LANL Tailored Standards Manual (TSM)

STD-342-600

An Alternative to the Engineering Standards Manual
for Commercial-Type Work Available to
Projects Meeting Scope/Applicability Conditions

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CHAPTER 1 GENERAL

Note: "(Requirement T-####)" appears throughout this document. A spreadsheet, available to LANL, provides the basis for the requirement corresponding to that number.

1.0 SCOPE AND APPLICABILITY

A. This document may be used in lieu of the complete LANL Engineering Standards (including LANL Engineering Standards Manual [ESM], STD-342-100) when the following are met (Requirement T-1001)[1]:

1. Project is non-nuclear-affecting and involves no radiation hazards, therefore:[2]

   a. Excludes ML-1, ML-2, and nuclear-related ML-3 SSCs

   b. Scope is limited to ML-4 or to ML-3 that is not associated with a nuclear or radiological facility safety basis (e.g., project is ML-3 due to mission score or environmental considerations)

2. Facility Design Authority Representative concurs with use of the TSM.[3]

B. This document applies to facilities, utilities and infrastructure, and programmatic work as defined in LANL ESM Chapter 1, Section Z10.

C. For only those portions specifically invoked by this document, comply with the applicable project-scope requirements of the LANL Engineering Standards Manual (ESM) STD-342-100, LANL Master Specifications STD-342-200, LANL CAD Standards Manual (CSM) STD-342-300, LANL Standard Details and Example Drawings & Designs STD-342-400 and any web-published variances against those documents. (Requirement T-1002)

Guidance: The TSM establishes the minimum acceptable requirements[4]; however, users may elect to exceed them, including following portions of the LANL Engineering Standards that are not invoked by reference in this document. For example, users may elect to follow the entire set of LANL Master Specification (LMS) sections to ensure compliance with LANL-adopted codes, standards, and LANL-specific requirements.

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[1] TSM applicability is generally aligned with SD 413.3-7's thrust on conventional construction and risk. Three main exceptions are: (1) no upper total project cost (TPC) limit on TSM usage, (2) the TSM does not invoke the SD criteria that the project is "not part of a phased set of projects as defined in DOE O 413.3B *(Appendix C, Section 28.b, pp. 31–33*), nor requires integration with other projects to provide a complete and usable product," and (3) is not concerned with the matter of critical technology elements as defined in DOE Guide (G) 413.3-4A, *Technology Readiness Assessments Guide* [archived], or NNSA Policy (NAP) 413.4, *Technology Readiness Assessments*. These three criteria are not particularly relevant to appropriateness of use of TSM, and may only affect project's ability to follow the SD.
In addition, regarding hazards, the TSM makes one interpretation: the SD includes a criteria that "The project has no hazards above those that can be addressed using 10 CFR 851.23 safety and health standards;" however, that CFR part sets no hazard limits (only invokes selected codes and standards applicable to them, as does the TSM). Therefore, this specific SD criteria is not cited.

[2] So, cannot use to produce a new "Below (less than) Hazard Category 3 (< HC-3) or Radiological" facility as defined in DOE-STD-1027; however; two permitted activities are: (1) work in/on clean (non-radiological) portions of < HC-3 facility, and (2) new facilities with only sealed sources are allowed if facility follows DOE-STD-1027-2018, Section 3.1.2 requirements.

[3] FDAR approval is true of all design inputs; TSM use should be captured by controlling documents (e.g., PPD, DCF, RCD, SOW) due to its limitations relative to ESM and to ensure clear design agency direction.

[4] The most important contractual and preferential requirements for safety, operability, maintainability, and cost-effectiveness are included; extensive guidance is not.

The full Standards, including additional context and guidance, are available at engstandards.lanl.gov.

D. Requirement reductions and clarifications included in LANL ESM Chapter 1, Section Z10 may be applied with Engineering Standards discipline-specific POC permission.

E. LANL Personnel only: This document does not reduce any program- or administrative-type requirements applicable to LANL in the LANL Engineering Standards (e.g., Building Code Program, Code of Record change, Emergency Evacuation Diagrams (EEDs)), LANL Project Engineer's actions, Owner, and AHJ reviews and inspections.

