications" to mean only those required by this TSM document and those used electively by Project.

| | |
|---|---|
| 01 3545 | *Water Discharge Requirements* |
| 01 4000 | *Quality Requirements – Non-nuclear* |
| 01 4216 | *Definitions* |
| 01 4731 | *Flange Assembly for B31 Systems* |
| 01 5705 | *Temporary Controls and Compliance Requirements* |
| 01 6000 | *Product Requirements* |
| 01 7700 | *Closeout Procedures* |
| 01 7823 | *Operation and Maintenance Data* |
| 01 7839 | *Project Record Documents* |
| 01 8113.13 | *Sustainable Design* |
| 01 8734 | *Seismic Qualification of Nonstructural Components (IBC)* |
| 01 9100 | *Commissioning* |

## 17.0 PROJECT CLOSEOUT

A. Final project record documents shall include the incorporation of LANL-approved interim changes (e.g., field change requests (FCRs) design revision notices (DRNs), redlining when allowed or required (e.g., design-build team internal process), and discovered differences (e.g., from walkdowns) in the native software (e.g., AutoCAD) and in PDF, and signed by Design Agency. Ref. LANL Master Spec Section 01 7839 Project Record Documents. *Design Agency encouraged to walk down the work.*

1. For calculations, Design Agency shall as built/finalize those that contained non-bounding (non-conservative) assumptions and provide matrix tabulating how such assumptions were verified.

2. Interim change (e.g., FCR) incorporation is not necessary for: demolition plans that become moot; vendor data; QA records; informal isometric sketches for piping installation; temporary bracing plans for formwork or erection.

B. As-built (A-B) drawings: These are a subset of project record documents. A-B drawings accurately reflect the final condition ascertained by LANL walk down and are only produced for the most critical documents (see Definitions). LANL will utilize record drawing drafts (produced per direction above), walk them down, and deliver any additional changes to Design Agency or other Final Document Creator shown in Table 1-1 to produce the as built. *Design Agency also encouraged to walk down the work*.

1. When “Final Document Creator” incorporates redlines from Verifier walkdown and add “as-built with (or without) changes” — and by whom verified — to the document record of revision, provide for LANL for review, and re-issue. (ref. CAD Std Manual Section 100 for details).

   *Guidance: LANL A-B walkdowns are appropriate for all “Priority” and “Support” documents which are generally those necessary for safe operation. Most are captured by the categories shown in the table below.*

*(This is generally under 10% of the total for nuclear and, for non-nuclear, only a handful of drawings). See A-B in Definitions.*

Table 1-1. LANL Roles in As Built by Doc Category

| Doc Category | Doc Types | Typical LANL Verifier | Final Doc Creator |
|---|---|---|---|
| **Where Final Document Creator is Typically Not LANL** | | | |
| Building automation system (non-nuclear facility HVAC) | Shop drawings, programming | I&C engineering or delegate (*ES-EPD*) | Constructor (e.g., delegated design/build sub tier) |
| Fire protection<br>1. Fire Area Boundary Drawings<br>2. Fire Barrier Penetrations Database<br>3. Fire Suppression P&IDs, Details and Schedules, and Sequence of Operation / I&C Diagrams<br>4. Sprinkler System Hydraulic Calculation(s)<br>5. Location Drawings of Underground Water Mains and Control Valves, Hydrants, and Fire Department Connections<br>6. Fire alarm system diagrams and programming | Calcs, drawings, shop drawings, specs, FACP programming | Field Eng, Building Insp, or FP per Div. of Responsibility | Constructor (e.g., delegated design/build sub tier) |
| System and Facility Design Descriptions | SDDs, FDD | System Eng or others | Author of latest approved version (Design Agency is default) |
| All other drawings required to be A-B by FDAR and not shown above, typically including P&IDs, electrical one-lines and panel schedules, other *Priority* and *Support* documents. | Drawings: specs (unless waived by FDAR) | Field Engineer or Building Inspector | Design Agency |
| **Where LANL Performs all Roles** | | | |
| Floor Plan of Record (FPR) | Drawing per ESM Ch. 4 GEN and CAD Standards Manual | IFPROG | |
| Emergency Evacuation Diagram (where required; based on FPR) | same | ES-EPD, ES-UI, or others | |

C. At the completion of facility projects, transmit drawings, specifications, and other project records to LANL Document Control (*SI-DCRM*) in accordance with LANL Master Specifications Section 01 7839, *Project Record Documents* (or project-specific spec section with equivalent or superior requirements).

1. For drawings, follow additional requirements for transmittal in the LANL CAD Standards Manual.
2. Also follow any LANL project management (*internal*) on commissioning, turnover, acceptance, and closeout imposed by the Subcontract.
3. In addition to any hardcopy requirements, transmit all submittals electronically in native format (e.g., Word, AutoCAD, etc.) when that is available (pdf otherwise). PDF OCR requirements under Project Files heading above also apply here.

# CHAPTER 2 FIRE

## 1.0 CONSENSUS CODES AND STANDARDS

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On or about February 1st, 2023, LANL is adopting the 2021 edition of selected ICC-codes; Projects with a code of record (CoR) date after that point shall apply the 2021 editions for the following codes referenced within this document*: International Building Code (IBC), International Existing Building Code (IEBC), International Fire Code (IFC).* Questions regarding code and standard year compliance should be directed to the ESM discipline chapter point of contact (POC).

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A. Follow requirements of DOE documents in Chapter 1, *General* and codes and standards referenced therein.

B. Comply with the IBC and all applicable NFPA codes and standards.

C. Where multiple codes and standards overlap, comply with the most stringent unless dictated otherwise by the LANL Fire Protection Office (FP).

D. This document does not document all possible requirements and criteria for projects, including when to provide automatic sprinklers. The designer is responsible for reviewing and implementing the requirements of applicable codes and standards.

E. To clarify applicability for LANL specifically, the design shall comply with the following editions of codes and standards*:

- International Fire Code (IFC) – 2015 Edition (2021 Edition effective 02/01/2023)
- NFPA 1, *Fire Code* – 2015 Edition (2021 Edition effective 02/01/2023)
- NFPA 10, *Standard for Portable Fire Extinguishers* – 2013 Edition (2018 Edition effective 02/01/2023)
- NFPA 13, *Standard for the Installation of Sprinkler Systems* – 2016 Edition (2019 Edition effective 02/01/2023)
- NFPA 14, *Standard for the Installation of Stationary Pumps and Fire Protection* – 2016 Edition (2019 Edition effective 02/01/2023)
- NFPA 72, *National Fire Alarm and Signaling Code* – 2016 Edition (2019 Edition effective 02/01/2023)
- NFPA 80, *Standard for Fire Doors and Other Opening Protectives* – 2016 Edition (2019 Edition effective 02/01/2023)
- NFPA 80A, *Recommended Practice for Protection of Buildings from Exterior Fire Exposures* – 2017 Edition (2022 Edition effective 02/01/2023)
- NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems* – 2018 Edition (2021 Edition effective 02/01/2023)
- NFPA 101, *Life Safety Code* – 2015 Edition (2021 Edition effective 02/01/2023)

- NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls* – 2015 Edition (2021 Edition effective 02/01/2023)
- NFPA 780, *Standard for the Installation of Lightning Protection Systems* – Current Edition
- NFPA 1144, *Standard for Reducing Structure Ignition Hazards from Wildland Fire* – 2018 Edition
- FM Global Property Loss Prevention Data Sheet 5-4, *Transformers* (latest edition)

* The applicable codes and standards may not be limited to those in this list. Confirm with LANL Fire Protection Group regarding editions to be used for other NFPA codes and standards.

† LANL requires compliance with the requirements of NFPA standards in addition to IBC and IFC requirements. NFPA 90A requirements apply in lieu of those of the IBC and Uniform Mechanical Code (UMC) regarding fire protection of air-conditioning and ventilating systems.

## 2.0 AUTHORITY HAVING JURISDICTION

A. The LANL Fire Marshal, typically the Group Leader of the LANL Fire Protection Office (FP) serves as the technical authority for fire protection and life-safety related DOE Orders, and codes and standards as delegated by the DOE/NNSA Los Alamos Field Office.

B. Where codes and standards refer to the Fire Code Official (International Fire Code) or Authority Having Jurisdiction (NFPA), at LANL it is the LANL Fire Marshal.

C. LANL FP serves as the LANL Fire Marshal designee as assigned by the LANL Fire Marshal.

D. LANL FP determines the level of fire protection required for LANL facilities and projects with respect to highly protected risk (HPR) criteria. Replacement value, mission importance, and other factors provided by the project determine the HPR criteria.

E. The design of fire department access roadways; marking of fire lanes; locations of fire department connections (FDCs) and test headers; location of fire alarm control panels; location of riser/pump rooms; type of sprinkler, extinguishing, and standpipe systems; and other emergency functions and fire protection systems are subject to LANL Fire Marshal approval.

## 3.0 DESIGN AND DESIGN DOCUMENTATION

Developing an effective fire protection design and maintaining an effective fire protection program at a new or modified facility requires consideration of a variety of fire protection topics at an early stage of any project, and oversight by a qualified fire protection engineer. *These considerations should be continually revisited throughout the project with increasing attention to detail until the project is completed.*

A. Fire protection features may include, but are not limited to:

1. Fire department access roadways, physical access, and equipment for fire department intervention.
2. Water supply and distribution for manual firefighting and fire suppression.
3. Life safety and means of egress per IBC and NFPA 101.
4. Fire-resistance rated construction and barriers to isolate hazards, protect vertical openings, and maintain availability of the means of egress.
5. Automatic sprinkler systems design and installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, and as modified within this Section.
6. Standpipe systems in accordance with NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, where required by the IFC, NFPA 101, or DOE-STD-1066.
7. Fire detection and alarm systems in accordance with NFPA 72, *National Fire Alarm and Signaling Code*, and as modified within this Section.
8. Audible and visual signaling for building occupants, and emergency responder notification.
9. Special fire extinguishing systems for unique hazards or occupancies in accordance with the applicable NFPA standard.

B. All new facilities and major modifications to existing facilities shall prepare a fire protection design analysis (FPDA) to document compliance with the applicable fire protection and life safety requirements and criteria.

1. The FPDA shall be prepared by a qualified fire protection engineer.
2. Prepare the FPDA early in the preliminary or conceptual design phase.
3. Discuss the following minimum fire protection provisions (include required versus provided):
    a. Building code analysis (i.e., type of construction, height and area limitations, and building separation or exposure protection).
    b. Classification of occupancy and alteration/work category.
    c. Analysis of highly-protected-risk (HPR) criteria described in DOE-STD-1066, detailing DOE recommendations and other risk guidelines that must be applied.
    d. Requirements for fire-rated walls, fire-rated doors, fire dampers with their fire-resistive ratings, smoke compartmentation, smoke barriers.
    e. Means of egress in accordance with NFPA 101, *Life Safety Code* and the IBC (occupant loads, exit capacities, etc.).
    f. Analysis of automatic sprinkler systems and other suppression systems and protected areas, including hydraulic analysis of required water demand.

g. Water supplies, water distribution, location of fire hydrants, including hydraulic analysis of the required water supply and manual fire flow.

h. Smoke control methods and smoke control systems.

i. Fire alarm system (the type of alarm system and location of major equipment).

j. Fire detection system (the type of detection system and coverage areas).

k. Standpipe systems and fire extinguishers.

l. Interior finish ratings and materials of construction.

m. Connection to and description of fire alarm supervising system.

n. Identify the various occupancies and hazardous areas associated with the facility.

o. Coordination with security requirements.

p. Fire department access.

q. Draft analysis of unresolvable deficiencies or code conflicts (IBC versus NFPA), variances, or alternate methods requiring a request for relief (NNSA Field Office disposition, or equivalency or exemption request).

C. Specifications shall be provided, based on the LANL Master Specifications, and modified appropriately for the project.

1. Use the applicable LANL Master Specification section in Division 21 for the type of sprinkler system to be installed. They contain standardized equipment and installation practices.

2. Use LANL Master Specification 28 4600 for fire alarm system installations. It contains standardized equipment and installation practices.

D. Calculations per the applicable NFPA standard shall be provided to support the fire protection design, including but not limited to:

1. Water supply analysis and hydraulic calculations to determine available and adequate water supply and distribution for firefighting and fire suppression.

2. Preliminary and detailed hydraulic calculations for automatic sprinkler systems and other fire suppression systems.

3. Occupant load and egress capacity calculations.

4. Emergency lighting levels.

5. Battery load, voltage drop, and line resistance calculations for fire alarm systems.

6. Supporting calculations for special hazard, smoke removal, and other fire protection systems.

E. Fire protection drawings shall be provided to support the fire protection detailed design (shop drawings), including but not limited to:

1. Code analysis, including occupancy/hazard classification, level of alteration/rehabilitation, height and area, fire resistance rating, means of egress, sprinkler and suppression, fire alarm and detection, vertical openings, opening protectives, fire exposures and fire separation distance, and other relevant details.

2. Life safety drawings detailing occupancy classification, occupant loads, egress capacity, travel distances, areas of emergency lighting coverage, fire and smoke barriers and partitions, opening protectives, firestopping, fire-resistant joints, fire extinguishers, and other relevant details.

3. Site compliance plans detailing fire department access roadways, fire lane marking, fire department connections, Knox boxes, hydrant and post indicator valve location and spacing, hose pull lengths from hydrants and roadways around building perimeter, and other relevant details.

4. Fire protection drawings detailing the desired fire suppression (sprinkler) system, performance requirements, preliminary plans, and supporting information and analyses for the detailed design (i.e., shop drawings), which is typically delegated and deferred. Detailed designs (i.e., shop drawings) shall comply with NFPA 13.

5. Fire alarm drawings detailing the desired fire alarm and fire detection system desired, preliminary plans, performance requirements, and supporting information and analyses for the detailed design (i.e., shop drawings), which is typically delegated and deferred. Detailed designs shall comply with NFPA 72, including Section 7.2 Minimum Required Documentation and 7.4 Shop Drawings (Installation Documentation).

6. Other documentation as required for special hazards and systems, non-standard conditions, alternative means of compliance, etc. to support the fire protection design.

F. Fire sprinkler and fire alarm system detailed designs (shop drawings) shall bear a stamp of a professional engineer registered in the state of New Mexico, unless approved otherwise by the LANL Fire Marshal.

G. Fire protection and life safety features, devices, and criteria shall be included in all other discipline drawings to clearly demonstrate compliance and coordinate different structures, systems, components, and trades.

## 4.0 BUILDING CONSTRUCTION

A. Construction type shall be noncombustible, at a minimum IBC Type II-B / NFPA 220 Type II (000), except buildings under 5,000 square feet with LANL FP approval.

B. Fire barriers shall be provided to protect vertical openings, the means of egress, separate occupancies, create control areas, limit property loss, protect from

exposure hazards, separate hazardous areas; as required by the IBC, NFPA 101, DOE O 420.1C, DOE-STD-1066, and other codes and standards.

C. Fire-resistance and smoke leakage rated assemblies (e.g., fire walls, barriers, and partitions) and smoke barriers and partitions shall be labeled above removable ceilings; below raised floors; and in mechanical, electrical, and similar spaces not normally occupied.

D. Openings, penetrations, and joints in fire-resistance and smoke-leakage resistance assemblies shall be protected with an appropriate listed assembly or system to maintain continuity and the rating. Obtain engineering judgments for configurations and conditions for which no listed assembly or system exists. Alternative means of firestopping provided in the IBC, and NFPA codes and standards are permitted.

E. Provide protection from exposure hazards:

1. Comply with NFPA 80A, Recommended Practice for Protection of Buildings from Exterior Fire Exposures, in addition to IBC requirements.

2. Comply with NFPA 1144*, Standard for Reducing Structure Ignition Hazards from Wildland Fire*. As a minimum, a 10-foot-wide space around buildings shall be maintained clear of all trees. In more heavily forested areas, a 50-foot-wide space around buildings shall be maintained clear of trees (several isolated trees may be acceptable), and the next 50 feet beyond shall be thinned. In less heavily forested areas, less clearing/thinning may be acceptable. Consult LANL Fire Marshal for guidance.

3. Provide lightning protection systems in accordance with NFPA 780*, Standard for the Installation of Lightning Protection Systems*; UL 96A, *Installation Requirements for Lightning Protection Systems*; and Lighting Protection Institute (LPI) Standard LPI-175, *Standard for the Design – Installation – Inspection of Lightning Protection Systems*, when determined to be required by a risk assessment in accordance with NFPA 780. *See NFPA 780 Appendix L for guidance on the risk assessment.*

4. Separate oil-filled transformers from the facility as required by NFPA 70*, National Electric Code*; and FM Datasheet 5-4, *Transformers*.

## 5.0 FIRE WATER SUPPLY AND FIRE SERVICE FEATURES

A. Fire protection water supply distribution systems and associated appurtenances shall comply with NFPA 24. Combined fire protection and potable/domestic water supply distribution systems shall also comply with the applicable AWWA standards.

B. Fire protection water supplies shall be designed to provide minimum manual fire flow and the most demanding fire suppression flow and pressure, non-concurrently.

C. Fire protection water service from a combined water supply source shall enter the building and be controlled separately from potable/domestic water.

D. Fire hydrants, fire department connections, test headers, hose valves, and similar hose connections shall be National Hose (NH) thread.

E. Fire hydrants shall:

1. Be provided to meet spacing and fire flow demands in accordance with the IFC and NFPA 1;
2. Be three-way with two 2-1/2” diameter outlets and one diameter 4-1/2” outlet;
3. Be no closer than 40 feet from the facility’s exterior walls;
4. Be provided in number at minimum two to a building with hose runs from hydrants to not exceed 300 feet to all exterior portions of the facility;
5. Be provided (at least one) not more than 150 feet from the fire department connection; and
6. Be on a branch piping not more than 300 feet long.

F. Fire department access roads shall:

1. Have a minimum inside turning radius of 30 feet, a minimum outside turning radius of 50 feet, and support a fire apparatus with a total weight of 83,500 pounds and an axle weight of 63,000 pounds.
2. Be a paved, all-weather surface, unless approved otherwise by the LANL Fire Marshal.
3. Be marked as fire lanes within vehicle parking lots, along alleys or roadways that are not designated or marked as a LANL street or road, within 15 feet of a fire hydrant or fire department connection; and other locations where required by the LANL Fire Marshal.

G. Fire lanes shall be marked on both sides with signs, curb markings, and/or road surface markings. The designer shall consult with the LANL Fire Marshal regarding acceptable means and methods.

## 6.0 AUTOMATIC SPRINKLERS, STANDPIPES, AND OTHER WATER-BASED SYSTEMS

A. Automatic sprinklers shall be provided when required by the applicable codes and standards, and for all facilities greater than $5.9M in maximum possible fire loss (MPFL) or 5,000 square feet in area. The LANL Fire Marshal may require a fire suppression system when warranted by significant life safety hazards or other concerns.