2.0 DEFINITIONS AND ABBREVIATIONS

A. Refer to the Conduct of Engineering Glossary for definitions and abbreviations used in this document and its references.

3.0 CONVENTIONS IN THIS DOCUMENT

A. This document includes minimal guidance. *Italicized text* —or "*Guidance*" heading—indicates guidance information. Reference titles are also italicized for formatting consistency.

B. Reference to chapters generally refers to TSM chapters unless specifically identified as references to the LANL ESM.

4.0 DOCUMENTS IMPLEMENTED

A. Refer to Appendix A for a list of DOE/NNSA mandates, codes, and standards implemented in the TSM to ensure compliance.

5.0 CODES AND STANDARDS

A. **Code of Record:** Comply with the requirements defined in the applicable Code(s) of Record (CoR), as defined by the project Scope of Work (SoW), including Functions & Requirements or Requirements & Criteria type-documents.

B. **Consensus Codes and Standards:** Comply with all required or applicable voluntary consensus and industry codes and standards including their addenda. Use code-invoked code and standard editions, or latest editions when not specified. Refer to Chapter 16 for additional requirements related to model building codes. Project cannot change a LANL-adopted code or standard edition to a newer version without permission from the appropriate AHJ.

C. **Code of Record Document:** Submit a Code of Record document that lists design codes and major standards, including edition dates, that the project commits to follow for LANL review and approval no later than the 30% design milestone (earlier submission is encouraged). Refer to TSM Appendix A regarding Code of Record list. (Requirement T-1003)

D. **Conflicts:** Where conflicts between codes, standards, and TSM exist, the most stringent requirement shall apply, unless otherwise directed by the LANL Authority (AHJ/SMPO).

E. **Variances and Alternate Methods:** Deviation from this document requires approval from the LANL Authority (AHJ/SMPO). Follow LANL ESM Chapter 1, Section Z10 requirements. The LANL Integrated Project Team (IPT) will

coordinate with the Engineering Standards discipline-specific POC to discuss proposed approaches and produce request forms as required.

6.0 SITE SPECIFIC DATA (MULTI-DISCIPLINE)

A. The Design Agency shall use the following site-specific data for design at LANL. (Requirement T-1004)

1. Elevation
   a. Nominal = 7,500 ft
   b. Range = 6,250 – 7,780 ft (depending on specific location)
2. Latitude: 35.9 deg N, Longitude 106.3 deg W
3. Barometric Pressure (avg): 11.10 psia (22.65 inches Hg).
4. Air Density (7,500 feet): I-P: 0.057 pounds/cubic foot (0.075 pcf at standard air)
   a. S-I: 0.00091 g/cm^3 (0.0012 at standard air/sea level)
5. Air Density Ratio: 0.075/0.057 = 1.32 (reciprocal = 0.76)

Note: Exceptions to the above (where elevation or other data must be corrected to actual values for remote sites) are included in LANL ESM Chapter 1, Section Z10.

7.0 EQUIPMENT LOCATION

A. **Maintenance Access**: Active mechanical, electrical, controls, and similar equipment shall be located to allow safe access for inspection, maintenance, repair, and replacement without demolition of permanent construction or unsafe work practices (e.g., crawling on ducts, piping, conduit, or cable trays). Equipment containing electrical components that require servicing shall be provided with the working space specified by the National Electrical Code (NEC), Article 110. (Requirement T-1016)

B. **Outdoor Equipment Locations**: Carefully evaluate site conditions when locating equipment at grade. Equipment shall be positioned to minimize the effects of snow accumulation and drift, ice formation, high winds, roof drainage, and other environmental conditions that could adversely affect equipment performance, reliability, or maintenance access. *Guidance: For equipment serving a main entrance, avoid locations on the north side of the building whenever practicable.*