B. Design:

1. All systems shall be hydraulically designed.
2. Use of Light Hazard occupancy protection criteria requires LANL pre-approval, including a determination agreeing that the use or occupancy of the facility is unlikely to change in the future.
3. The minimum design area shall be 1,500 $ft^2$ (no area reduction allowed when using quick-/fast-response sprinklers).

4. Provide a minimum hose stream allowance of 250 gpm, unless NFPA 13 specifies a greater quantity for the specified protected hazard or occupancy.
5. Hydraulic calculations shall include a design pressure margin of 10% or 10 psi, whichever is greater.
6. For sprinkler system seismic bracing calculations, use a seismic coefficient, $C_p$, of 0.52; except for TA-50/55 where 0.42 may be used if desired.
7. The classification of the standpipe system and proposed configuration shall be approved by the FP Office in consultation with the Los Alamos Fire Department.
8. A hydrant flow test can be requested via a LANL Facility Service Request for Utilities and Infrastructure (UI) and the Fire Protection Office.

C. Detailed design drawings (i.e., shop drawings, installation drawings), shall be prepared by a fire protection technician, at a minimum, NICET Level III certified in Water-Based Systems Layout.

D. The drawings shall be stamped by P.E. registered in the State of New Mexico, unless LANL determines otherwise.

E. Title II (i.e., architectural-engineering preceding construction start) design drawings for automatic sprinkler and other water-based systems shall, at a minimum, include:

1. Types of automatic sprinkler, standpipe, and other systems to be provided.
2. Hazard classification, commodity classification, discharge density, and other performance criteria of the systems.
3. Fire water service, system riser, control valve, test header, and fire department connection locations.
4. Preliminary system design at hydraulically remote locations, with risers and mains to support preliminary hydraulic calculations.
5. Locations exempt from fire sprinkler coverage.
6. Exterior areas to be provided with fire sprinklers.
7. Means of freeze protection, when required.
8. Interfaces with other systems (e.g., fire alarm).
9. Ceiling elevations and ceiling features, structural members, large ducts, unit heaters, skylights, and other features potentially impacting the design of the sprinkler system.

F. Reduced-pressure backflow prevention is required for sprinkler risers when fire protection water supply is from a combined domestic and fire protection water supply systems. A drain shall be provided to direct nuisance flows to a sanitary floor drain and catastrophic releases to the exterior of the building.

G. For forward flow testing of backflow preventers, provide a test header on the exterior of the facility.

H. Sprinkler and standpipe system risers shall be located adjacent to exterior walls. Provide minimum clearances around system riser alarm valves of 12 inches rear, 20 inches sides, and 36 inches front.

I. The top of the alarm valve shall be no higher than 72 inches above the finished floor.

J. Provide dry-type sprinkler heads instead of dry-pipe, anti-freeze, or heat-tracing, whenever possible. Anti-freeze subsystems shall utilize Tyco LFP anti-freeze solution.

K. Provide isolation valves on fire sprinkler supply lines serving elevator hoist ways, elevator machine rooms, computer rooms, and similar special protection areas. Electrically supervise isolation valves for automatic sprinkler, standpipe, and other suppression systems; including post indicator valves and alarm trim isolation valves. Provide waterflow switches for detached or remote portions of the facility, not accessible from the interior. Valves shall be accessible from the finished floor without use of a ladder or other equipment.

L. Sprinkler system air vents shall be vented to the exterior of buildings or sanitary drain, unless equipped with an automatic shutoff. An inspector's test valve may be used with the approval of the LANL Fire Marshal.

M. Use of quick-/fast-response sprinklers requires approval of the LANL Fire Marshal.

N. LANL has standardized on manufacturer and model of fire suppression system monitoring devices and equipment for the purposes of life-cycle maintenance, spare parts management, and technician training and qualification; as follows:

1. Potter Model PS10 Pressure Waterflow Switch
2. Potter Model WFSP-F Pressure Activated Waterflow Alarm Switch with Retard
3. Potter PS40 High/Low Supervisory Air Switch
4. Potter BVS Supervised Ball Valve
5. Potter Electric Model VSR
6. Potter Model PAV Automatic Air Vent or Potter Model PAAR Automatic Air Vent with Drip Pan
7. FEBCO Mode LF880V Backflow Preventer or Wilkins Model 475V Backflow Preventer

O. Water discharges shall be dechlorinated prior to entry into storm systems or the surrounding environment.

*Guidance: For modifications to existing automatic sprinkler systems, an in-service (working pressure) leakage test is acceptable when the modified portions cannot be easily isolated from the remainder of the system; e.g., relocation of*

*sprinkler heads by modification of arm-overs or drops, or installation of additional sprinkler heads because of obstructions or new walls; regardless of the number of sprinkler heads affected. This work is typically performed with the entire sprinkler system or floor zone drained during a few workdays. Extensive modifications such as additions/extensions to the system, complete rework or reconfiguration of portions of the system, and similar that is most effectively performed with the work area isolated from the remainder of the system by an air gap, blank, or valve and tied-in once complete; and affects more than 22 sprinkler heads (new, removed, or relocated) shall be hydrostatically tested in accordance with NFPA 13 requirements.*

## 7.0 FIRE ALARM AND DETECTION SYSTEMS

A. All facilities shall have a means to summon emergency services in the event of a fire or other emergency. Unless approved otherwise by the LANL Fire Marshal, at a minimum this shall be a manual fire alarm pull station. All fire alarm systems shall report to the LANL Proprietary Supervising Station via fire alarm control panel with a Digital Alarm Communication Transmitter (DACT). The DACT connected by three CAT 5E telecommunication cables that shall be run from the DACT location to the telecommunications service entrance room in the building.

B. Fire alarm systems and fire detection systems shall be provided when required by the applicable codes and standards. Fire alarm systems shall be provided when automatic sprinkler systems, or other fire protection systems or emergency control functions are provided, for monitoring and supervision.

C. Documentation shall be provided for fire alarm designs, installation, and testing. Comply with NFPA 72 Section 7.2 Minimum Require Documentation, 7.3 Design (Layout) Documentation, 7.4 Shop Drawings (Installation Documentation), and 7.5 Completion Documentation.

D. Detailed design drawings (i.e., shop drawings, installation drawings), shall be prepared by a fire protection technician, at a minimum, NICET Level III certified in Fire Alarm Systems. The drawings shall be stamped by P.E. registered in the State of New Mexico, unless LANL determines otherwise.

E. Title II (i.e., architectural engineering) drawings for fire alarm shall, at a minimum, include:

1. Fire alarm control panel, NAC panel, and annunciator locations.
2. HVAC control equipment/panels requiring equipment shutdown.
3. Fire/smoke or smoke dampers.
4. Fire doors with hold-open devices to be released in an alarm event.
5. Elevator interface.
6. Location of fire suppression isolation valves.
7. Any other emergency interfaces (e.g., lighting controller, door access control, etc.).

8. Ceiling height and features, structural members, proposed equipment and furniture layout, and other features impacting device layout.
9. One-line diagram showing schematic system configuration.
10. Preliminary input/output sequence of operation matrix.

F. Fire alarm control panels and associated components shall be an addressable EST or Notifier model. LANL has standardized on manufacturer (EST or Notifier) and equipment for facility fire alarm systems and reporting to the LANL site-wide fire alarm monitoring system as specified within LANL Master Specification 28 4600, *Fire Detection and Alarm*, for the purposes of life-cycle maintenance, spare parts management, and technician training and qualification.

G. Locate the fire alarm control unit in a temperature and humidity-controlled area at the main entrance to the building.

H. Provide 20% capacity on notification appliance voltage drop calculations to allow for future additions. Provide backup battery capacity to provide 24 hours of normal FACP operation followed by 10 minutes (as opposed to 5 minutes per NFPA 72) of system operation in full alarm mode. Provide 50% spare backup battery capacity (as opposed to 20% per NFPA 72) within calculations.

I. Fire alarm control panels shall have an LED annunciator/switch card providing the ability to disable emergency control functions, individually, and notification appliance.

J. Provide surge suppression devices in fire alarm power, initiating device, and notification appliance circuits entering or leaving a facility (due to frequent lightning activity), as described within LANL Master Specification 28 4600. Surge suppression devices shall be readily accessible from the finished floor level.

K. Provide manual transfer switch and capability for hook-up of portable generator in the normal power circuit for fire alarm control panels and remote power supply panels, as described in LANL Master Specification 28 4600.

L. Provide a standard 110VAC power outlet within 6 ft of the FACP to support connection of a laptop computer for fire alarm testing and troubleshooting purposes.

M. Fire alarm systems, when provided, shall be full feature, including manual pull stations at every exit door, occupant notification, emergency services notification, visual signaling in common areas, and supervision via tamper switches of all suppression system isolation valves.

N. SLC, NAC, and IDC circuits shall be Class B, unless noted otherwise, Network circuits between fire alarm control panels shall be Class A or X. NAC and SLC circuits shall be zoned to coincide with building outer walls, building fire or smoke compartment boundaries, floor separation, or other fire safety subdivisions. Zoning of circuits is subject to approval by the LANL Fire Marshal.

O. Conductors shall be no smaller than 16 AWG for fire alarm systems and 12 AWG for power. The installation shall provide standardized EMT/conduit color (red)

and wire/conductor colors for fire alarm system circuits and installation work, specified in LANL Master Specification 28 4600.

P. Manual fire alarm pull stations shall be double-action, key resettable, non-break-glass type.

Q. Provide horns or speakers for audible signaling. Public mode signaling is required in all occupiable areas, except bathrooms provided with strobes, stairwells, and elevator cars, where private mode signaling is permitted. Average ambient sound pressure levels shall be provided for all areas, based on use, occupancy, HVAC design, equipment, and other factors.

R. Visual signaling shall be provided in all public use and common areas (e.g., lobbies, restrooms, conference rooms, break areas, corridors, aisles), computer/server rooms, open offices will occupant loads of 10 or more, storage rooms over 500 square feet, mechanical equipment rooms and other locations with high ambient sound levels, and other locations specifically requested by LANL.

S. The fire alarm system shall be interfaced with emergency control functions for supervision, monitoring, and activation; including but not limited to elevator controls (per ASME A17.1 for Phase I and II operations), HVAC systems (per NFPA 75, 76, 90A, and others), fire doors and other opening protectives (per NFPA 80), lighting controllers or access control (per IBC and NFPA 101), and suppression system releasing/control panels. Elevator power shut trip shall be triggered by heat detectors in the elevator machine room and elevator hoist ways.

## CHAPTER 3 CIVIL

### 1.0 SITE SPECIFIC REQUIREMENTS

A. Geometric Relative Positioning Accuracy Standards for Three-Dimensional Surveys Using Space System Techniques

| Survey Categories | Order | (95% confidence level) Minimum geometric accuracy standard: Base Error e (cm) | Line-length Dependent Error p (ppm) | Line-length Dependent Error a (1:a) |
|---|---|---|---|---|
| Global-regional geodynamics; deformation measurements | AA | 0.3 | 0.011 | : 1000,000,000 |
| National Geodetic Reference System, “primary” networks; regional-local geodynamics; deformation measurements | A | 0.5 | 0.1 | : 10,000,000 |
| National Geodetic Reference System, “secondary” networks; connections to the “primary” NGRS network; local geodynamics; deformation measurements; high-precision engineering surveys | B | 0.8 | 1 | : 1,000,000 |
| National Geodetic Reference System, (Terrestrial based); dependent control surveys to meet mapping, land information, property, and engineering requirements | 1<br>2-I<br>2-II<br>3 | 1.0<br>2.0<br>3.0<br>5.0 | 10<br>20<br>50<br>100 | : 100,000<br>: 50,000<br>: 20,000<br>: 10,000 |
| **Note:** For ease of computation and understanding, it is assumed that the accuracy for each component of a vector baseline measurement is equal to the linear accuracy standard for a single-dimensional measurement at the 95% confidence level. Thus, the linear one-standard deviation(s) is computed by: $s = +/- = <e + (0.1dxp)_2 > / 1.96$ where **d** is the length of the baseline in kilometers. | | | | |

B. Coordinate the placement, number, and location of permanent survey monuments for horizontal and vertical control with and approved by the LANL Project Leader and LANL UI Infrastructure Information Team. Provide the location and description of the nearest permanent survey monument on construction drawings. Tie these monuments by Grid Bearing, ground distance and elevation to the New Mexico Coordinate System and referenced to NAD of 1983 and the NGVD of 1929.

C. Identify permanent survey monuments with a metal cap set in conformance with national Geodetic and New Mexico Survey Practice. Permanently stamp identification numbers into the metal cap.

D. Install two steel angle guard posts or bollards painted white adjacent to permanent survey monuments in high traffic areas to preclude vehicular damage. Do not remove permanent survey monuments without prior authorization from LANL U&IF Institutional and Facilities Group.

E. Establish a minimum of one permanent benchmark for vertical control in each new development area. Establish a minimum of three benchmarks if there are no existing benchmarks within a 3-mile radius of each new development area. Additional benchmarks may be established, as necessary. Benchmarks may coincide with permanent survey monuments or temporary control monuments.

F. Reference benchmark elevations to the NGVD of 1929.

G. Level section misclosures between fixed benchmark elevations shall equal or exceed Third Order Accuracy, as defined in FGCC Standards and Specifications for Geodetic Control Networks and shown below.

| **Accuracy Standards for Level Closures [5]** | | |
|---|---|---|
| **First Order*** | **Second Order#** | **Third Order*** |
| 0.017 ft. $M^{1/2}$ | 0.035 ft. $M^{1/2}$ | 0.05 ft. $M^{1/2}$ |
| *M is the distance in miles of the total level route running forward and back between fixed elevations or along a level loop. | | |

H. Surveys for Location of Existing Underground Utilities: Where exact routes of underground utilities are not defined within record drawings and such information is essential to subsequent design efforts, the surveyor shall coordinate necessary electronic line detection and exploratory excavation activities with the LANL's U&IF, UMAP. Locate such utilities by survey and document on the construction drawings.

I. Grading: Establish grades such that site drainage is away from all structural foundations and open utility excavations. Good engineering practice requires at least a one-half (0.5) foot drop in 10 feet away from the structure. In general, surface drainage systems are preferred over closed-conduit systems. Divert roof runoff away from exterior door openings and walkways. During design, consider the effect of water and wind erosion upon the altered drainage patterns adjacent to new structures. Design must give consideration to winter shade conditions, i.e., north sides of structures, and heavy vegetation. Take precautions to preclude the continuation or acceleration of soil erosion at the project site.

J. Earthwork: Natural soil shall not have a finished slope steeper than 2 horizontals to 1 vertical (2:1). Undisturbed volcanic tuff shall not have a finished slope steeper than 1 horizontal to 6 verticals (1:6).

K. Density, Moisture Content and Compaction

[5] Source: Standard and Specifications for Geodetic Control Networks, FGCC.

1. Density: Determine optimum density in accordance with ASTM D6938 or ASTM D1557. Determine field control of density of in-place material in accordance with the Nuclear Method (ASTM D6938) or the Laboratory Determination (ASTM D4253) for relative density of cohesion-less soil.
2. Moisture Content: Field control of moisture content shall be determined by the Nuclear Method (ASTM D6938) or the Laboratory Determination (ASTM D4253) for relative density of cohesion-less material.
3. Compaction: Comply with Table G1030-1 requirements for approved material, moistened to optimum conditions, and placed in layers not to exceed 8 inches before compaction.

**Table G1030-1, Compaction Requirements**

| % of Maximum Density | Type of Material |
|---|---|
| **95** | Structural fill, embankment, backfill, subgrade and base course under building floor slab, concrete sidewalks, and paved areas. |
| **90** | General area grading, backfill, and embankments not under paved area. |
| **90** | Sand bedding for underground utility system, except under roadways where density shall be 95%. |

L. Pavement design shall conform to the New Mexico Department of Transportation entitled Structural Design Guide for Flexible Pavement, NMDOT Bulletin 102.

M. Roadways (pavement structure designs) shall conform to AASHTO HS-20 Highway Loading. Any deviations for HS-20 Highway Loadings must be approved by LANL Utilities & Institutional Facilities Group.

N. Comply with the New Mexico Department of Transportation Standard Specifications for Highway and Bridge Construction including their latest modifications (supplemental specifications and special provisions).

O. Portland Cement Concrete Pavement: Use design criteria outlined within the New Mexico Department of Transportation Standard Specifications in the structural design of Portland Cement concrete pavements.

P. All temporary traffic control devices shall conform to the FWHA Manual on Uniform Traffic Control Devices (MUTCD), latest edition.

Q. Provide thrust blocks to restrain piping against movement; water service lines, sewer force mains, effluent force mains, etc. Refer to Civil Standard Detail ST-G30GEN-2, Thrust Blocks, for additional requirements.

R. For site civil and mechanical utilities, provide tracer wire in all non-metallic, cast iron, and ductile iron piping systems per LANL ST-G30GEN-3.

S. For site civil and mechanical utilities, provide 6-inch-wide, reinforced (non-metallic) color-coded identification tape 12 inches below finished grade and directly above buried pipe. Color coding shall conform to American Public Works Association (APWA) Uniform Color Code.

T. Facilities and structures shall not be sited within 10 feet of an existing or new utility.

U. Follow Table below for underground utility clearances.

**TABLE G30GEN-1**

**UNDERGROUND MINIMUM UTILITY LINE CLEARANCES [1]**

Dimensions are in inches as measured between the outside surfaces of the lines at the closest point

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Vertical Crossings[1]** | | | | | | | | | |
| Water (potable/fire protection) | 12 | | | | | | | | |
| Sanitary Sewer | 24[2] | 12 | | | | | | | |
| Force Main | 24 | 12 | 12 | | | | | | |
| Storm Drain | 12 | 12 | 12 | 12 | | | | | |
| Natural Gas | 24 | 24 | 24 | 24 | 24 | | | | |
| Steam or Hot Water[1] | 24 | 24 | 24 | 24 | 24 | 24 | | | |
| Open Telecommunications | 12 | 12 | 12 | 12 | 24 | 24 | 12 | | |
| RLW Lines | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | |
| Electrical (13.2 kV, 4160 V) | 24 | 24 | 24 | 24 | 24 | 24 | 12 | 24 | 12[3] |
| **Parallel Lines[1]** | | | | | | | | | |
| Water (potable/fire protection) | 24 | 120 | 120 | 60 | 60 | 60 | 36 | 60 | 36 |
| Sanitary Sewer (4” service) | | 24 | 36 | 24 | 60 | 60 | 36 | 60 | 36 |
| Sewer Mains and/or > 8’ Deep | | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 |
| Force Main | | | 36 | 24 | 60 | 60 | 36 | 60 | 36 |
| Storm Drain | | | | 24 | 60 | 60 | 36 | 60 | 36 |
| Natural Gas | | | | | 60 | 60 | 60 | 60 | 60 |
| Steam or Hot Water[1] | | | | | | 60 | 60 | 60 | 60 |
| Open Telecommunications | | | | | | | 12[1] | 60 | 24 |
| RLW Lines | | | | | | | | 24 | 60 |
| Electrical (13.2kV, 4160 V) | | | | | | | | | 12[3] |

**Notes:**

[1] Non-metallic piping shall have a minimum parallel clearance distance of 20 feet from steam or hot water lines; vertical crossings of steam or hot water lines with non-metallic piping are not permitted.

[2] Sewer below water line, if possible

[3] Alternatively, 3 inches if concrete encased

V. When sewer and water lines have a vertical crossing, the sewer line shall not have a joint within 10 feet of the water line. Concrete encase the sewer line within 10 feet of a water line when the sewer line passes over the water line.

W. Utility trenches: Bed piping with selected granular material to provide protection to the pipe. Bedding shall be installed around pipe both interior and exterior to building wall. Bottom of trench shall be graded to provide a smooth, flat bearing surface, free of ridges and valleys, to provide continuous support for the pipe. Do

not complete backfill for underground piping systems until the piping systems have been tested and approved. Specify the width of trenches for pipe and conduit to be not greater than noted in standard piping trench detail to permit satisfactory jointing and thorough tamping of the bedding. Excavate trenches 6 inches below the pipe invert and backfill to the pipe bottom with bedding material. After the pipe has been installed and all testing has been completed, backfill all around the pipe with 6 inches of sand and then with select backfill material, at optimum moisture content to the appropriate density in layers not exceeding 8 inches in loose depth. Take care to ensure thorough compaction of the fill under and around the full length of pipe and the full depth of the trench. On steeper slopes, approximately 2:1, when compaction is difficult, a flowable fill that will meet general structural requirements is acceptable; see LANL Master Specification 31 2323.33. Refer to LANL Master Specification 31 2000, *Earth Moving*; and Civil Standard Detail ST-G30GEN-4, Single Trench detail, for additional requirements.

X. Provide a minimum of 4 feet of cover for freeze protection on water lines (except irrigation systems with automatic drain valves) and sanitary sewer lines.

Y. Domestic water and fire sprinkler water systems water supply lead-ins shall not be run under buildings; risers shall be inside building within 3 feet of the exterior building wall. Refer to LANL Master Specification Section 33 1000, *Water Utilities*, for additional requirements.

Z. Fire Hydrants shall be provided in accordance with Chapter 2 Section 5.0 D and E unless otherwise approved by FP.

AA. All site and building drains connected to the sanitary sewer collection system shall have an approved Waste Profile Form (WPF) for discharge to the sanitary sewer for all anticipated wastewater. The WPF shall be submitted to the LANL STR or LANL MSS project coordinator and the UI wastewater representative prior to completion of system design. The LANL project team is responsible for working with the future tenant to generate the WPF and obtain approval.

BB. For sanitary sewer design, the population of the contributing area should be determined, and the design flows calculated to be 25 gallons per capita per day, minimum. Special facilities may require more sophisticated sanitary sewer design flow/volume calculations.

CC. Curvilinear sanitary sewers are not recommended and must be approved by the LANL UI FOD wastewater system representative.

DD. Steam and Condensate

1. For new buildings in TA-3 using the site steam distribution system, design for incoming supply temperature of 500° deg F and 125 psig. For the condensate return system design for 250° degrees F and 125 psig.
2. Cast iron is not permitted.

EE. Design natural gas system piping capacity based on 60 psig gas pressure; use 100 psig maximum operating pressure for pressure containment design.

## 2.0 STORM WATER MANAGEMENT AND COMPLIANCE

Storm water management design and implementation at LANL is subject to the Federal and State regulatory requirements listed and described below. Designs must be developed using local jurisdictional values (i.e., LANL rainfall data) and methodologies (i.e., runoff calculations). Follow VAR-10468, Revised Storm Water Material (posted to ESM Civil Chapter) which identifies these jurisdictional requirements.

## 3.0 MAINTAINABILITY

A. Construct exterior sidewalks, curbs, gutters, curb ramps, utility pads, drive pads, and all other concrete structures with air-entrained concrete, f'c = 4000 psi.

B. Roadway asphalt paving and parking lot paving shall consist of a minimum of 4 inches of a plant-produced hot-mix asphalt (HMA) on top of a minimum of 8 inches of aggregate base course on a prepared subbase.

## 4.0 OPERABILITY

A. Road Design

1. The minimum acceptable gradient consistent with proper drainage is 0.5%. Roads and driveway gradients shall not exceed 4%.
2. Due to local terrain and climatic conditions the maximum rate of super elevation shall not exceed 4% within LANL boundaries.
3. Roadways, driveways, parking lots, and pedestrian facilities shall optimize most available sun exposure for winter months.
4. Where unusual circumstances require the use of acute angles at road intersections, these angles shall not be less than 80 degrees.
5. Design intersections to pass a WB-50 design vehicle.
6. Provide 6-inch-high, barrier-type curb and gutter with 1-1/2 inch gutter depth for standard section. Use this curb and gutter section for all internal corridors, collectors, and internal roads within LANL boundaries. Reverse outflow gutter shall be used only with approval of LANL U&I FOD.

B. Provide parking areas with a maximum gradient of 5% and a minimum gradient of 1.00%.

C. Bumper blocks, guardrails, and other obstructions are not appropriate in parking lots due to snow removal concerns.

D. Exterior sidewalks shall be a minimum of 6 feet wide.

E. Sanitary sewer manholes

1. The distance between manholes for 6 to 21-inch sewers is 450 feet maximum in undeveloped areas and 300 feet maximum in urban areas.
2. Manholes are required for 6 inch and larger service connections to sewer mains.
3. Manhole depths shall not be less than 6 feet, as measured from rim to invert, without prior approval of the LANL U&I FOD.

4. The manhole shall have a minimum inside diameter of 4 feet.
5. The manhole shall have a shelf, with a minimum width of 9 inches on each side of each main line within the manhole.
6. Where the primary flow changes direction within a manhole, the manhole must be of a sufficient size to accommodate a centerline radius of curvature of the flow invert larger than the pipe diameter.
7. Rim elevation shall be minimum 6 inches above final grade in undeveloped areas.
8. Manholes shall not be located in areas where surface infiltration is possible.
9. Do not exceed 90-degree changes in horizontal flow direction within manholes.
10. Note invert elevations for each inlet and outlet to a manhole on construction drawings.
11. Provide a slope across the manhole invert at least equal to the average of the slopes of the incoming and outgoing sewers, with a minimum drop of 0.10 feet. Design the inverts to produce a smooth water surface at design flow with no backwater conditions in any of the incoming sewers.

F. Sanitary sewer service lateral

1. Minimum service lateral pipe size shall be 4 inch.
2. Connect 4-inch service laterals directly to existing sewers with factory manufactured saddles or tees only or manholes. Four-inch service lateral connections greater than 100 feet in length may require new manholes This determination shall be made by the LANL sanitary sewer system engineer.
3. Use a manhole to make 4-inch and 6-inch service lateral connections to 6-inch sewers and all service lateral connections 8 inches and larger. Service connections to a manhole shall be made with the invert of the new service lateral at 0.2 feet above the invert of the existing sewer.
4. Construct service connections without bends unless cleanouts are installed as approved by the LANL UI FOD wastewater system representative.
5. Provide service laterals with a minimum slope of 1/4 inch per foot between the sewer and the facility being served.

## CHAPTER 4 ARCHITECTURAL

A. Architectural Design Philosophy

1. The vision for the physical development of the Laboratory is to create an exceptional work environment that supports its mission and attracts and retains the quality personnel needed to meet that mission. Using the standard of a world-class working environment the Laboratory sets out to revitalize and develop its facilities and infrastructure in a manner that improves and upholds the functionality, safety, security, appearance, and life-cycle effectiveness of the built environment. To that end, LANL's basic design goals are fully described in the *Site & Architectural Design Principles*.

B. Follow Chapter V, Guidelines for Architectural Design, to support stylistic cohesiveness, building façade color and material consistency within the LANL planning area in which the facility is located.

C. The expected life span of new facilities at LANL is 30–50 years with average levels of maintenance and some system replacements expected to occur during that life span.

D. Prepare occupant means of egress and code analysis establishing compliance with IBC Chapter 10 and NFPA 101, *Life Safety* Code, criteria, and requirements.

E. The use of Exterior Insulation and Finish Systems (EIFS) for exterior finishes is not acceptable unless protected from the elements by projections (e.g., canopies, verandas, cantilevered stories above, and/or the like).

F. Only Styrene-Butadiene-Styrene (SBS) or Atatic-Polypropylene (APP) modified bitumen roofing systems are acceptable for low-slope applications. For mid- to high-slope applications metal panel roofing may be employed. Other types of roofing systems may be utilized when approved in advance by the Point of Contact (POC).

G. Roof access by ships ladder or extended stairways are preferred over fixed vertical ladders.

H. For interior doors use Best Lock Corporation 9K Series cylindrical locksets with Style 14 or Style 15 levers. For exterior doors not equipped with exit devices, use Best 47H Series mortise locksets with Style 14 or Style 15 levers. Only Best 7-pin changeable cores will be used and will be supplied and installed by LANL.

I. Signage/Room Numbering

1. Signs

a. Interior signs designating spaces shall include the space name and room number(s) in accordance with Article 2 below, shall be of appropriate size, and mounted at appropriate locations in accordance with ADA requirements.

b. Exteriors signs designating buildings are to be provided and installed by LANL.

c. Sign materials shall be durable and easy to maintain, providing reasonable ease of replacement and updating. A LANL standard specification for these signs is available upon request.

2. Room Numbering

a. A four-digit room numbering scheme will be provided by LANL after a conceptual floor plan is developed, received, and approved.

J. Minimum plumbing fixture counts shall be per the Project code of record.

*Guidance: At time of writing, ESM Ch. 1 Z10's "most stringent" rule dictated that the UPC counts, and not the NM Admin Code's reduction of same, must be followed. Project circumstances may warrant exceeding, even the UPC and the users' input should be sought.*

K. Gender-neutral: For new facilities, additions that add restrooms, reconfiguration of existing restrooms (an IEBC Level 2B Alteration), and IEBC Level 3 Alterations:

1. Wherever separate male/female restroom facilities are provided, at least one (1) all-gender/gender neutral (GN/all-access) restroom facility shall also be provided.

a. They shall be in the same general area as the male/female facilities to the extent practical (wayfinding signage as appropriate).

b. GN restrooms shall also comply with ADA/ABA provisions and signage shall reflect the GN and ADA characteristics.

c. Amenities provided in male or female restrooms shall also be provided in GN restrooms including but are not limited to bathroom accessories, showers/bathing, lockers, and mirrors.

d. Plumbing fixture total count shall be in accordance with applicable codes at a minimum and may exceed the code minimum in response to unique project requirements. The ratio of fixture count assignments shall be 45% male, 45% female, and 10% GN equaling 100% of the total occupant load served. Alternative ratios (based on unique project circumstances) require LANL Building Official approval.

# CHAPTER 5 STRUCTURAL

## 1.0 COMMERCIAL DESIGN & ANALYSIS REQUIREMENTS

This Chapter provides the minimum requirements for the structural design and analysis of new and existing commercial (i.e., non-nuclear) structures, systems, components (SSCs), to include non-building structures and, as applicable, programmatic equipment. Such designs/analyses are performed using the International Building Code (IBC) and International Existing Building Code (IEBC), which are "commercial codes" with the LANL site-specific requirements as noted below. Section numbers are in reference to the 2015 IBC.

**********

On or about February 1st, 2023, LANL is adopting the 2021 edition of selected ICC-codes; Projects with a code of record (CoR) date after that point shall apply the 2021 editions for the following codes referenced within this document*: International Building Code (IBC), International Existing Building Code (IEBC), International Fire Code (IFC).* Questions regarding code and standard year compliance should be directed to the ESM discipline chapter point of contact (POC).

**********

**NOTE -** IBC Sections may not match 2021 Edition

## 2.0 IBC SECTION 16 STRUCTURAL

A. Section 1608 Snow Loads

1. 1608.2 Ground snow loads.

   The ground snow load shall be taken as 16 psf

B. Section 1609 Wind Loads

1. 1609.1.1 Determination of wind loads.

   The ultimate design wind speeds, $V_{ult}$, are based on site-specific wind analysis in accordance with IBC 1609/ASCE 7.

2. 1609.3 Ultimate design wind speed.

   The ultimate design wind speed, $V_{ult}$, for the determination of the wind loads for the design of buildings and structures shall be as follows:

   - 105 mph for Risk Category I,
   - 115 mph for Risk Category II, and
   - 120 mph for Risk Category III and IV.

3. 1609.4 Exposure category.

   The exposure category shall be taken as Exposure C for each wind direction considered. (Note there are areas at LANL where the effects of upslope winds require consideration following the requirements of ASCE 7)

C. Section 1612 Flood Loads

1. 1612.3 Flood hazard areas. Pajarito Canyon, Los Alamos Canyon, and Water Canyon shall be considered *flood hazard areas*, the design flood elevations shall be determined in accordance with paragraph 1612.3.1.

2. 1612.3.1 Design flood elevations. Structures located within the canyons mentioned in 1612.3 will require the EOR to perform a site-specific flood analysis as specified in 1612.3.1.2.

## 3.0 IBC SECTION 1613 EARTHQUAKE LOADS

A. 1613.3 Seismic ground motion values

1. The following parameters shall be used for all Risk Categories unless the provisions in the exception at subparagraph 3.0.A.2 are met:

a. 1613.3.1 Mapped acceleration parameters. Substitute the following text:

**$S_S$ and $S_1$**

| | |
|---|---|
| At short periods, $S_S$ | 0.63 |
| At long periods, $S_1$ | 0.45 |

b. 1613.3.2 Site class definitions. Substitute the following text:

The site class shall be taken as Site Class D except as demonstrated otherwise by site specific geotechnical information that Site Class C requirements are met.[6]

c. 1613.3.3 Site coefficients and adjusted maximum considered earthquake spectral response acceleration parameters. Substitute the following text:

**$S_{MS}$ and $S_{M1}$**

| | |
|---|---|
| At short periods, $S_{MS}$ | 0.82 |
| At long periods, $S_{M1}$ | 0.67 |

d. 1613.3.4 Design spectral response acceleration parameters. Substitute the following text:

**Five-percent damped design spectral response acceleration**

| | |
|---|---|
| At short periods, $S_{DS}$ | 0.55 |
| At long periods, $S_{D1}$ | 0.44 |

e. Replace in Sections 11.3 and 11.4.5 of ASCE 7, the definition for $T_o$ from $T_o = 0.2\ S_{D1}/S_{DS}$ to = 0.12 sec.

f. 1613.3.5 Determination of seismic design category. Substitute the following text:

[6] In order to meet Site Class C requirements, borings must be deeper than what has become the norm for LANL geotechnical investigations. Refer to IBC 1613.3.2 and ASCE 7 Ch. 20 for details. In the event that the geotechnical investigation indicates that Site Class E or F exist, para. 3.3.B (1809.13 Footing seismic ties) herein is applicable and shall be complied with.

The seismic design category shall be taken as Seismic Design Category D.[7]

2. Exception for Risk Category I and II structures. To use this exception, the conditions in subparagraph 3.0.A.2.f below must be met. Otherwise, the parameters outlined in subparagraph 3.0.A.1 shall be used. This exception does not allow the use of long-period accelerations.

   a. 1613.3.1 Mapped acceleration parameters. Substitute the following text:

      **$S_s$ and $S_1$**

| | |
|---|---|
| At short periods, $S_S$ | 0.54 |
| At long periods, $S_1$ | N/A |

   b. 1613.3.2 Site class definitions. Substitute the following text:

      The site class shall be taken as Site Class D

   c. 1613.3.3 Site coefficients and adjusted maximum considered earthquake spectral response acceleration parameters. Substitute the following text:

      **$S_{MS}$ and $S_{M1}$**

| | |
|---|---|
| At short periods, $S_{MS}$ | 0.74 |
| At long periods, $S_{M1}$ | N/A |

   d. 1613.3.4 Design spectral response acceleration parameters. Substitute the following text:

      **Five-percent damped design spectral response acceleration**

| | |
|---|---|
| At short periods, $S_{DS}$ | 0.49 |
| At long periods, $S_{D1}$ | N/A |

   e. 1613.3.5 Determination of seismic design category. Substitute the following text:

      The seismic design category shall be taken as Seismic Design Category C.

   f. Conditions. All of the following conditions must be met to use this exception:

      (1) Structure height from bottom of footings to the highest point of the seismic force resisting system is less than or equal to the following[8]:

[7] In the event that the geotechnical investigation indicates that Site Class E or F exist, para. 3.3.B (1809.13 Footing seismic ties) herein is applicable and shall be complied with.

[8] The intent of this exception is that natural frequencies of the structural systems and heights respond at natural frequencies such that the seismic analysis would be controlled by the $S_{DS}$ parameter; thus, consideration of the $S_{D1}$ parameter is not required.

| Seismic Force Resisting System Type | Maximum Structure Height |
|---|---|
| Steel Moment Frame | 25 feet |
| Concrete Moment Frame | 33 feet |
| Steel Eccentrically/Buckling-Restrained Braced Frame | 29 feet |
| All Other Systems[9] | 50 feet |

(2) Equation 12.8-2 of ASCE 7-10 is used to determine the seismic response coefficient.

(3) The diaphragms are rigid as defined in Section 12.3.1; or, for diaphragms that are not rigid (i.e., semirigid or flexible), the distance between vertical elements of the seismic force resisting system does not exceed 40 ft.[10]

g. *Guidance Note: For new facilities that will perform activities or operations that are not necessarily RC IV (essential) by IBC definition but considered important to the mission [e.g., mission-essential, mission-critical, or anticipated to have a high mission dependency index (MDI)], or where damage to the facility from a significant seismic event would cause adverse or unacceptable program interruption, utilization of the higher SDC-D categorization should be considered to ensure greater structure resilience and post-earthquake integrity—or selection of RC IV to ensure equipment also survives. LANL Project Engineer should engage customer on this matter and, if opting for SDC D or RC IV, capture this in RCD.*

B. 1613.5 Amendments to ASCE 7

1. Add 1613.5.2 Siting. Modify ASCE 7 11.8.1, Site Limitation for Seismic Design Categories E and F, to read as follows:

Site Limitation

Hazardous waste treatment, storage and disposal facilities must not be located within 200 feet of a fault that has had displacement within the last 11,000 years.