C. **Rooftop Equipment Locations**: Whenever practicable, locate rooftop equipment a minimum of 10 feet from the roof edge or the inside face of a parapet. Where equipment must be located within 10 feet of the roof edge, provide a 42-inch-high protective barrier (e.g., guardrail, parapet, or screen wall). Alternatively, when approved by the Engineering Standards discipline-specific POC, other OSHA-compliant fall protection measures, such as designated tie-off points, may be used where they provide a cost-effective means of fall prevention. (Requirement T-1005)

8.0 PROJECT DOCUMENTS AND FILES — GENERAL

A. Design Agency shall comply with the following requirements for Project Documents and Files (Requirement T-1006):

1. **Project Records:** Produce and deliver electronic files that include all information necessary to support the project throughout its lifecycle, including design, procurement, construction, testing/startup, commissioning, operations, and maintenance.
2. **Document Numbering:** Follow TSM Appendix B for numbering calculations, drawings, specifications, reports, and other project documents.
3. **Design Documentation[5]:** Document the original design and all design changes through the project design package—calculations, drawings and/or sketches, and design or evaluation criteria appropriate to the project scope—demonstrating that the design is both safe and cost effective. The completed project record shall provide a clear history of design development and the basis for significant design decisions and changes.
4. **Controlled Design Documents:** Work shall only be performed to LANL-approved, controlled design documents, including specifications, drawings and/or sketches, and approved revisions through field change requests, subcontractor deviation disposition requests, or other authorized change mechanisms. The Constructor shall maintain the latest electronic, sharable version of these documents at the work site. Unless otherwise agreed upon by the LANL IPT, the Design Agency shall provide current files to both the Constructor and LANL IPT.
5. **Project Closeout Records:** The project closeout files shall include, at a minimum:
    a. Design review records;
    b. Submittals and submittal reviews;
    c. Design changes and revisions;
    d. Test and inspection records;
    e. Design Agency observation reports; and
    f. Other significant project records such as written correspondence, summaries of important telephone conversations, design and design-evaluation criteria (whether furnished by LANL or generated by the Design Agency), and relevant working notes.
6. **Electronic File Requirements:** Electronic files shall include Optical Character Recognition (OCR) functionality to enable content searches. Non-electronic deliverables shall be submitted only when electronic format is not feasible (e.g., physical samples, mockups, prototypes, or spare parts).
7. **Project File Delivery:** Deliver the complete project files as described above. However, IF LANL directs the use of LANL document review or document control and records management tools to either (a) manage selected reviews (e.g., submittals reviews), or (b) maintain official

[5] Basis-of-design is documented through the project design package. Basis-of-design documentation is required for projects that meet Total Project Cost requirements specified in Chapter 20.

versions of drawings, documents, or records, THEN the Design Agency is not required to maintain duplicate copies of those records and shall not include duplicate records in the final project files to avoid confusion and inconsistencies. Refer to Article *Project Closeout* at end of this chapter.

9.0 COMPLETE DESIGN PACKAGE

A. The Design Agency is responsible for developing a complete, coordinated and constructible design package. The design package shall be (a) consistent with calculation results, and (b) coordinated with outputs (BIM, drawings and project specifications) from other disciplines. (Requirement T-1010)

The design package includes, but is not limited to the following:

1. **BIM:** A Building Information Model, when required by the LANL CSM, Section 400, *BIM Standards* (Table 400-1), complying with the applicable requirements. (Requirement T-1007)

2. **Drawings or sketches**

   a. Drawings, when required, prepared in accordance with the LANL CSM, unless an alternative approach approved by LANL CoE is specified in the SoW. (Requirement T-1008)

3. **Title Sheet of Drawing Package** – Minimum Content Requirements

   a. LANL Standard Title Block information.

   b. Fundamental building code information, including:

      1) IEBC Alteration Level (if applicable);

      2) Type of construction;

      3) Occupancy group;

      4) Occupancy loads;

      5) Number of stories;

      6) Floor area;

      7) Fire protection system/features (e.g., sprinklers, fire separations, exits, fire-resistance ratings of walls or assemblies being penetrated).

   c. Egress/Life safety plan including travel distances, fire-rated walls, and exits.

   d. Building height and area calculations.

   e. Applicable editions of governing codes, standards and the TSM, as required by the project.

   f. Design Agency contact information, including Licensed Professional Engineer's seal and signature, where required.

4. **Specifications Package:** A CSI-format specification package consisting of applicable specification sections. Exceptions for very small projects are

permitted as provided in LANL ESM Chapter 1, Section Z10, Attachment F. (Requirement T-1009)

5. **Test and Inspection:** The design documents above shall include test and inspection requirements. Refer to Chapter 16 for additional information.

B. **Quality Requirements:** The design package shall be clear, concise, correct, complete and coordinated. Documents shall be developed in accordance with the industry standard of care and shall: (Requirement T-1010)

1. Specify products and materials with availability that support the project schedule;
2. Avoid unnecessary repetition and internal conflicts;
3. Be consistent with Subcontract requirements including general conditions;
4. Incorporate all established design inputs and any approved changes.

C. **Checking and Verification:** The Design Agency shall perform all required internal checking and verification reviews in accordance with their Quality Assurance (QA) program before submitting deliverables to LANL. LANL will review externally prepared designs. The Design Agency shall resolve review comments using a process agreed upon with LANL IPT to satisfy the design needs and contractual requirements to enable permitting. (Requirement T-1011)

D. **LANL Review:** Submit design deliverables in accordance with the review schedule established by LANL. If a review schedule is not explicitly identified in the SoW, use the schedule provided in LANL ESM Chapter 1, Section Z10 Attachment C, *Design Deliverable Schedule*. At a minimum, projects subject to the LANL ESM Chapter 16 *Building Code Program* require a satisfactory final "Plan review".

10.0 CALCULATIONS

A. Design Agency shall comply with the following requirements for developing Calculations: (Requirement T-1013)

1. **Preparation and Content:** Prepare design calculations to document analytical determinations in accordance with the Design Agency's processes. Refer to Chapter 21 when software is used to perform design in calculations. Room numbers, equipment nomenclature, fixture numbers, zone numbers, and other designations shall be consistent with those used in the drawings and specifications. Calculations shall be checked, reviewed, signed and dated by both the designer and checker, and signed and sealed by a Licensed Professional Engineer when required. Calculations shall be complete and shall clearly document the basis for selecting systems and components.
2. **Calculation Format:** Calculations shall be prepared, numbered, checked, reviewed and approved using a consistent format. At a minimum, calculations shall include the following sections, as applicable:
   a. Purpose
   b. Methodology

c. Acceptance Criteria

d. Unverified Assumptions

e. Assumptions

f. Limitations

g. Calculation Inputs

h. Computer Hardware and Software

i. Summary and Conclusions

j. References

k. Calculations.

Include explanatory information to communicate design intent and improve understanding of design process in the calculation. Identify the source of any unusual formulas or analytical methods, including the reference title, edition and applicable section or paragraph or equation number. Clearly label all variables and constants and provide the appropriate engineering units. Include copies of analytical models and tabulated data or software output used in the analysis.

3. **Alternative Calculation Format:** Design Agencies whose calculation format does not adequately address the requirements above shall prepare calculations in accordance with LANL AP-341-605, *Calculations* or another LANL-approved format.

4. **Supporting Information:** Organize sketches, input data, output data, and other supporting information in a clear and logical manner. Use 8½ × 11-inch sheets whenever practical and include all supporting material as part of the complete calculation package.

5. **Readability and Organization:** Calculations shall be legible and produced with sufficient contrast to ensure readability. Organize calculations in a logical sequence and include adequate sketches, diagrams and explanatory information to enable reviewers and future users to readily understand the analysis and results.

6. **LANL Review:** Submit calculations to LANL for review and acceptance when requested or required. LANL review and acceptance does not relieve the Design Agency of responsibility for the accuracy of the calculations or their coordination with the drawings and specifications.