2. Add 1613.5.3 Design Approach to Commercially Fabricated Buildings Used in Multi-State Jurisdictions. Refer to Article 10 of this chapter of this document.

[9] Prior approval from ESM Structural POC is required in order to use "All Other Systems." The reason being, the intent of the applicable code provisions (i.e., IBC 1613.3.5.1 and ASCE 7 12.8.2.1 and 12.8.6.2) is that they are applied to a specific SFRS, and CAL-99-MULT-651 (i.e., the source of the seismic ground motions values herein, to include the "SDC-C exception") does not apply to any specific SFRS. Thus, it is more than reasonable/prudent for LANL to ensure that a given "Other System" intended to be installed here (and under the exception) complies with the applicable code provisions. SDC D shall be used if prior approval is not obtained, or if the SFRS of the "All Other System" is not approved (for use with SDC C).

[10] The 40-foot-spacing limitation shall be assumed to be applicable unless it is demonstrated that the rigid-diaphragm condition exists (in accordance with ASCE 7-10 Section 12.3.1).

3. Add 1613.5.4 Nonstructural Components Exempt from Seismic Design. Modify ASCE 7 13.1.4, Exemptions, to read as follows[11]:

   Exemptions. The following nonstructural components are exempt from the requirements of this chapter.

   a. Furniture (except for "Cabinets" in ASCE 7 Table 13.5-1)[12].

   b. Temporary[13] or movable components/equipment[14].

   c. As stated in subparagraphs 5 and 6 of ASCE 7 paragraph 13.1.4.

4. Add 1613.5.5 Anchorage of architectural, mechanical, and electrical components. Follow Appendix A, *Anchorage to Concrete and Masonry*, of ESM Ch. 5 Section II.

5. Add 1613.5.6 Restraint of Non-Facility Equipment (e.g., Programmatic, Utilities, Infrastructure, Environmental Remediation). Follow Article (11.0), "Design Approach for Restraint of Non-Facility (e.g., Programmatic) Equipment," of this chapter.

## 4.0 IBC SECTION 17 SPECIAL INSPECTIONS AND TESTS

Refer to LANL TSM Chapter 16 Building Program for LANL amendments to this and other IBC chapters.

## 5.0 IBC SECTION 18 SOILS AND FOUNDATIONS

A. Section 1803 Geotechnical Investigations

1. 1803.5 Investigated Conditions.

   a. 1803.5.12 Seismic Design Categories D through F. Modify the first item (i.e., "1.") to read as follows:

      The determination of dynamic seismic lateral earth pressures…A conservative alternative for obtaining such pressures on exterior embedded walls is use of the Simplified Method in ASCE 4 (para. 8.2.2). And, for retaining walls, such pressures can be obtained using the Mononobe-Okabe approach in accordance with ASCE 4 (para. 8.3).

B. Section 1808 Foundations

1. 1808.1 General. Add the following text:



[11] The ASCE 7 exemptions are modified because LANL is both the Building Official and the owner. Refer to ASCE 7 C13.1.1 and C13.1.4 for details.
[12] No cabinet-like furniture is exempt (e.g., relatively tall, narrow, and heavy components /equipment, like some safes, etc.).
[13] Refer to Article, TEMPORARY FACILITIES, STRUCTURES, AND BUILDING SYSTEMS & COMPONENTS (Z1050), in ESM Ch. 16, IBC-GEN.
[14] Movable components /equipment that are not "temporary", are not moved often, are in/ near occupied areas, and that are cabinet-like will likely require at least "non-permanent anchorage (e.g., detachable cable restraint, etc.)." Contact the ESM Ch. 5 POC for guidance.

Permanent buildings and similar structures shall have a permanent foundation (e.g., full perimeter support, rodent-excluding, no trailer skirting, etc.). Permanent is described in ESM Chapter 16, Section IBC-GEN.

a. Exception: For non-temporary relocatable buildings (as defined in ESM Chapter 16, Section IBC-GEN)[15], a permanent foundation may be achieved by placing gravity bearing pads on 24 inches of non-frost susceptible ground or fill (95% compacted granular material with less than 6% material passing the 200 sieve)*, and providing insulated skirting around the perimeter of the buildings, and by providing a means to resist the lateral and uplift forces that result from seismic and wind loads. *For temporary foundations for temporary relocatable buildings*, *see LANL Standard Detail ST-Z1052-1 and -2 regarding foundation support for temporary transportables.*

*If fill is used, it must replace the existing material to a depth of at least 24 inches.

C. Section 1809 Shallow Foundations

1. 1809.5 Frost protection. Edit the first sub-bullet (i.e., “1”) to read as follows:

Extending to 36”.

2. 1809.13 Footing seismic ties**.** Revise the first sentence to read as follows:

Individual spread footings founded on soil defined in Section 1613.3.2 as Site Class E or F shall be interconnected by ties.

## 6.0 IBC SECTION 19 CONCRETE

A. Section 1901 General

1. 1901.3, Anchoring to concrete: Revise the first part of the sentence to read as follows, and add the following second sentence (i.e., an exception):

Anchoring to concrete shall be in accordance with Appendix A, *Anchorage to Concrete and Masonry* given in ESM Chapter 5, Section II; ACI 318 Chapter 17; and the amendments to ACI 318 Chapter 17 in Section 1905.

Exception: Seismic-related provisions are not applicable to anchoring that is seismically-exempt per 1.0.E.3 of this chapter of this document.

B. Section 1904 Durability Requirements

Add 1904.3 Mass Concrete:

[15] A transportable is an easily moved prefabricated building (e.g., a trailer or manufactured office) generally intended for less than a 20 year life. See ESM Ch 1 Sect. Z10 on design goals and Ch 16 IBC-GEN on temporary and prefabs.

1. Mass concrete is defined as “any volume of structural concrete in which a combination of dimensions of the member being cast, the boundary conditions, the characteristics of the concrete mixture, and the ambient conditions can lead to undesirable thermal stresses, cracking, deleterious chemical reactions, or reduction in the long-term strength as a result of elevated concrete temperature due to heat from hydration. *In general, a placement of structural concrete with a minimum dimension ≥ 4 ft should be considered mass concrete. Similar considerations should be given to other concrete placement that do not meet this minimum dimension but contain Type III cement, accelerating admixtures, or cementitious materials in excess of 660 lb/yd$^3$ of concrete. Consideration should also be given to placements that trap heat.*

2. The Construction Documents shall designate those portions of the structure, or concrete placement that are to be treated as mass concrete. The Project Specification (e.g., Section 03 3001, *Reinforced Concrete*) shall adopt the ACI 301, Section 8 requirements. The structural Engineer of Record (SEOR) shall review the Project-Specification-version of 03 3001 against the checklists presented in ACI 301 (i.e.., Mandatory, Optional Requirements, and Submittals) to ensure that this Section adequately addresses mass concrete.

    a. In lieu of mass concrete designation and specification requirements, the SEOR can opt to demonstrate (analytically, using ACI 207.2R) that these requirements are not required/applicable.

C. Concrete Mix Design

1. Note: LANL Master Specification Section 03 3001 is an acceptable approach to satisfaction of ACI reinforced concrete requirements and recognizes LANL pre-approved mixes available from the local supplier within a practicable travel distance. Use of this template is highly recommended.

## 7.0 IBC SECTION 20 ALUMINUM

No change.

## 8.0 IBC SECTION 21 MASONRY

A. Section 2107 Allowable Stress Design

1. 2107.1 General. Add the following sentence to the end:

   Anchoring to masonry shall be in accordance with Appendix A, *Anchorage to Concrete and Masonry* of this document and TMS 402/ACI 530/ASCE 5.

B. Section 2108 Strength Design of Masonry

1. 2108.1 General. Add the following sentence to the end:

Anchoring to masonry shall be in accordance with Appendix A, *Anchorage to Concrete and Masonry* of this document and TMS 402/ACI 530/ASCE 5.

## 9.0 IBC SECTION 22 STEEL

A. Section 2205 Structural Steel L

1. 2205.1 General: Add the following text:

Designs shall allow for, if not ensure, compliance with OSHA provisions 29 CFR 1926, Subpart R (Steel Erection), Section 755(a), General Requirements for Erection Stability. Columns shall be securely anchored with a minimum of four (4) anchor rods or anchor bolts to address construction safety. Furthermore, each column base plate assembly, including the column-to-base plate weld and the column foundation, shall be designed to resist a minimum eccentric gravity load of 300 pounds located 18 inches from the extreme outer face of the column in each direction at the top of the column shaft to address construction safety. *See also LANL Master Specification Section 05 1000, Structural Metal Framing, for additional discussion*.[16]

## 10.0 IBC SECTION 23 WOOD

No change.

## 11.0 DESIGN APPROACH TO COMMERCIALLY FABRICATED BUILDINGS USED IN MULTI-STATE JURISDICTIONS

A. Approval is currently limited to the following (others with Chapter POC written permission): ARMAG, MSSI, and US Chemical.

B. For ASCE 7 Risk Category I and II structures designated-as-ML-4, commercially fabricated building-like structures that are not one of the type categories described in ASCE 7 Chapter 12 may be designed/treated as follows:

1. Such buildings may be treated as those structures that are designed and detailed in accordance with ASCE 7 Section 15.5 for non-building structures similar to buildings, as stipulated in Section 11.1.3. However, if a nationally marketed structure type does not fit into the categories listed in Chapter 12 or in Section 15.5, then ASCE 7 Section 15.6 covering non-building structures not similar to buildings shall be used as the default structure type under the listing of "All other self-supporting structures, tanks, or vessels not covered above or by reference standards that are not similar to buildings."

[16] As is indicated in the User Note associated with AISC 360, Section J9, Anchor Rods and Embedments, OSHA mandates special erection requirements for anchor rods. Subpart R definitions: *Column* means a load-carrying vertical member that is part of the primary skeletal framing system. Columns do not include posts. *Post* means a structural member with a longitudinal axis that is essentially vertical, that: (1) weighs 300 pounds or less and is axially loaded (a load presses down on the top end), or (2) is not axially loaded, but is laterally restrained by the above member. Posts typically support stair landings, wall framing, mezzanines and other substructures.

## 12.0 DESIGN APPROACH FOR RESTRAINT OF NON-FACILITY (E.G., PROGRAMMATIC) EQUIPMENT

Restraint (i.e., anchorage and/or bracing) of non-facility (e.g., programmatic) equipment is required in either of the following two circumstances:

A. When required by the manufacturer for normal operations.

1. If this is the sole reason restraint is required (i.e., seismic restraint per para. B below not required), then the design need not be per Ch. 5 if the manufacturer provides alternative design requirements.

B. In all other cases, seismic restraint is required unless the equipment is "Seismically Exempt" per Para. 1.0.E.3 of this chapter of this document.

1. If seismic restraint is required, the design must comply with Ch.5 Section II, the installation and quality control per the appropriate LANL Master Spec(s), and the QA per ESM Ch. 16.

2. An alternative method may be proposed to the LANL Building Official (LBO) for approval provided:

a. An analysis that indicates the interaction effects of the unrestrained equipment[17] is acceptable at the Design Basis Earthquake (DBE), or

b. The equipment will be located in an essentially unoccupied area[18] and is protected as such through administrative or engineering control.

3. In an existing facility, unless the building is undergoing more than a limited structural alteration as defined in the IEBC (907.4.4 in 2015), it may be that restraint can be designed to lesser requirements; see Code of Record/Structural discussion in ESM Ch. 16 Sect. IBC-GEN Att. B., 301.1 (which specifically addresses anchorage).

**NOTE for Equipment Outside:** Both of the above criteria also apply outside of a building; if the above require an item to be restrained for wind and/or seismic, were it inside, then restraint must either be provided or shown/proven unwarranted. Ref ASCE 7-10 Section 15.1.1, *Nonbuilding Structures*, and Ch. 29, *Wind Loads on Other Structures and Building Appurtenances*.

**NOTE for Laboratory Equipment Inside:** Seismic restraint of lab equipment inside of a building can be achieved using the Safe-T-Proof Laboratory Equipment Anchorage Kit (STP-MP-203-09-ICC) in accordance with ICC ES ESR-4167 or other approved systems.

[17] E.g., from rocking, swaying, overturning, sliding, impact, etc. Also: In all cases, equipment must be anchored if it is permanently attached to utility services (electricity, gas, and water). (ASCE 7 C13.1.1)

[18] I.e., incidental occupancy: occupied for a total of less than 2 hours/day, yearly average (RP 8 exemption 1.3.d utilized herein). Not the same as *incidental use* (IBC sec. 509 term relating to certain adjunct uses).

# CHAPTER 6 MECHANICAL

## 1.0 GENERAL—DESIGN DOCUMENTATION

A. General

1. Provide documentation to include, but not limited to, the following:

a. Calculations: Note the source of each formula or method used, list all assumptions and exceptions, and define all units. Provide copies of tabulated data used. If a computer program was used (e.g., for HVAC sizing), provide input data in the calculation.

b. HVAC System Calculations: Heating and cooling loads, ventilation, exhaust and outside air requirements, building pressurization, humidity control when required, duct sizing, and air system pressure drops for equipment selection. Correct calculations for altitude.

c. Piping System Calculations: Flow rates, pipe sizing with friction factors, velocities, expansion/contraction, and system equipment pressure drops for pump selection.

d. Equipment Selection Criteria: Include flow rates, pressure or head requirements, operating temperatures, efficiency, energy consumption, and sound ratings. If manufacturer selection program is used, verify that altitude correction for motor size is properly performed.

e. Vibration Isolation/Sound Attenuation Measures: List uncorrected and corrected equipment criteria in the design documentation.

f. Plumbing System Calculations: Provide for water supply and drainage fixture unit requirements, roof drainage, and makeup water requirements for mechanical systems.

g. Plumbing and Piping Systems: Riser/schematic diagrams, isometrics, and calculations are required for the following systems: water, waste/vent, natural gas, roof/overflow drains, steam & condensate, and refrigeration. Plans and calculations are required for irrigation systems, gases, and other liquid and vapor systems. (ESM Mechanical POC may allow variance to these requirements.)

h. Include copies of catalog sheets showing equipment performance points for all major equipment included in the systems design.

i. Mechanical rooms: provide layout complete with estimated equipment sizes, pipe routing, and sizing to LANL for approval prior to design completion.

2. For sustainable design, mechanical systems design, materials, and construction are an integral component; design mechanical systems and specify equipment for compatibility with the building and site aesthetics, electrical systems requirements, and indoor environmental quality requirements (i.e., meet ASHRAE 55 and 62.1) to ensure multi-discipline whole-building sustainable design practices are followed.

3. Locate roof-mounted mechanical equipment (all parts) a minimum of 10 feet from the edge of roof or inside face of parapet. If the distance is less than 10 feet, specify a 42-inch-high restraint, e.g., guard rails, parapet, screen wall, fall protection anchorage system points, etc. Mechanical POC approval must be obtained prior to installing roof-mounted air heating/cooling equipment (maintenance and roof damage issues).

B. HVAC OPTIONS–LIFE CYCLE COST ANALYSIS (LCCA)

Unless another building design life is specified in the statement of work, select mechanical systems using a 40-year LCCA. Use first cost, operating efficiency, maintenance, and unit replacement costs to determine the most life cycle cost efficient mechanical system. Analyze only the systems indicated with an "X".

| HVAC Options | Analyze |
|---|---|
| Cooling with air-cooled chiller plant | X |
| Cooling with air-cooled condensing unit(s) | X |
| Cooling or heating with existing district system (if available) | X |
| Heating with indirect-fired air handling units (AHU) and electric heat variable airvolume (VAV) boxes | X |
| Heating with DX Heat pump air handling units (AHU) and electric heat variable airvolume (VAV) boxes | - |
| Heating with condensing boiler plant and hot water system to AHU and VAV | X |
| Complete conditioning with variable refrigerant flow (VRF) system | - |

## 2.0 GENERAL—EQUIPMENT/PIPING IDENTIFICATION

A. General

1. Label exhaust fans that serve fume hoods and other local exhaust ventilation systems with a permanent printed label indicating fan static pressure, RPM, and motor current. The data for these labels is to be supplied by the Test, Adjust, and Balance (TAB) Agency.

## 3.0 GENERAL—SOUND CONTROL

A. General

1. Specify that equipment (fans, chillers, VAV terminal units, air handling units, etc.) comply with the sound rating of the applicable standards of the Air Conditioning and Refrigeration Institute (ARI) or the Air Movement and Control Association (AMCA).

2. For mechanical equipment, request sound power (preferred) or sound pressure levels for all eight octave band center frequencies from 63 to 8000 Hz.

3. For sound control materials, specify sound transmission loss (TL) capabilities and sound absorption coefficients, depending on the material. State TL in decibels (dB) and octave band center frequencies for both.

4. Seal penetrations through walls, floors, and ceilings.

B. Acoustical Design

1. The following criteria are acceptable for mechanical system noise levels in normally occupied spaces during unoccupied times (RC=Room Criterion).

**Table D10-30GEN-1**

| | |
|---|---|
| 1. Conference Rooms | NC/RC 25-35 |
| 2. Private Offices | NC/RC 25-35 |
| 3. Open Plan Offices | NC/RC 30-40 |
| 4. Public Areas & Corridors | NC/RC 35-45 |
| 5. Computer/Business Machines | NC/RC 40-45 |
| 6. Laboratories (with fume hoods) | NC/RC 40-50 |

C. Fan Noise

1. Locate duct silencers as close to equipment as is possible and practical, while not encroaching on the silencer manufacturer's installation instructions.

*Guidance: The preferred location for duct silencers is in the Mechanical Equipment Room. When this is not possible or practical, silencers may be located outside of the Mechanical Equipment Room.*

2. Select silencers for the lowest possible static pressure drop, while still providing the specified insertion loss. Specify silencers to have a certified dynamic insertion loss (DIL) in decibels for the critical frequency or frequencies of concern, not less than the calculated requirement.

3. Where conditions prohibit the use of acoustic fill used in conventional silencers, use packless duct silencers.

*Guidance: These devices are designed especially for use in facilities handling gasoline, grease, solvents, and other hazardous materials.*

## 4.0 GENERAL—VIBRATION CONTROL

A. General

1. For criteria on vibration and vibration control, refer to the ASHRAE Application and Fundamentals Handbooks and NEBB publication "Sound and Vibration Design and Analysis."

a. The equipment vibration severity rating for vibration on equipment structure or bearing caps shall be "slightly rough" or better per ASHRAE Applications Handbook (*Chapter 48, Figure 42 in 2011)*.