11.0 LANL MASTER SPECIFICATIONS (LMS) AND STANDARD DETAILS

A. **LMS:** Requirements for LMS are provided in TSM Appendix C.

B. **Standard Details:** Standard Details (CAD templates similar to LMS templates) are maintained within the STD-342-400 collection. Any Standard Details specifically required by the TSM are subject to the same expectations for incorporating and using LANL-specific content as described for LMS above. The same collection also includes *Example Drawings* and *Example Designs*, which illustrate acceptable levels of content, format, and professional quality. Additional

drawing requirements and examples are provided in the LANL CSM, Section 300).

12.0 PROJECT EQUIPMENT LIST (PEL)

A. **PEL:** Projects shall develop a Project Equipment List (PEL) as a project turnover deliverable. LANL will use the PEL to create or update the operating facility's Master Equipment List (MEL). (Requirement T-1012)

B. **PEL Requirements:** The PEL shall comply with the requirements of LANL ESM Chapter 1, Section 200 – *Master Equipment List; Item Numbering and Labeling* requirements, including:

1. Identification of all required Structures, Systems, and Components (SSCs);
2. Inclusion of all required data fields;
3. Use of prescribed item numbering and labeling conventions;
4. Use of approved system names, item names, and acronyms;
5. Use of Attachment 1: CMMS Upload Workbook

The PEL shall be developed to facilitate efficient transfer to the MEL and upload to the Computerized Maintenance Management System (CMMS).[6]

C. **Design Agency Responsibility:** The Design Agency shall initiate and populate the PEL. The Design Agency shall coordinate with the LANL Facility Design Authority Representative (FDAR) and MSS-APT CMMS personnel to ensure accuracy and completeness of the PEL. The PEL shall include all items specified in the design and all information known at the time of final design completion.

D. **Constructor Responsibility:** Unless otherwise specified in the Subcontract Documents, the Constructor is responsible for completing the Design Agency-created PEL workbook with the actual model numbers of equipment selected and approved by the Engineer of Record (EOR) for installation.

1. Through the LANL Project Engineer, coordinate with the LANL FDAR, Facility Operation Director (FOD), and MSS-APT CMMS personnel to verify the accuracy and final approval of all field labeling. Equipment identification shall clearly correspond to the systems they support. Any additional or system-specific information shall be coordinated with the Engineering Standards discipline-specific POC and the System Engineers supporting the project.
2. Upon completion, submit the PEL to the EOR for review and approval. Upon approval, deliver the PEL as a project record document. The LANL FDAR or designee is responsible for ensuring the completed PEL is uploaded into CMMS.

13.0 PROJECT DOCUMENT LIST (PDL)

A. Unless waived by LANL (e.g., IPT), the Design Agency shall prepare a Project Document List that serves as an index of all project drawings, calculations, study reports, and other documents produced during the project. The PDL shall be

[6] For in-house design, if a CoE-approved Workbook alternative tool exists, it may be used to process MEL changes.

finalized at project closeout and included in the project deliverables. (Requirement T-1013)

Guidance: The PDL should include all design outputs and project deliverables, including document numbers, revisions and dates. Document and Records Management System used for the project may be able to generate the PDL.

14.0 PROFESSIONAL ENGINEER SEALING (STAMPING)

A. Design documents and other engineering work products (e.g., Issued for Construction drawings, calculations, specification package, reports) prepared by non-LANL engineers, consultants, and others engaged in the practice of engineering shall bear the seal (stamp) and signature of a Professional Engineer (P.E.), who is currently licensed in New Mexico, and who has responsible charge of, and direct responsibility for, the engineering work. (Requirement T-1014)

B. P.E.s shall practice and seal documents only within the disciplines for which they have demonstrated competency and are qualified through the NM Licensure Board. This requirement may be waived by the LANL Engineering Deputy Division Leader or higher-level authority based on documented evidence of significant relevant experience and demonstrated competency (e.g., documented in a project file memorandum).

C. Clarifications and exceptions for P.E. sealing identified in the tables in LANL ESM Chapter 1, Section Z10 are permitted.

15.0 PROJECT CLOSEOUT

A. **Final Project Record Documents (PRDs):** Final project record documents (PRDs) shall incorporate all approved interim changes (e.g., Design Agency field change documentation, Field Change Requests (FCRs), Design Revision Notices (DRNs), redlines when allowed), and verified field conditions identified during walkdowns at project closeout. Final documents shall be provided in both the native software format (e.g., AutoCAD or Revit) and in PDF format.