## 5.0 GENERAL—WATER DISCHARGED TO THE ENVIRONMENT AND SANITARY SEWER

A. Obtain LANL Water Quality Group approval prior to discharging:

1. Potable water from flushing/cleaning of potable piping systems, hydrostatic testing, line disinfecting, etc., to the environment or sanitary sewer.
2. Non-potable water or other liquid discharges from equipment drains, blowdowns, overflow piping, flushing/cleaning piping systems, or cleaning cooling towers, etc., to the environment, sanitary sewer, or any National Pollutant Discharge Elimination System (NPDES) permitted outfall.

   NOTE: Facility floor drains shall not be designed to discharge directly to the environment.

## 6.0 PIPING—CROSS CONNECTION CONTROL

A. General

1. Locate building and fire protection backflow preventers (BFPs) inside the building to prevent freezing and facilitate maintenance.
   a. For inside installations, provide a floor drain, connected to the sanitary sewer, near the BFP, sized to handle a full-open condition; do not install BFPs in areas without reliable drainage. Discharge BFPs at riser through drain/collection pipe to building exterior.
   b. Locate outside BFPs above ground in heated enclosures (e.g., “Hot Boxes”) set on concrete pads and protect units from freezing; ESM Civil POC must approve outside installations in heated enclosures.
2. Provide parallel BFPs if building water supply cannot be interrupted in critical systems.

B. Temporary Office Buildings[19]

1. Provide a pressure-reducing valve (PRV) with a check valve in the potable water service line to each temporary office building (trailer, transportable, etc.).
2. Refer to Mechanical, ST-D2020-2, Sheet 2, for PRV detail.

C. Emergency Showers and Eye Wash Stations

1. For tempered water for emergency showers, provide a prepackaged, fully engineered and tested, mixing valve assembly furnished and/or manufactured by the manufacturer of the emergency equipment.

   *Guidance: A comfortable delivered water temperature range (per ANSI Z358.1-2009, Appendix B) is 60-100° degrees F. Units should be designed to provide a minimum discharge temperature of 80° F.*

[19] Defined in ESM Ch. 16 IBC-GEN

2. Drains are not required to be provided for eye washes, safety showers, or combination installations. They shall not be routed to sanitary drains, storm drains, or the radioactive liquid waste system. If installed, the drains shall be routed to a holding tank capable of accepting a minimum full rated flow (not less than 20 GPM) for a single installation; sampling of collected water will determine appropriate disposal path.

3. Provide a recirculation pump in the hot water system when the developed length of piping from the heater to the fixture exceeds 100 feet. Set the aquastat at 95° degrees F to control the pump.

   *Guidance: In installations where the hot water use is fairly continuous, eliminate the thermostat and run the pump continuously. In either case, consider including a timeclock to save energy during off-hours.*

4. Minimize the number of floor drains in equipment rooms to prevent possible contamination (oil, etc.) transfer to the sanitary sewer system.

5. Route drain piping from equipment close to walls or equipment to minimize a tripping hazard.

## 7.0 PIPING—STORM WATER

A. General

1. Design roof drain system for a 2.25 inches rainfall in a 1-hour period.

   a. To prevent ice build-up, do not discharge storm water on the north side of the building near doors, sidewalks, etc. Route storm water away from the building and pedestrian walkways.

   b. To prevent ground erosion, provide concrete splash blocks, river rocks, etc., under down spouts.

## 8.0 PIPING—COMPRESSED AIR INCLUDING BREATHING AIR

A. General

1. Determine free air delivery (FAD) cfm (actual volume flow rate of compressed air converted back to the inlet ambient conditions of the compressor), including remembering that altitude correction is required and consideration that there is a good possibility of sizable diversity in demand.

2. Design piping to eliminate areas where water may accumulate, e.g., slope piping to oil/water separators, specify drain valves or traps at low points, etc.

3. Provide an oil/water separator (torpedo) in drain piping from a lubricated compressor system that discharges into the sanitary sewer. Oil-less/oil-free compressor piping systems do not require an oil/water separator but do require an automatic drain valve. Refer to the compressed air piping drawings referenced below for details.

B. Altitude Correction

1. Derate the compressor free air delivered to what is listed in the manufacturer's catalog data for altitude and temperature.

C. System Components

1. Aftercooler: Equip each compressor with an aftercooler sized to provide a 5 to 20° degrees F approach temperature.
2. Air Dryers: Use a refrigerated air dryer (35 – 38° degrees F pressure dew point) when the compressed air system's ambient temperature is always 40° degrees F and above. For portions of thesystem below 40° degrees F ambient temperature, use a regenerative air dryer (minus 40° degree F pressure dew point).[20]

   **Note**: Heatless regenerative air dryers typically consume 5 to 18 percent of compressed air capacity.
3. Intake Air Piping: Take intake air from the cleanest possible location. Avoid air intakes from dirty locations within the building, and hot (greater than 100° degrees F) or humid locations.
4. Air Intake Filter: Equip the compressor inlet with a filter to remove dirt from the air.
5. Receiver: Equip each reciprocating air compressor with a receiver tank to dampen pulsations. Provide a receiver tank with a pressure gauge, safety relief valve, and drain valve, and an NBIC Numbered and Registered tank.
6. Mechanical Air/Water Separator: Provide separators with the compressor package to remove water that has condensed in the aftercooler of the compressor.
7. Sound Attenuation: For applications requiring low noise (below 85 dBa), specify a sound enclosure for a rotary screw compressor or intake filter/silencers and/or mufflers for reciprocating compressors.

D. Outdoor Installation

1. To protect the unit from weather and freezing, equip the compressor with the following:
   a. TEFC motors and NEMA 4 controls, starters, and pressure switches.
   b. Heaters as recommended by manufacturer.
   c. Watertight intake filters.
   d. Heat-tape for air/water separators and any other condensate drain piping.

## 9.0 HVAC—ALTITUDE/CLIMATIC CRITERIA AND HEAT GAIN EQUATIONS

1. See Chapter 1 Section Z10 for altitude, latitude, barometric pressure, air density, and air density ratio values.

[20] Prevents condensate freeze-up

2. Heating Degree-Days (annual mean): 6219 at 65° degrees F base; 2680 at 50° degrees F base.

3. Cooling Degree-Days (annual mean): 2187 at 50° degrees F base, 272 at 65° degrees F base.

4. Correct Q for altitude. Values for 7500 feet (*suitable for many locations/situations*) are:

   *Q (sensible heat)(Btu/hr) = 0.82 (@W = 0) X cfm X ∆t (at sea level 0.82 would be 1.08)*

   *Q (latent heat)(Btu/hr) = 0.52 X cfm X ∆W (gr.) (at sea level 0.52 would be 0.68)*

   *Q (total heat)(Btu/hr) = 3.42 X cfm X ∆h (at sea level 3.42 would be 4.50).*

   *Where:*

   *cfm = Air flow Rate, cubic feet/min.*

   *∆W (gr) = Humidity Ratio Difference, gr. water/lb. dry air.*

   *∆h = Enthalpy Difference, Btu/lb. dry air.*

   *W = Humidity Ratio, lb. water/lb. dry air.*

   *∆t = Temperature Difference, degrees F.*

5. Use Table D30GEN-1 local climate information for HVAC system sizing/design. It is presented in the format of the 1993 ASHRAE Fundamentals Handbook, Load and Energy Calculations Division, Weather Data Chapter 24. Refer to ASHRAE Handbook for explanation of columns and acronyms.

   a. If Los Alamos, NM weather data is included as part of a commercially available HVAC Calculation software program, this information may be used in lieu of Table D30GEN-1.

**TABLE D30GEN-1**

Climatic Conditions for the United States (from ASHRAE Fundamentals 1993 Weather Data Table 1)

| | | | | | | Winter, deg F | | Summer, deg F | | | | | | | Prevailing Wind | | Temp, deg F | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Col. 1 | Col. 2 | | Col. 3 | | Col. 4 | Col. 5 | | Col. 6 | | | Col. 7 | Col. 8 | | | Col. 9 | | Col. 10 | |
| State/ Station | Lat. | | Long. | | Elev. | Design Dry-Bulb | | Design Dry Bulb and Mean | Coincident | Wet-Bulb | Mean Daily | Design Wet-Bulb | | | Winter | Summer | Median of Annual Extr. | |
| | deg | N | deg | W | Feet | 99% | 97.5% | 1% | 2.5% | 5% | Range | 1% | 2.5% | 5% | Knots | | Max. | Min. |
| New Mexico | | | | | | | | | | | | | | | | | | |
| Los Alamos | See note[21] | | | | | 5 | 9 | 89/60 | 87/60 | 85/60 | 32 | 62 | 61 | 60 | | | 89.8 | -2.3 |

[21] Use Chapter 1 constants

## 10.0 HVAC—ELEVATION CORRECTION

*Guidance: At LANL's elevation, the air pressure and density are lower than at sea level, the condition for which HVAC equipment is designed/rated. Therefore, HVAC equipment operating at LANL produces less than its catalog rating. Correcting for this during design is required so that procurement of appropriately larger equipment occurs.*

A. Only the calculated, actual operating parameters (capacity, static pressure, cooling/heating loads) required at 7500 ft elevation should be shown on the design drawings and in the technical specifications. Only a statement such as "ALL CAPACITIES SHOWN OR INDICATED ARE AT 7500 FT ELEVATION" should be included in the drawings or specifications. It is the responsibility of the Engineer to select equipment to meet the requirements at the 7500 ft elevation. *The equipment manufacturer should be asked to provide submittal (fan curves, performance data) to back up their selection.*

## 11.0 HVAC—FANS

A. Correct catalog data before applying it at LANL's 7,500-foot altitude. *Invaluable Guidance is available in ESM Ch. 6 D30HVAC*.

B. Air Conditioning and Refrigeration Equipment, etc.

1. Derate air-cooled equipment (e.g., chillers, coils, condensers, cooling towers, VAVs, VFDs) for altitude.

C. Chemical Water Treatment

1. Clean, flush, and chemically-treat process water in HVAC systems, e.g., steam, hot water, heating, cooling systems, etc. to address LANL's higher-than-neutral pH and silica scaling problems.

## 12.0 HVAC—COILS - HEATING/COOLING

A. General

1. Provide Air Conditioning and Refrigeration Institute (ARI)-certified heating and cooling coils for central station HVAC units and field built-up systems(Requirement 6-0025).

2. For coil selection, use a manufacturer's computerized selection program to facilitate selection for the most energy efficient system, and to obtain the coil rated performance data in accordance with AHRI Standard 410, *Forced-Circulation Air-Cooling and Air-Heating Coils*, Table 1, Range of Standard Rating Conditions: https://ahrinet.org.

3. Limit air velocities of wet coils (these both cool and dehumidify) to values that prevent water carryover into the ductwork.

## 13.0 HVAC—PREHEAT COILS

A. General

1. Building air handling units shall include a preheat coil upstream of chilled water or hot water reheat coils. The preheat coil shall be sized to heat building from initial 40°F degrees to 55°F degrees within one hour while maintaining minimum outside airflow requirements (for buildings with automation systems, the additional capacity to provide for minimum outside air requirements is not necessary if outside air dampers will be closed during warm-up).
2. Operate face and bypass coils with constant steam or water flow. Do not modulate flow.
3. Provide a sensor in the discharge air stream to maintain a constant discharge air temperature, regardless of variations in inlet air temperature.

B. Design

1. Design coils for an entering air temperature of minus 10° degrees F for 100 percent outside air systems. For steam coils, oversize condensate return piping to handle large condensate flow at startup.
2. Provide supply air preheat coils, using hot water or low-pressure steam, with the necessary controls, etc., to protect them from freezing. The following are acceptable systems:
   a. Hot water coil with circulating pump to maintain a minimum coil water velocity of 4 fps.
   b. Vertical tube integral face and bypass steam or water coils with clamshell type dampers to control airflow.[22]
   c. Steam coil with properly designed control valve, steam trap with check valve, and vacuum breaker.

## 14.0 HVAC—DESIGN TEMPERATURES

A. Outdoor

1. Winter: 5° degrees F dry bulb
2. Summer: 89° degrees F dry bulb, 60° degrees F wet bulb

B. Indoor (Dry-Bulb)

1. Cooling:
   a. General Comfort: 75° degrees F.
   b. Mechanical/Electrical Rooms: Refer to ESM Mechanical Section D30, Ventilation.
2. Heating:
   a. Office/Laboratories: 72 degrees F (general comfort)

[22] Integral face and bypass coils are used as a freeze protection measure. The temperature of the discharge air is controlled by proportioning entering air through the multiple heating and bypass channels of the face and bypass coils. The air is proportioned by clamshell-shaped dampers, which maintain a constant pressure drop, thus allowing a constant volume of air to pass through the unit.

b. Mechanical Rooms: 50 degrees F

c. Storage Space (unoccupied): 55 degrees F

d. Warehouses: 50 degrees F

e. Kitchens: 60 degrees F

f. Change Rooms: 75 degrees F

3. Note: Program requirements may require different indoor design temperatures.

## 15.0 HVAC—HUMIDITY CONTROL

A. Provide humidity control only when programmatic requirements specify humidity levels in a zone or zones (e.g., in computer/information technology areas to prevent the buildup of static electricity).

1. Provide humidity monitoring system to automatically adjust building conditions as appropriate.[20]

2. *Guidance: Humidity Control is typically not practical for general comfort because of the dry climate in Los Alamos.*

B. When humidity is added to a space, provide an analysis (to prevent condensation) on where dew point temperatures will occur for exterior walls, roofs, and windows.

C. Provide humidification units with deionized water; Mechanical POC and FOD approval required for other sources.[23] Consult with humidifier representative for water quality requirements (conductivity in micro-ohms).

D. When using a mechanical cooling system for dehumidification, install the heating coil downstream of the cooling coil to provide reheat.

## 16.0 HVAC—PUMPS

A. Provide redundant pumps for all chilled water and heating hot water systems. Operate pumps in a lead/standby configuration.

B. Secondary pump containment (metal pan, angle iron barrier, etc.) may be required for systems handling caustic, contaminated, etc., fluids. Consult with the area Environmental or Industrial Hygiene and Safety (IHS) representative or customer for requirements.

C. Provide a steam-powered pump when condensate must be moved to a higher elevation or great distances.

1. If an electrical-powered condensate pump must be specified, provide an isolation valve between the pump and receiver to prevent draining the receiver during pump maintenance.

[23] Tap water at LANL is high in silica and scale deposits will cause operational and maintenance issues. DI systems contain scale in vessels relatively easy to change/maintain.

## 17.0 HVAC—SYSTEM DESIGN

A. Unoccupied Operation: Primary HVAC systems for office areas shall be designed to allow unoccupied shutdown and temperature setback and shall not provide primary cooling for rooms that require 24-hour consistent temperature control. Server rooms, telecommunications rooms, and other rooms that require 24-hour consistent temperature control shall be served by dedicated air conditioning systems as their primary cooling source. See also ESM Chapter 19 Communications Section D6010 Data Communications for additional HVAC requirements on such rooms.

## 18.0 HVAC—HEATING SYSTEMS

A. General

1. For heating design loads, do not take credit for internal heat gains from equipment that is often de-energized, especially during off hours, e.g., lights, personal computers.
2. Design low-temperature heating hot-water systems for a maximum of 180° degrees F supply temperature.
3. For 100% outside air systems, use hydronic heating. Steam, electric resistance, and other methods are allowed only with ESM Mechanical POC permission.
4. When using TA-3 Powerhouse steam, design for incoming temperature of 500 deg F and 150 psig with ability to handle 80 psig. Civil POC may grant variance to this (*pressure is normally 100-115 psig at time of writing but may be increased to about 140 psig in the future*).
5. Locate the equipment room at the point of entry of the high-pressure steam distribution supply to the building. Provide a steam pressure relief valve (PRV) within the equipment room per LANL Mechanical Standard Drawing(s) ST-D3020-2, Steam PRV Station.
6. Mechanical rooms shall have redundant heating to prevent freeze-up in case of a boiler malfunction (e.g., gas heat, electric heat, or multiple boilers).
    a. When gas is available, it is preferred to use gas-fired radiant heaters with millivolt gas controls. Millivolt gas controls allow the unit to operate when there is an electrical power outage.
7. Entry vestibules: Provide a source of heat to prevent freezing of water on floor and reduce cold drafts in lobbies during peak use times.
8. Locate shell and tube heat exchanges so that the location of joints (unions, flanges, etc.) and adjacent piping, etc. are clear of the tube pulling space.
9. Stairwells: Provide a thermostatically controlled source of heat to prevent freezing of water on floor or in fire suppression system standpipes.

## 19.0 HVAC—BOILERS

A. General

1. A factory-authorized representative of the boiler manufacturer shall provide startup service, stack analysis, and training to the LANL operator. Test reports shall be furnished to LANL.

B. Provide boiler water treatment.

C. Provide a low NOx burner system, with a maximum NOx emission of 30 ppm, on all gas-fired boilers except where specifically waived by ESM Mechanical POC.

D. Provide boilers with minimum refractory.

E. Stacks: Design per the boiler manufacturer's requirements; e.g., do not exceed maximum stack weight on boiler, required draft at flue outlet, etc.

1. Group all gas vents and pipe one vent to atmosphere above roof to minimize roof penetrations. Side exterior wall penetrations are preferred.

2. Size vent piping through roof or side exterior wall at least one pipe size larger than the largest vent connection.

3. Provide vent caps on boiler stacks to keep rain, birds, and debris out of the stack. To prevent downdrafts and to induce draft (regardless of wind conditions) on atmospheric-type boiler stacks, provide aerodynamic-type vent caps (e.g., www.fieldcontrols.com, and navigate to venting/vent caps).

F. Where required, provide two or more boilers with the determination of the proportion of load each handles based on energy, redundancy, and maintenance requirements. *Guidance examples:*

1. *Two boilers: 40 percent and 60 percent or 50 percent and 50 percent of system load.*

2. *Three boilers: 40 percent and 60 percent with standby at 60 percent of system load or 50, 50, 50 percent configuration.*

G. On boilers with power burners, provide a temperature indicator on the boiler exit breaching.

## 20.0 HVAC—COOLING

A. General

1. Design cooling systems using mechanical vapor compression equipment (direct expansion coils or chillers) when close (better than plus or minus 5° degrees F) temperature control in the space is required.

## 21.0 HVAC—COOLING TOWERS

A. When used, follow ESM Chapter 6.

## 22.0 HVAC—BUILDING THERMOSTATIC ZONES

A. Permanent Partitions (floor-to-ceiling): Provide the following minimum thermostatic zones:

1. Each corner office on exterior walls

2. Each laboratory

3. Each conference room
4. Maximum of three (3) offices with similar exposure and/or internal loads
5. Each toilet room with a shower

B. Open Office Area (moveable partitions): Provide a thermostatic zone, 10-15 feet from the exterior wall, for each exposure (e.g., N, S, E, and W), and a thermostatic zone for the interior area unless Mechanical POC gives variance. Each VAV box within the zone shall serve no more than 6 supply air diffusers.

## 23.0 HVAC—DIFFUSERS, GRILLES, REGISTERS, AND LOUVERS

A. Select diffusers, registers, grilles, and louvers based on ASHRAE, SMACNA, and the manufacturer's recommendations. Give special attention to supply air diffusers and grilles in laboratory areas. Refer to latest ASHRAE Application Handbook chapter on laboratories.

B. Base selection on air flow, noise criterion (NC) level, air pattern, throw, mounting height, face velocity, pressure loss, aesthetic, etc., requirements.

C. Provide an integral opposed-blade damper only when a manual-balancing damper cannot be installed in the branch duct.

D. Provide drainable blade louvers with bird-screen for outside air intake and discharge louvers to provide proper drainage of snow and rainwater.

1. Louvers shall bear the AMCA Seal with ratings based on tests and procedures performed in accordance with AMCA Publication 511. The AMCA Certified Rating Seal applies to air performance and water penetration ratings.

E. Connect outside air ducts for building makeup air systems directly to a fan system. Do not use mechanical rooms as air plenums.

F. Provide flexible connections immediately adjacent to the suction and discharge ends of moving equipment, e.g., fans, AHUs, etc.

G. Construct exhaust systems with materials suitable for service, e.g., stainless steel, non-galvanized, etc. Ducts handling high abrasive or corrosive materials shall be sufficiently resistant to same.

H. Route trunk ductwork parallel to building walls to conserve ceiling space and allow for future utilities.

I. Provide an airflow indicator for new or modified fume hoods and other local exhausts such as welding bench hoods, etc. See Mechanical Standard Drawing(s) ST-D3040-1 for installation details on a hood static pressure gage.

J. Paint visible interior duct surfaces behind air terminal units flat black as required where reflection (dark rooms), or aesthetics is a concern.

## 24.0 HVAC—DUCT LINING

A. Limit the use of duct lining as much as possible (due to potential IAQ issues). Document justification for its use. If its use is justified, limit use to the following:

1. As an acoustical liner to absorb unwanted crosstalk, equipment, and air rush noise.
2. As an insulator when ductwork is located outdoors and requires insulation, but exterior insulation is not practical

## 25.0 HVAC—FANS

A. Select fan so that its minimum operating point, such as minimum airflow for VAV systems, falls on the negatively sloping portion of the pressure curve to prevent surging or pulsation.

B. Carefully analyze system effect in fan sizing to minimize a “derating” of the HVAC system fan. Refer to SMACNA HVAC Systems Duct Design Manual.

## 26.0 HVAC—FILTERS FOR HVAC SYSTEMS AND HEPA EXHAUST SYSTEMS

A. HVAC Systems

1. Pre-Filter: Provide a Minimum Efficiency Reporting Value (MERV) #8 filter, per ASHRAE Standard 52.2, unless usage of space dictates a higher efficiency and class of filter.[24]
2. Exhaust restrooms and janitor’s closets at a rate of not less than that specified in ASHRAE Standard 62.

## 27.0 HVAC—SUPPLY AIR INTAKES

A. Locate intakes at least 24 inches above grade to prevent intake of snow.



[24] Filter class per ASHRAE Handbook HVAC Systems and Equipment, 2012

# CHAPTER 7 ELECTRICAL

## 1.0 SITE-SPECIFIC REQUIREMENTS

A. Elevation

1. Diminished dielectric strength of air
    a. Use 600-volt contacts for 480-volt power circuits
    b. Order medium voltage equipment with a BIL of 110kV (at sea level) in order to achieve a BIL of 95kV at 7500 feet.
2. Diminished cooling
    a. Must derate equipment accordingly

B. Solar heat gain = 110 W/ft$^2$ (direct sunlight)

C. Lightning protection

1. Perform calculations per NFPA780 Annex L. If these calculations recommend lightning protection, LANL requires it.
    a. Ground strike rate: 3 / km$^2$ / year

D. Soil Rho: 225 $^o$C-cm/W

E. Ambient earth temperature of 20°C (68$^o$F) outside the perimeter of a heated building

F. Ambient earth temperature of 30°C (86$^o$F) inside the perimeter of a heated building

G. Utility: 15kV distribution system[25] (Responsibility of LANL-UI)

1. To obtain available fault current: faultcurrent@lanl.gov
2. Service point is at the secondary lugs of the utility transformer, unless otherwise indicated by LANL-UI.

## 2.0 MAINTAINABILITY

A. Provide door-in-door panelboards.

B. Install labels on receptacles and light switches indicating circuit number and panelboard.

C. Rodent proofing

1. Seal all cable entries and plug unused conduits entering outdoor equipment with material that rodents will not be able to gnaw through, squeeze through, or push side. *Suitable materials include 24-gauge or heavier galvanized sheet steel, 19-gauge galvanized woven/welded 1/4" mesh hardware cloth, 16 to 19-gauge stainless steel 1/4" mesh hardware cloth, and galvanized lath screen.*

[25] Substation transformers that supply the medium voltage distribution system have 13.8 kV secondaries. Utility transformers that are connected to this distribution system, for supplying facilities, have 13.2 kV primaries.

2. When penetrating an exterior wall, roof, or floor with conduit, wireway, enclosed busway, etc., seal openings and provide a metal collar securely fastened to the structure.

3. Seal all cable entries and plug unused conduits entering indoor equipment from outdoors with material that rodents will not be able to gnaw through, squeeze through, or push aside. Suitable materials include 24-gauge or heavier galvanized sheet steel, 19-gauge galvanized woven/welded 1/4" mesh hardware cloth, 16-19-gauge stainless steel 1/4" mesh hardware cloth, and galvanized lath screen.

D. Feed buildings with 480/277 volts

1. Use multiple small transformers (75kVA or less) for interior power distribution.

a. 75 kVA transformers have small amounts of available fault current and result in incident energies less than 1.2 cal/cm$^2$.

b. Larger transformers may be used with the permission of the electrical standards point of contact.

c. Supplying the facility with 480/277 also allows the option of using transformers with a European secondary, 400/230, for the powering of special equipment.

E. UPS installations

1. Supply batteries that are plug-in instead of wired terminals.

2. Power input to external maintenance bypass switch must be transformer isolated to prevent bonding issues. System Bonding Jumper must be in the external maintenance bypass switch only. The UPS itself and the Bypass Transformer must not have a system bonding jumper.

F. Identification and labelling

1. Provide engraved laminate nameplates on all equipment.

2. Provide incident energy information per NFPA 70E, *Standard for electrical safety in the workplace.*

G. Separately derived system

1. System Bonding Jumper at transformer location instead of first disconnect.

## 3.0 OPERABILITY

A. Locations above 40cal/cm$^2$:

1. Provide remote operation of circuit breakers.

a. Plug in Umbilical cord or pendant

b. Remote control panel

2. Provide Permanently Mounted Absence of Voltage Tester (e.g., Panduit VeriSafe) online and load side of OCP[26] switch in these locations.

B. Use equipment listed by a NRTL[27], where available. Unlisted equipment, if it contains an electrical circuit over 50 VAC or 100 VDC, must be approved by the AHJ before use.

C. Use IEEE-841[28] motors whenever possible.

D. Enclosed offices, conference rooms, and similar interior spaces: Provide one outlet on each wall plus additional outlets so no point measured horizontally on any wall space is more than 6 ft from a general-purpose receptacle outlet. In no case shall there be more than 8 devices per circuit.

## 4.0 SUSTAINABILITY

A. Provide remotely monitored (e.g., SCADA, EES, or BAS) metering for electrical service when structure > 5,000 ft$^2$.

1. See Chapter 14 and contact umetering@lanl.gov for specifications on type of meter.

B. Use LED lighting

1. Design facility to comply with applicable energy codes, and Federal Purchasing Requirements, including FEMP designated products.



[26] Overcurrent Protection. Either Circuit breaker or set of fuses
[27] Nationally Recognized Testing Laboratory. E.g. UL, FM, TUV, CSA
[28] Motor standard developed for the petroleum and chemical industries. IEEE-841 motors have an external ground lug on the frame, better vibration characteristics, more robust bearings, better Ingress Protection characteristics, more accurately milled frames for alignment concerns, and are inverter duty (for VFDs).

# CHAPTER 8 INSTRUMENTATION & CONTROLS (I&C)

## 1.0 BUILDING AUTOMATION REQUIREMENTS (I&C):

A. Provide a LANL yellow network connected Building Automation System (BAS) for new and existing facilities as follows:

1. Any air-conditioned facility > 5,000 $ft^2$
2. Modifications to facilities with an existing BAS
3. In buildings less than 5,000 $ft^2$ when complexity of system (i.e., VAV), accuracy (e.g., tight temperature control not more than +/-1 deg F), or energy payback justifies cost

B. The BAS shall be of the brand and manufacture stated in LANL Master Specification Section 25 5000 with no substitutions allowed, for the purposes of remote-monitoring by the LANL site-wide BAS server, life-cycle operations and maintenance, spare parts management, and technician training and qualification.

C. Equipment protection safeties must be hard wired to provide protection for the following (see LANL Master Specification Section 25 5911):

1. Freeze protection of water coils and/or water filled systems
2. High/low duct pressures that can damage ductwork or building structures
3. Fire alarm shutdown when required by code
4. Other safeties needed, not provided as part of the HVAC equipment, that protect equipment, property, or personnel

D. Control cabinets used for BAS shall:

1. Be designed to contain voltages no greater than 50V to allow safe serviceability
2. Be shown on the floor plans to allow locating for future maintenance
3. Have dedicated power sources, if power is not supplied by the controlled HVAC equipment, to ensure clean power for reliable operations

E. BAS power sources shall be of the NEC Class 2 type and use resettable breaker protection if sourcing greater than 40VA. Reset shall be accessible without exposing voltages greater than 50V.

F. When using HVAC/skid-mounted equipment with integral controls, the Engineer of Record must show proof that acceptable integration with the BAS can be accomplished during Title II review (see ESM Chapter 8, 5.3.D for acceptable means to accomplish this).

G. Special systems that must be monitored and generate alarms upon detection of failure by the BAS include, but are not limited to:

1. Heat trace systems for freeze protection
2. Server and equipment room temperatures
3. Water coil freeze protection circulation pumps

4. Other systems, where undetected failure can cause significant damage to facilities or programs

H. Sensors connected to the BAS must be adequate to remotely monitor and diagnose controlled equipment failures and shall include:

1. Temperature change sensing of heat/cool producing devices (e.g., coils)
2. Analog current sensors for the detection of operations for motors (e.g., fans, pumps)
3. Alarm contacts from internal system controls
4. VFD internal signals using network connections (i.e., BACnet MSTP).

I. Networks used for controller-to-controller or controller-to-equipment shall use ASHRAE BACnet MSTP or BACnet Arcnet for communications. Network connections shall not be used to directly control major equipment. Used hard wired points for major equipment control.

J. Night setback shall be implemented in all BAS control systems, independent of whether it is required for the current application. It may be disabled for 24/7 applications but must be easily re-enabled when needed.

K. Use Sections in Div 25 of the LANL Master Specifications for BAS installations, edited to the project requirements.

## CHAPTER 9 SECURITY

Follow ESM Chapter 9 and associated LANL Master Specifications and Std. Details; DOE O 473.1A Attachment 1 CRD, *Physical Protection Program* is mandatory.

## CHAPTER 10 HAZARDOUS PROCESS

Follow ESM Chapter 10 when hazardous materials are expected to be used in the structure.

## CHAPTER 11 RADIATION PROTECTION

N/A

## CHAPTER 12 NUCLEAR

N/A

## CHAPTER 13 WELDING, JOINING, & NDE

A. Follow LANL Master Specification Section 01 4444, *Off-Site Welding & Joining Requirements*. Use for all projects/procurements when welding is required by design or other sections of the Specification (e.g., items or assemblies fabricated specifically for LANL). This Section is not applicable to manufactured commercial items (“off-the-shelf”) where welding requirements are not subject to LANL approval, nor does it apply to mechanical joints (e.g., threaded, bolted, or clamped).

B. Follow LANL Master Specification Section 01 4455, *On-Site Welding & Joining Requirements*. This Section summarizes requirements for welding and joining on the LANL site as required by design or other sections of the Specification, consensus codes and standards, and/or engineering design.

C. Follow LANL Master Specification Section 01 4631, *Welding of B31 Piping*, for all ASME B31 series piping.

## CHAPTER 14 SUSTAINABLE DESIGN

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On or about February 1st, 2023, LANL is adopting the 2021 edition of selected ICC-codes; Projects with a code of record (CoR) date after that point shall apply the 2021 editions for the following codes referenced within this document*: International Building Code (IBC), International Existing Building Code (IEBC), International Fire Code (IFC).* Questions regarding code and standard year compliance should be directed to the ESM discipline chapter point of contact (POC).

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## 1.0 REQUIREMENTS

CAUTION: The project impact of this chapter can be significant, and warrants review early in the project planning and programming phases, such as CD-0 and CD-1.

A project's scope will determine the sustainable design and construction requirements for the project based on the following list of Federal Regulations (CFR), U.S. Code, and DOE/NNSA orders, as well as by LANL-adopted building codes. This subject is evolving rapidly, so check the web links included with the Chapter References for latest mandates and guidance.

| | |
|---|---|
| **7 USC 8102** | Title 7-Agriculture, Chapter 107-Renewable Energy Research and Development, 8102-Biobased markets program, requires the use of biobased products. |
| **10 CFR 433** | Energy Efficiency Standards for the Design and Construction of New Federal Commercial and Multi-Family High-Rise Residential Buildings. 433.8 requires life-cycle cost effectiveness. Subpart A establishes energy efficiency performance requirement and Subpart C establishes green building certification requirements for Federal buildings. |
| **10 CFR 436** | Federal Energy Management and Planning Programs: sets forth rules for energy management and planning to reduce energy consumption and promoting life-cycle cost analysis. Subpart C requires the use of efficient energy using equipment. |
| **42 USC 6834** | Title 42-The Public Health and Welfare, Chapter 81-Energy Conservation and Resource Renewal, Subchapter II-Energy Conservation Standards for New Buildings, (a)(3)(A)(iii) requires solar hot water in new Federal, and buildings undergoing a major renovation(modernization). |
| **42 USC 6962** | Title 42-The Public Health and Welfare, Chapter 82-Solid Waste, Subchapter VI-Federal Responsibilities, 6962-Federal procurement, requires the use of materials with recycled content. |
| **DOE O 436.1** | Departmental Sustainability |
| **EO 14057** | Executive Order on Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability, which states that "Each agency shall achieve net-zero emissions across its portfolio of buildings, campuses, and installations by 2045 and reduce greenhouse gas emissions by 50 percent from buildings, campuses, and installations by 2032 from 2008 levels, prioritizing improvement of energy efficiency and the elimination of onsite fossil fuel use." |
| **NA-SD-430.1** | Real Property Asset Management. Note: Its CRD implements the order and its mention of the NNSA RPO's SD requirements at 10.0 leads to following the GPs. |

***Table-2. Major SD Requirement Applicability***

**Note:** Column headings refer to a section heading that follows Table 1, but Table 1 does not indicate ALL requirements.

| | **Minimum Requirement(s)** | | | | | | |
|---|---|---|---|---|---|---|---|
| | IECC or 90.1[29] | 10 CFR 436 (Subpart C) | 10 CFR 433 | GP | Efficient Labs | Green Purchasing | Zero Carbon Emissions Ready |
| | **Corresponding to the following Sections:** | | | | | | |
| **Project Scope** | **A** | **B** | **C** | **D** | **E** | **F** | **G** |
| "Alteration"[30] or "repair" of buildings and building systems | **X** | **X** | | | | **X** | |
| New (or additions to) buildings | **X** | **X** | **X** | | | **X** | |
| New (or additions to) buildings over 5000 sq. ft. | | **X** | **X** | **X** | | **X** | |
| Modernization of buildings over 5000 sq. ft. | | | | **X** | | **X** | |
| Laboratories or fume hoods[31] | | | | | **X** | **X** | |
| New buildings or modernization over 25,000 sq. ft. | | **X** | | **X** | | **X** | **X** |

A. IECC or ASHRAE 90.1: Building and system alterations and repairs meeting LANL-centric versions of International Existing Building Code (IEBC) definitions of same[30] shall meet energy conservation requirements of the IEBC and IECC—see IECC-Commercial Provisions Chapter 5 [CE]—or simply follow the corresponding version of ASHRAE 90.1. When using the IECC, follow the more stringent of IECC or the New Mexico Commercial Energy Conservation Code (see ESM Ch. 16 Section IBC-GEN Att A for editions and details on both).[32]

B. Code of Federal Regulations: 10 CFR 436 Subpart C Agency Procurement of Energy Efficient Products. Projects that involve installation, alterations, repair, or replacement of energy using equipment or services, shall meet the Federal requirements.

[29] ASHRAE 90.1 is an alternate compliance path within the IECC.
[30] LANL-centric IEBC alteration definitions are in ESM Ch 16, IBC-GEN Form 1 Preliminary Project Determinations.
[31] Efficient Lab requirements are in addition to any and all applicable requirements in Table 1.
[32] Most stringent required by ESM Chapter 1 Section Z10. When extensive modifications and new buildings, additions, and modernizations meet the more stringent requirements (10CFR433, GP, LEED, etc.), compliance with IECC is automatic.

1. Select energy-consuming products and services consistent with the criteria of ENERGY STAR and FEMP-designated energy-efficient products in accordance with 10 CFR 436.40-436.43.

2. If ENERGY STAR/FEMP equipment is found not to be LCC effective, using the LCC analysis in 10 CFR 436, subpart A, document non-compliance and submit for LANL acceptance: site-sustainability@lanl.gov.

*Guidance: Subpart A of 10 CFR 436 points out that insignificant costs for energy or water saving equipment is to be automatically presumed LCCE and therefore no LCC analysis is needed. It also defines instances when it can be presumed not to be cost-effective.*

*When multiple, separate projects, in their entirety, may result in extensive alterations or modernization of a building greater than 5,000 square feet, projects should consider coordinating with the Sustainability Program, and other projects to design with the intent to meet the Guiding Principles for Sustainable Federal Buildings, see Guiding Principles section below and guidance posted with Chapter.*

C. Code of Federal Regulations: 10 CFR 433 Subpart A (new construction only)

1. Design new buildings and additions in accordance with 10 CFR 433 by meeting ASHRAE 90.1-2016[33] and, if life-cycle cost-effective, achieve energy consumption levels that are at least 30% below the levels of ASHRAE 90.1-2016 Baseline Building. Note: Use 2019 edition beginning April 7, 2023; sooner if required by Project.

   a. Energy consumption for the purposes of calculating the 30% savings requirements shall include the building envelope and energy consuming systems normally specified as part of the building design by ASHRAE 90.1 such as space heating, space cooling, ventilation, service water heating, and lighting but shall not include receptacle and process loads not within the scope of ASHRAE 90.1 such as specialized medical or research equipment and equipment used in manufacturing processes. Energy consumption levels for both the ASHRAE Baseline Building and proposed building shall be determined by using the Performance Rating Method found in Appendix G of ASHRAE 90.1 (and provide for LANL review).

   b. If a 30-percent reduction is not life-cycle cost-effective, the design shall be modified to achieve an energy consumption level at or better than the maximum level of energy efficiency that is LCC effective, but at a minimum complies with ASHRAE 90.1-2016.

[33] Per 87 FR 20293 (Apr. 7, 2022), design new buildings for which design for construction begins on or after April 7, 2023, using ASHRAE Standard 90.1-2019 as the baseline standard for 10 CFR part 433. Until then, LANL has opted to use the 2016 version of ASHRAE 90.1 to be congruent with New Mexico Commercial Energy Conservation Code. Projects may opt to use the 2019 baseline immediately.

(2019 edition beginning April 7, 2023; sooner if required by Project).

2. In analyzing the life-cycle costs of design options, compare the following:

   a. The cost to retrofit fossil-fuel burning equipment, if used, or modify the facility, to reach zero carbon emissions by 2030 (if over 25,000 GSF) or by 2045 (if less than 25,000 GSF).

   b. A Zero Carbon Emissions Ready Building such that the addition of solar panels or other renewable energy technologies would create zero emissions building operation, aligning with Guiding Principle 2.3 requiring LCC analysis of renewable electric energy sources.

   c. A zero-carbon emissions building.

   *Guidance: Access ASHRAE 90.1 training slides from the link web posted with this Chapter. Also, the 90.1 User's Manual is a 'must have' when addressing anything in the Standard.*

D. Guiding Principles (GP) for Sustainable Federal Buildings

1. New construction, additions, and modernization of buildings[34] over 5,000 square feet shall comply with the requisite criteria of the most current *Guiding Principles for Sustainable Federal Buildings* by meeting 18 core and 9 out of 12 non-core criteria of the GP [NNSA SD 430.1; DOE O 436.1].

   a. The building's inherent function, mission, safety, or designation may preclude it from meeting the minimum threshold of requisite criteria in a life-cycle cost-effective manner [U.S.C. § 17061(12)]. Buildings that have met as many of the requisite criteria that are life-cycle cost-effective may be designated as a "Federal high-performance building." GP performance must be tracked and reported throughout the project regardless of expected outcome.

2. Project management must establish roles and responsibilities for project verification and identify such in RCD, RFP, A/E subcontract or other pertinent project documents.

   a. Guiding Principles Appendix C allows for certification through other Green Building Certification Systems. Note that many statutory and regulatory requirements are not included in the third-party systems and must still be met and documented.

3. Buildings that are exempt from compliance with the GP:

   a. are non-building assets; or

   b. are leased; or

[34] Includes joined transportables when over 5,000 square feet.

c. Slated for disposal (as a status indicator of report of excess [ROE] submitted or ROE accepted, Determination to Dispose, or Surplus; or

d. meet all of these conditions:

(1) Unoccupied: The building is occupied 1 hour or less per person per day on average

(2) Low/No Energy Use: Total usage from all sources is less than 12.7 kBtu/GSF/year

(3) Low/No Water Use: Consumption is less than 2 gal/day on average

E. Efficient Labs: In accordance with 10 CFR 436, Subpart A (the objective being to apply LCC-effective energy and water conservation in the design of Federal buildings), when adding fume hoods or constructing new lab spaces[35] follow energy efficient laboratory design principles when safe and LCC-effective. If judged not possible, or not LCC effective, a reduction in this requirement will be allowed through a formal process (e.g., Variance Form 2137).

1. Such projects shall consider using the Labs21 Environmental Performance Criteria of International Institute of Sustainable Laboratories (I2SL) and the Sustainable Strategies Checklist. *The criteria and checklist will assist in meeting the required energy efficiency metric for GP and 10 CFR 433 and includes these seven key elements:*

a. Dynamic, direct-digital control systems

b. Real time demand-based ventilation to control air changes per hour

c. Efficient lighting (LEDs with occupancy sensors or timers)

d. Optimization or reduction of the exhaust fan discharge velocity (design study of exhaust dispersion based on site conditions)

e. Pressure drop optimization

f. Fume hood flow optimization: apply AIHA/ANSI Z9.5 Standard to analyze if fume hood standby ventilation can be reduced

g. Final commissioning and continuous commissioning with automated cross platform fault detection diagnostics.

*Guidance: Fault detection diagnostic software is managed by UI FOD and is easily achievable with a digital control system on the yellow network.*

*Refer to Lawrence Berkeley Lab's Design Guide for Energy-Efficient Research Laboratories for additional SD guidance.*

[35] Achieving GP certification for lab spaces often necessitates the use of programs such as this, and SmartLabs is a LANL initiative in the FY19 Site Sustainability Plan (SSPP). Refer to ASHRAE 90.1-2016 Section 6.5.7.3 for laboratory design requirements.

*In addition, LANL is an implementing partner of DOE's Smart Lab Accelerator Program. The Smart Lab concept includes an integrated set of laboratory design criteria and performance standards that improves safety protocols and reduces energy consumption while offering continuous commissioning for real-time monitoring of facility conditions. The LANL Sustainability Program page has more information and SME contacts.*

*I2SL Best Practice Guides (may have value for non-lab applications, too).*

F. Green Purchasing/Environmentally Preferable Products (EPP)[36]

Sustainable acquisition, or "green purchasing," refers to purchasing products with specific environmental or energy attributes. The US Department of Energy (DOE), and therefore LANL and its subcontractors are required to purchase goods and services that can reduce environmental impact.

1. To expedite green purchasing in facility related projects, several LANL Master Spec sections have been revised to specify EPP where appropriate; however, this may not address all potential products for every project, therefore, the project's design agency is responsible for the creation of appropriate project spec sections.
2. Refer to the listing of required EPP and recommended attributes in Attachment 1 of ESM Chapter 14 to guide in the incorporation of EPP products.[37] Additional resources are posted with the Chapter.
3. Facility projects, both new construction and alterations, must purchase products with EPA, DOE, and USDA environmental or energy-attribute recommendations unless the product:
   a. Is not available at a reasonable price (code "CU")
   b. Is not available competitively within a reasonable period of time ("DNI")
   c. Does not meet the Laboratory's performance standards ("DNMS")
4. The following categories of products are required:
   a. 7 USC 8102 and FAR clause 52.223-2: The United States Department of Agriculture (USDA) designates certain biobased products for federal procurement and specifies minimum biobased

[36] DOE O 436.1, Departmental Sustainability; CRD requires a LANL EMS that protects the environment and enhances mission accomplishment. LANL contract and ASM requirements based on FAR, Part 23 for requirements, FAR 52.223-5 and other clauses; DEAR 970.5223-7 (POC and EPC-ES have details). Also, LANL EMS and FY19 SSPP included environmentally preferable purchasing commitment derived from the DOE Sustainability Performance Office webpage: "Numerous Federal laws and regulations outline specific agency energy consumption, renewable energy, and water efficiency requirements. The DOE Federal Energy Management Program (FEMP) offers information on these laws and regulations. SPO focuses on the following high-level requirements…Ensure 95% of new purchases and contracts meet sustainable procurement requirements…" FY19 SSPP stated: "Promote sustainable acquisition and procurement to the m
aximum extent practicable, ensuring BioPreferred and biobased provisions and clauses are included in 95% of applicable contracts."

[37] Attachments to the Chapter will be updated periodically by Ch 14 POC-only approval and without revision to chapter body based on changing guidance.

content levels for those products. Designated products shall meet USDA BioPreferred Program's minimum biobased content level.

b. 42 USC 6962 and FAR clause 52.223-17: Under the Comprehensive Procurement Guidelines (CPG) program, the Environmental Protection Agency (EPA) designates products that are or can be made with recovered materials and recommends practices for buying these products. Any designated product shall meet the minimum recommended content levels as identified under the CPG program.

c. ENERGY STAR and FEMP-designated products per 10 CFR 436, Subpart C for all energy consuming products and services. See section B of this Chapter.

5. Although not required by a statute or regulation, LANL encourages the LCC effective use of construction products and building supplies recommended under *EPA's Recommendations of Specifications, Standards, and Ecolabels for Federal Purchasing*, as appropriate and applicable. When purchasing for a GP or LEED facility, low-emitting materials will be required.

G. Zero Carbon Emission Ready Buildings: Design new construction and modernization projects greater than 25,000 gross square feet to be net-zero emissions by 2030.[i]

1. Zero Carbon Emission Retrofit Design: When project will not achieve net-zero, it shall also provide future retrofit design at the conceptual (30%) maturity level. Plans shall be prepared and delivered separately from plans for initial construction and labeled as "Zero Carbon Retrofit". Whole building energy modeling shall be used to demonstrate that plans will achieve the goal; assume that LANL's electricity may not be zero emissions until 2032 or later.

2. Concerning initial project scope versus retrofit decisions, projects shall initially construct all design elements that:

a. are LCC effective

b. would cost considerably more to retrofit before 2030, than to install with initial construction (for example installing structure/floor space, conduit, pull-boxes, etc. instead of doing renovations before 2030 to accommodate a future PV system)

c. would cause the major renovation or demolition of portions of the building that have not yet reached their useful lifespan (for example demolition of a VAV system to retrofit to a VRF system by 2030)

*Guidance: Designs should focus on elimination of onsite fossil fuel use, and should include infrastructure such as electrical pull boxes, space*

*planning for battery back-up, and structural planning for future installation and connection of carbon-emissions-free energy sources.*

H. Install building-level energy and water meters.

Follow ESM Ch. 14 Att. 2, *Utility Metering Requirements*.

I. Other SD Requirements

1. Provide electric vehicle (EV) chargers where dedicated Government Owned Vehicle (GOV) parking is part of the scope of the project. When non-GOV parking is part of the scope of the project, EV chargers may also be needed to fulfill requirements in Guiding Principles or LEED projects.
2. Install cool roofs for new construction or when replacing roofs unless determined uneconomical by a life-cycle cost analysis.[38] [Secretarial Memo of June 1, 2010]
3. Per 42 USC 6834, install a solar thermal system to supply 30% of the hot water load in new buildings and major renovations, if LCC effective.[39]
    a. Use the FEMP solar hot water calculator when performing initial simple payback analysis; use Albuquerque for nearest city. If simple payback period is greater than 24 years, solar water heating is not cost effective.
    b. Follow IAPMO *Uniform Solar Energy Code (USEC)*, edition and amendments per ESM Chapter 16 Section IBC-GEN Attachment A, *LANL Building Code,* when designing a solar thermal system.

    *Contact site-sustainability@lanl.gov for guidance which may preclude the need to calculate.*
4. Develop and follow a Waste Minimization Plan. Develop prior to construction start and follow throughout project. The goal is that constructor recycle or salvage at least 50 percent of construction, demolition and land clearing waste, excluding soil, where markets or on-site recycling opportunities exist. Architectural POC may have examples. Guiding Principles and LEED Projects will have related requirements.



[38] To be considered cool, a low-sloped roof (pitch less than or equal to 2:12) must be designed and installed with a minimum 3-year aged solar reflectance of 0.55 and a minimum 3-year aged thermal emittance of 0.75 in accordance with the Cool Roof Rating Council program, or with a minimum 3-year aged solar reflectance index (SRI) of 64 in accordance with ASTM Standard E1980-01. Steep-sloped roofs (pitch exceeding 2:12) must have a 3-year aged SRI of 29 or higher.

[39] Energy Independence and Security Act (EISA 2007) Section 523, through amendment of the Energy Conservation and Production Act, states, "if lifecycle cost-effective, as compared to other reasonably available technologies, not less than 30 percent of the hot water demand for each new Federal building or Federal building undergoing a major renovation be met through the installation and use of solar hot water heaters." Domestic hot water should not be the only considered load, but hot water used for the purpose of space heating should be considered as well. ESM Ch. 1 Z10 design goal references give a 24-year life for a heat exchanger.

## CHAPTER 15 COMMISSIONING

Note: LANL will perform startup and commissioning (Cx) for the majority of projects and systems constructed to this document, including but not limited to new buildings (including prefabricated buildings), building additions, International Existing Building Code (IEBC) Level 3 alterations, all other projects performed under System Description (SD) 350, *Project Management for Capital Asset Acquisition and Construction*, and other projects identified by the Facility Design Authority Representative (FDAR).

A. The Site M&O Contractor will perform or contract with an experienced commissioning provider (CxA) who is independent of the project design and construction team and the operations team. The CxA will employ commissioning tailored to the size, complexity, and management level of the building and its system components in order to optimize and verify performance of building systems.

B. Commissioning will be performed per LANL Engineering Standards Manual (ESM) STD-342-100 Chapter 15 Commissioning with a graded approach. The appropriate level of rigor for ML-4 projects can be found in *Table 1 – Minimum Level of Rigor in Cx* in Section 1.0.E of the ESM STD-342-100 Chapter 15 Commissioning.

C. LANL Master Specification 01 9100, *Commissioning* specifies additional requirements associated with Commissioning.

## CHAPTER 16 BUILDING PROGRAM

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On or about February 1st, 2023, LANL is adopting the 2021 edition of selected ICC-codes; Projects with a code of record (CoR) date after that point shall apply the 2021 editions for the following codes referenced within this document*: International Building Code (IBC), International Existing Building Code (IEBC), International Fire Code (IFC).* Questions regarding code and standard year compliance should be directed to the ESM discipline chapter point of contact (POC).

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### 1.0 BUILDING DEPARTMENT

Because LANL is a standalone jurisdiction (including LBO and AHJ for codes), LANL processes for design review, permitting, inspection, and certificate of occupancy shall be followed; LANL project engineer will broker/handle all LBO interactions.

### 2.0 DESIGN PROFESSIONAL IN RESPONSIBLE CHARGE (DPIRC) DUTIES

A. Develop statement of special inspections (SSI) when required by IBC 1704.3; see ESM Chapter 16 Section IBC-IP for acceptable template.

B. Submit required structural observations to the LANL Lead Chief Inspector. Structural observations are the responsibility of the structural engineer of record (EOR) unless otherwise stated in the Subcontract. EOR must subcontract observations if he/she is in the same company as the prime Subcontractor, and LBO must approve observation performance by persons other than the structural EOR.

C. Submit any revised occupancy and use categories [and IEBC alteration level(s) for existing building modifications] through LANL Project personnel.

D. Delegated design: The DPIRC is ultimately responsible for delivering all engineering products required by the ESM/Subcontract to the LBO, even those specialties that are delegated [exception: design by constructing firm's subtiers (e.g., fire protection), in which case such design is accepted by DPIRC]. When retained for engineering services during construction, this includes managing change control, as-built construction documents (where required by contract), etc.

E. Edit LANL Master Specification Section 01 4000, *Quality Requirements – Non-nuclear* and include in Project Specification.

F. Design revision after permitting: LBO re-approval is required when the changes (a) do or could affect code compliance including but not limited to fire, structural, life safety, and/or egress or (b) change the scope.

### 3.0 CONSTRUCTION SUBCONTRACTOR DUTIES

A. Develop test and inspection plan (TIP); see ESM Chapter 16 Section IBC-IP for acceptable template.

B. Follow the Offsite Structural Fabricator Approval Process (ESM Ch.16 Section IBC-FAB) when seeking approval of fabricators to perform certain IBC work without mandatory in-shop special inspection/expense, then submitting Offsite Structural Fabricator Certificate of Compliance (IBC-FAB Att B). Submit any requests to LANL; Chief Inspector requires two (2) weeks lead time.

C. Ensure only LBO-approved third-party testing agencies are used (listing on ESM Ch.16). If preferred testing agencies are not on the approved list, subcontractor the testing agencies they prefer to use are not on that list they may submit the necessary data for evaluation (see IBC-TIA). Submit any requests to LANL; Chief Inspector requires two (2) weeks lead time.

D. Begin work when authorized. Construction work including offsite structural element fabrication work must not start until authorized by the LANL Bldg Program after evaluating that the project has complied with all necessary IBC and LANL Bldg Program requirements. (Exceptions: grading, excavation, storm water protection, and D&D not affecting life safety/egress or requiring design may proceed).

Note: Only the LBO may authorize construction-at-risk or procurement involving submittals or inspection with sufficient justification.

E. Project must follow the approved inspection plan(s) and, where applicable, Subcontractors submit ESM Chapter 16 Section IBC-IP Att H “Subcontractors Statement of Responsibility (with respect to Special Inspection)”.

# CHAPTER 17 PRESSURE SAFETY

## 1.0 BUILDING REQUIREMENTS

A. Applicable Code of Federal Regulations

1. 10 CFR 851, Worker Safety and Health Program

B. New Mexico Administrative Code

1. NMAC Title 14 Housing and Construction, Chapter 9 *Mechanical Codes*

C. This approach is valid for pressure systems that are not strong oxidizers like oxygen, nonflammable, nontoxic, and not damaging to human tissues.

D. Positive pressure systems, the minimum internal design pressure is 15 psig (103 KPa). The maximum internal design pressure is limited to the following:

1. Steam and condensate: 150 psig (1 034 KPa gage)
2. Liquids: 350 psig (2 413 KPa gage)
3. Compressed air and gas: 150 psig (1 034 KPa gage)
4. Refrigeration
   a. High side of water-cooled or evaporatively cooled systems: 104°F (40°C)
   b. High sides of air-cooled systems: 122°F (50°C)
5. Natural gas maximum125 psig

E. Vacuum systems shall be designed a minimum of 0 psig internal pressure and a maximum of 15 psig (103 kPa). of external pressure.

F. The minimum design temperature is 0°F (−18°C), and the maximum design temperature is limited to the following:

1. Steam and condensate: 366°F (186°C)
2. Other gases and vapors: 200°F (93°C)
3. Other nonflammable liquids: 250°F (121°C)

G. Boilers are restricted to ASME Section IV, *Rules for Construction of Heating Boilers*, when they are a minimum of 200,000 BTU/HR (60Kw), or 120 gallons. Boiler external piping shall meet or exceed ASME B31.9, *Building Services Piping*.

H. Water heaters not built to Section IV will be constructed to meet the following standards.

1. Interior finish shall comply with NSF/ANSI 61- [2016] barrier materials for potable-water tank linings.
2. Tank construction will be to ASME BPVC Section VIII, Division 1 [2021] when greater than 200 MBH or 120-gallon storage steel with 150-psig working-pressure rating.

I. Gas water heaters:

1. CSA/ANSI Z21.10.1:19/CSA 4.1:19, *Gas water heaters,* Volume I*, storage water heaters with input ratings of 75,000 Btu per hour or less*,] CSA/ANSI, Eighth edition, 2019, Incorporating Errata: September 2020
2. CSA/ANSI Z21.10.3:19/CSA 4.3:19, Gas-fired water heaters, Volume III, storage water heaters with input ratings above 75,000 Btu per hour, circulating and instantaneous, CSA/AM, Ninth edition, 2019

J. Electrical water heaters

1. UL 1453 UL Standard for Safety Electric Booster and Commercial Storage Tank Water Heaters [Sixth Edition]
2. UL 174 UL Standard for Safety Household Electric Storage Tank Water Heaters [Eleventh Edition]

K. Pressure vessels above 15 psig internal pressure are restricted to ASME BPVC Section VIII Division 1 [2021] construction.

L. Tanks below 15 psig internal pressure shall meet national consensus standards for their construction. ASME Section VIII may be used for tanks.

M. Refrigeration systems will be pressure tested, leak tested, and vacuum tested. Evaporator and condenser coils shall both be designed for the high side pressure. As an alternative leak testing may be performed to ASHRAE 15-2019 Addendum E (01/27/2022) paragraph 9.13.6. for acceptable leak testing alternatives.

N. Relief devices shall be ducted away from occupied areas to an area for safe release.

O. Leak testing of systems with design pressures of 150 psig or less may be an initial service leak test. A preliminary leak test at 10 psig is allowed.

P. Leak testing of systems with design pressures of greater than 150 psig shall be 1.5 times design pressure hydrostatically. If the LANL owner accepts, a gas system may be tested at 1.1 to 1.3 times design pressure. All joints shall be leak tested. A preliminary leak test at 10 psig is allowed for both hydrostatic and pneumatic testing.

Q. Welding evaluations shall meet the ASME B31.3 [2020] criteria for Normal Fluid Service.

R. Soldering joints are limited to copper. ASME B31.9 [2020] Table 917.3 provides maximum pressure and temperature ratings of copper soldered and brazed joints. Work shall meet ASTM B828, *Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings*. Copper that is soldered or brazed shall be evaluated in the annealed condition.

S. Weld or braze joints shall be used for pressure and temperature above the allowable solder range.

T. Threaded, welded, brazed, or flared joints shall be used within buildings. A pipe thread compound suitable for oil shall be used on threaded joints. Joints relying on friction, or a combustible material shall not be used. Brazing fittings or flare fittings shall be wrought. Flanged or grooved joints may be used with a gasket material meeting the requirements of ASME B16.20 and ASME B16.21 or another standard acceptable to the owner.

U. Pipe supports shall be defined by the Engineer and meet the MSS SP-58, *Pipe Hangers and Supports — Materials, Design, Manufacture, Selection, Application, and Installation*, [year] unless an engineering designed support is accepted by the LANL structural. When a structural support design is presented by a qualified designer and is determined to meet ESM Chapter 5, Structural, the design meets the ASME B31 piping support element fixtures requirements. Pre-engineered fixtures (e.g., off-the shelf built to specifications such as MSS SP-58) shall meet the applicable ASME B31 COR. (Requirement 17-0142) Site Specific Requirements.

V. The LANL Engineering Services Division acts as the “owner” as designated in the ASME Codes.

W. Single fault analysis required to determine expected pressures for pressure design or relief.

X. Boiler natural gas train to meet ASME CSD-1.

Y. ASME stamped relief devices are required for pressures of 15 psig and greater.

Z. Relief valve sized to no greater than twice required flow to prevent chatter.

AA. Rupture discs reverse ratio ≤1.

BB. Rupture discs damage ratio ≤1.

CC. Rupture disc operating ratios between 0.5 to 0.95.

DD. Hose restraints

1. Flexible hoses over 12 inches in length and in service pressure greater than 150 psig must be constrained at both ends or shielded in case of end-connector failure. The maximum separation distance between flexible hose restraints must not exceed 6-ft intervals. (e.g., an 8-ft. flexhose must use 3 restraints).
2. Hoses that are self-safeing do not require hose restraints, examples include Global Passive Safety Systems Lifeguard Hose, and U.S. Hose Corporation 402X with Spring Guard, that have a valve enclosed within each hose end do not require hose restraint because these hoses do not whip.

EE. Owners Inspector will be provided by LANL.

FF. Natural Gas distribution is governed by both ASME B31.8 and 49CFR192. The most stringent requirements of either apply. These requirements apply from the distribution system to the low-pressure side of service regulator. See ESM Chapter 3 for natural gas information.

GG. Natural gas from the low-pressure regulator to the appliance is required to meet NFPA 54.

HH. The test pressure will be reduced to the design pressure prior to allowing personnel into the area to examine for leakage. Pneumatic testing requires an exclusion zone evaluation (for example see ASME PCC-2, Repair of Pressure Equipment and Piping; Article 5.1, Mandatory Appendix III, Safe Distance Calculations for Pneumatic Pressure Test).

II. Use of ASME listed components is required, or an evaluation of an unlisted component will be provided as required by the code of record.

JJ. A copy of any ASME manufacturer's data report is required.

KK. All ASME accredited equipment (heating boilers, pressure vessels, etc.) will be NBIC registered and numbered.

LL. Test instrumentation used to meet the requirements of this chapter and codes must be calibrated as required by P330-2, *Control and Calibration of Measuring and Test Equipment (M&TE).*

## 2.0 MAINTAINABILITY PREFERENCES

A. Pressure system shall be provided with a means to safely vent relief system pressure for maintenance.

B. Boiler installation for maintenance shall be in accordance with the manufacturer's requirements or NBBI NBIC NB-23 Part 1.

## 3.0 OPERABILITY PREFERENCES

A. Documentation is required to support approval for use. See P101-34, Attachment A, *Acceptance for Use (AFU) of Pressure Systems*.

B. Pressure and Vacuum Gauges: Overpressure relief protection must be provided on Bourdon-tube dial-indicating pressure gauges that operate at pressures greater than 15 psig. Two methods that satisfy this requirement are:

1. Pressure gauges approved by Underwriters Laboratories (UL) in accordance with UL-404, "Standard for Gauges, Indicating Pressure, for Compressed Gas Service" Standard for Safety.
2. Tempered safety glass or plastic face or shield and a blowout back or plug for pressure relief.

## 4.0 SUSTAINABILITY REQUIREMENTS

A. Boilers, pressure vessels and piping shall be designed to provide corrosion allowance for a service life of 40 years.

## CHAPTER 18 SECURE COMMUNICATIONS

Follow ESM Chapter 18 when this is applicable.

## CHAPTER 19 COMMUNICATIONS

Follow ESM Chapter 19.

## CHAPTER 20 SYSTEMS ENGINEERING

Projects shall apply a graded approach for the following Systems Engineering requirements based on the project complexity and shall document the approach in the Requirements Criteria Document (RCD). Project complexity is determined by a series of criterion summarized in Section 5.2 (Conduct Project Complexity Analysis) of AP-350-100, *Initiation for Projects ≤ $50M.*

A. Systems Engineering requirements affecting A/E must be included in the Statement of Work to the A/E.

B. A/E shall generate, maintain, and provide a Requirements Verification Matrix (RVM; see ESM Chapter 20, Appendix F, for RVM content requirements).

C. The project shall generate and maintain a Test Acceptance Criteria (TAC) Table (see ESM Chapter 20, Appendix E, for TAC content requirements).

D. Verification methods shall be as established by the project.

E. A/Es shall conduct SSC verification activities for the SSCs within their scope.

F. A/Es to provide verification results and supporting documentation that are appropriate to the method of verification used.

G. A/Es shall capture in the RVM current status and verification completion results from all RV-performing parties throughout the project duration.

1. LANL Systems Engineer shall review verification results as they are completed to (1) confirm adequate satisfaction of the requirements by the SSC and (2) to resolve issues of inadequate performance. In absence of a Systems Engineer, PE takes responsibility or reviewing results.

## CHAPTER 21 SOFTWARE

N/A

## APPENDIX A: DEFINITIONS AND ACRONYMS

| Term | Definition |
|---|---|
| AE (or A/E) | Architect-Engineer. A design agency, normally not LANL but could be. |
| AHJ | Authority having jurisdiction. Term for technical authority in NFPA, safety, and Uniform Plumbing and Mechanical documents. This and similar terms are known generically as SMPOs at LANL (see SMPO). |
| As built | Documentation verified by physical inspection as depicting the actual physical configuration and verified as consistent with the design requirements. [DOE-STD-1073-93]. Alternatively, see Record Document. |
| ASHRAE 90.1 | *ANSI/ASHRAE/IESNA 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings* |
| Building Official | See ESM Chapter 16 Section IBC-GEN and LBO definition |
| Commissioning | A systematic process of assuring, by verification and documentation, from the pre-design phase to a minimum of one year after construction, that all facility systems perform interactively in accordance with the design documentation and intent, and in accordance with LANL's operational needs [see ESM Chapter 15, Commissioning when issued] |
| Consider | When used in a guidance (e.g., italicized) statement, it is suggesting the designer look at and think about following the guidance offered.<br>When "consider" is used in a requirement statement it strongly indicates that LANL does not want the suggestion dismissed out of hand. Good practice is to document the thought process of this consideration, particularly when rejecting the suggestion partially or wholly. In some cases, in the ESM, documentation is specifically required (e.g., design notes or memo to file); in other cases, submittal of such documentation for approval is required. See also "shall consider." |
| Constructor | Term for the entity performing fabrication or physical construction activity used primarily in the Engineering Standards but not contracts. When not LANL self-performed, this is the Subcontractor. |
| Contractor | Procurement (ASM) proforma (aka boilerplate) defines this as Triad, the prime contractor to DOE; however, in older ESM chapters this term may still be in use as the entity performing the work which may be design, offsite fabrication, onsite construction, and/or maintenance. This may be a subcontractor of Triad or a Triad employee. When the intention is that task is performed by Triad, then the term LANL is preferred since unambiguous and more timeless. |
| Design agency | The LANL organization or subcontractor (A/E) responsible for the preparation of engineering design and documentation [PD342]. See also DPIRC and EOR. |
| Design basis | This includes the design inputs such as design criteria and codes, plus design decisions captured in studies and calculations. |
| Designer | Anyone working in a design agency capacity, whether engineer, architect, drafter, or designer. |
| DPIRC | Design professional in responsible charge; the lead project engineer or architect in the Design Agency. Term is used by IBC (e.g., 107.3.4) and ESM Chapter 16. For AEs, the persons sealing (stamping) the documents. |
| EOR | Engineer of Record. Normally refers to the discipline lead in the Design Agency. |
| EPP | Environmentally Preferable Products |

| Term | Definition |
|---|---|
| ES | Engineering Services Division of LANL (includes design, project, and facility system engineers). |
| ESM | LANL's Engineering Standards Manual of which this document is a part |
| FDAR | Facility Design Authority Representative. The LANL [Facility Design Authority] designates FDARs to facilities and projects. An FDAR is a qualified individual who is responsible for approving design requirements, design configuration, and changes thereto throughout the facility and the project lifecycle. The designated Laboratory FDARs cannot delegate their FDAR authority.<br>FDARs are responsible for maintaining design requirements, design configuration, and changes thereto during the facility operating life in the area noted on their qualification cards [PD340]. The receiving FDAR is the person to be responsible for the equipment once a project is turned over to operations. |
| Federal High-Performance Building | A federal building which does not meet all requisite criteria outlined in the *Guiding Principles for Sustainable Federal Buildings;* due to its inherent function, mission, safety, or other factor; but which has optimized the GP's criteria on a life cycle basis. |
| FEMP | Federal Energy Management Program, focuses on key services that help agencies meet energy- and water-reduction requirements and goals. |
| Fire Marshal | Authority having jurisdiction for fire protection and life safety requirements of the building codes, fire codes, and NFPA set of codes and standards. Typically, the group leader of the LANL Fire Protection Group. |
| FOD | Facility Operations Director. One of approx. eight LANL managers responsible for the operation, engineering, and maintenance of facilities and tenants. "The FOD takes direction from the Responsible Associate Laboratory Director (RALD) and is the senior line manager who provides owner stewardship and overall facility operations. The FOD provides organizational leadership for facility Maintenance; Operations; Environment, Safety, Health, and Quality (ESH&Q); Waste Services; and Engineering. The FOD has the role of coordinating the efforts of these managers to ensure that all facility and programmatic activities are performed in a safe and compliant manner. Facility operations related deployed personnel will report through the FOD; exceptions for unique reasons will report through the RALD." [SD312] |
| Green Building Certification System | A type of building certification system that rates or rewards relative levels of compliance or performance with specific environmental goals and requirements. Rating systems and certification systems are terms frequently used interchangeably.<br>Examples include Guiding Principles, LEED, Green Globes, and Living Building Challenge. |
| GP | The group of criteria defined by *Guiding Principles for Sustainable Federal Buildings and Associated Instructions* issued by the Council on Environmental Quality in December of 2020. Often referred to as "The Guiding Principles", the document outlines a set of sustainable principles and practices to guide agencies in designing, locating, constructing, maintaining, and operating Federal buildings in a sustainable manner. |
| IBC | *International Building Code*, published by the International Code Council. See ESM Chapter 16. |
| IEBC | *International Existing Building Code*, published by the International Code Council |

| Term | Definition |
|---|---|
| IECC | *International Energy Conservation Code*, published by the International Code Council |
| IgCC | *International Green Construction Code*, published by the International Code Council. While not adopted by LANL, it is frequently used as a compliance path in the *Guiding Principles for Sustainable Federal Buildings*. |
| LANS | Take all references in the Standards to LANS to mean Triad National Security (TNS), the prime contractor beginning November 1, 2018, or its successor. LANS was the prime contractor at LANL from 2006 to October 31, 2018. |
| LCC | Life Cycle Cost (discussed in detail at this link) |
| LMS | LANL Master Specifications. These CSI-numbered/formatted specifications address construction-type work, fabrication, and maintenance (maintenance examples: piping repairs and testing, carpet and other similar replacements). |
| MEL | Master Equipment List: an online database of installed equipment (SSCs) that require maintenance or surveillance. The MEL is in the CMMS (e.g., Asset Suite) system for most facilities. [AP-341-404] |
| ML | Management level: A classification system for determining the degree of management control that is applied to work. This document only addresses a subset of ML-4 SSCs, the lowest risk category. Defined in AP-341-502. |
| Modernization | The comprehensive replacement or restoration of virtually all major systems (such as plumbing, mechanical, electrical), interior finishes (such as ceilings, partitions, doors, and floor finishes), and building features (as in space reconfiguration or exterior wall, window, or roof replacement). |
| PE | Normally professional engineer but might be project engineer depending on the context. |
| POC | Point-of-Contact. Every document in the Standards set has one person responsible for its interpretation, upkeep, and general assistance. The LANL Site Chief Engineer designates POC for the majority of subject areas of the Engineering Standards including civil, architectural, structural, mechanical, pressure safety, etc. The SMPOs of other LANL Safety Management Programs (e.g., fire protection, radiation protection, electrical safety) and Security designate POCs in their areas of responsibility. |
| Programmatic | A synonym for Personal Property and Programmatic Equipment. PP&PE is equipment used purely for programmatic purposes, such as reactors, accelerator machinery, chemical processing lines, lasers, computers, machine tools, etc., and the support equipment dedicated to the programmatic purpose. This property/equipment is also referred to as organizational, research, production, operating or process and was formerly known as Class B. [DOE Order 4330.4B]. Work or equipment that is tenant, R&D, or process – not facility, utility, infrastructure, or environmental program related. |
| Project | As used in the Engineering Standards only, ANY task or activity involving the installation, modification, or permanent removal of an SSC at LANL managed formally or otherwise. Includes related fabrication, construction, procurement, and maintenance activities (may not be a formal project or subproject per SD350 definitions). “Task” means the same. |
| RCD | Requirements and Criteria Document. Establishes design requirements and maintains the technical baseline for a project. Required for line item, GPP, and complex projects. Will be based on FRD if present. [AP-341-602] |

| Term | Definition |
|---|---|
| Record Document | Term popular in AE community describing typically provided documents that incorporate field changes performed by constructor (e.g., subcontractor) but not necessarily verified by the EOR. These are not as-builts (see that definition above. [based on DPIC's 1999 Contract Guide (risk management handbook for AEs), pgs. III-23 thru 25] |
| SD | Sustainable Design (green building) |
| Shall | Denotes a requirement (versus "should") [DOE O 6430.1A and DOE Std Style Guide]. "Must" denotes the same and is the preferred term in DOE orders and LANL policy documents [LANL P311-1]. ("Will" is sometimes used to convey future LANL actions, often within specifications). |
| Shall consider | Requires that an objective assessment be performed to determine to what extent the specific factor, criterion, guideline, standard, etc., will be incorporated into or satisfied by the design. The results and basis of this assessment shall be documented. Such documentation shall be retrievable and can be in the form of engineering studies, meeting minutes, reports, internal memoranda, etc. [archived DOE O 6430.1A Glossary].<br>Such documentation shall be submitted to Chapter POC and/or FDAR for approval where directed herein or upon request. |
| SI-DCRM | Service Innovations Division's Document Control and Records Management Group (formerly IRM-DCS) |
| SSC | Structure, system, or component |
| STR | Subcontract Technical Representative. The LANL STR has technical and performance oversight of the Subcontractor's Scope of Work, including but not limited to engineering, procurement, safety, quality, schedule, and coordinated execution of the Work that is carried out by the Subcontractor. The STR has no authority to direct commercial or technical changes to the Subcontract. |
| Subcontractor | Term for entity under contract to Triad. Sub tier Subcontractors (Subtiers) work for Subcontractors. Prime Subcontractor is a term used occasionally to reinforce responsibility of that entity (versus sub tier responsibilities). |
| Sustainable Federal Building | A federal building which has been designated as meeting the requisite criteria outlined in the *Guiding Principles for Sustainable Federal Buildings*. |
| Standard Drawings and Details | The example drawings and repeatable details on the Engineering Standards website, collectively STD-342-400. |
| TNS (or Triad) | Triad National Security, LLC Services, the prime contractor at LANL at time of writing. |
| Zero Carbon Emissions Ready Building | A highly efficient building which has been designed and built to make use of or plans for the future use of if not initially life-cycle cost-effective, carbon-free energy for all of its operational energy needs through the use of any combination of on-building, on-site, local utility-scale, or purchased carbon-free energy. |

[i] Executive Order 14057 Section 205(c)(ii) and the Climate Adaptation, Resilience, and Sustainability in Project Management (CARP) memo from Deputy Secretary of the DOE dated April 5, 2022