1. The Design Agency shall update and finalize any calculations containing non-bounding (non-conservative) assumptions and provide a matrix documenting how each assumption was verified.

2. Incorporation of interim changes is not required for:

   a. Demolition plans no longer applicable after construction;

   b. Vendor data;

   c. QA records;

   d. Informal piping installation isometric sketches;

   e. Temporary formwork or erection bracing plans.

B. **As-Built Documents and Record BIM:** As-Built drawings are a subset of PRDs and are only produced for the most critical documents (refer to Table 1-1). As-Built drawings, and any associated data within a Record BIM used to generate them, shall accurately reflect the final installed condition as verified through LANL walkdowns and formal discrepancy resolution.

1. The LANL Verifier will use the record drawing and model drafts prepared in accordance with the requirements above, perform field walkdowns, and provide any additional required revisions to the Final Document Creator identified in Table 1-1 for incorporation into the as-built documents.
2. The Final Document Creator shall:
    a. Incorporate redline revisions resulting from LANL Verifier's walkdown;
    b. Update the Document Record of Revision to indicate whether the document is "As-built with Changes" or "As-built without Changes", including identification of the verifying organization or individual;
    c. Submit the revised document to LANL for review; and
    d. Re-issue the finalized document.
3. For drawings, see LANL CSM (*Section 100*) for additional requirements.

Table 1-1. Documents Requiring As-Builting, and Roles for Same

Document Category[7]	Document Types	Typical LANL Verifier	Final Document Creator
Where Final Document Creator is Typically Not LANL			
Building automation system (BAS for non-nuclear facility HVAC)	Shop drawings, programming	I&C engineering or delegate	Constructor (e.g., delegated design/build sub tier)
Fire protection 1. Fire area boundary drawings 2. Fire barrier penetrations database 3. Fire suppression P&IDs, details and schedules, and sequence of operation / I&C Diagrams 4. Sprinkler system hydraulic calculation(s) 5. Location drawings of underground water mains and control valves, hydrants, and fire department connections 6. Fire alarm system diagrams and programming	Calculations, drawings, shop drawings, specs, FACP programming	Field Engineer, Building Inspector, or ES-FP per FP Division of Responsibility	Constructor (e.g., delegated design/build sub tier)
System and Facility Design Descriptions	SDDs, FDD[8]	System Engineer or others	Author of latest approved version (Design Agency is default)
All other documents specifically required to be as-built by FDAR and not shown above, typically including P&IDs, electrical one-lines and panel schedules, and certain other *Priority* or *Support* documents.	Drawings, specifications	Field Engineer or Building Inspector	Design Agency[9]
Document Categories where LANL Performs all Roles			
Floor Plan of Record (FPR)	Drawing per ESM Ch. 4 B-C GEN and CAD Standards Manual	MSS-DATA	
Emergency Evacuation Diagram (where required; based on FPR)	EED	Emergency Management (labor typically by ES-Div)	

[7] LANL walkdowns are required to support the development of as-builts documents for any “Priority” and “Support” documents necessary for safe operation of the facility. Most of these document types are included in the categories identified in the table. In most cases, this involves only a limited number of drawings.
[8] Refer to LANL ESM Chapter 1, Section Z10, Attachment B to determine when SDDs and FDD are required.
[9] If a walkdown identifies differences between the approved design and the installed configuration, a PE seal is typically required to document the PE’s review and acceptance of the final as-built configuration.

C. **Project Record Document Transmittal:** Upon completion of a facility project, transmit drawings, specifications, and other project record documents to LANL as directed by the LANL IPT.

1. Transmit all files electronically in both PDF-with-OCR functionality and native formats (e.g., Word, AutoCAD, etc.), when available.
2. Drawing transmittals shall comply with additional requirements in the LANL CSM.
3. Record BIM transmittals shall comply with additional requirements in the LANL CSM, Section 400, *BIM Standards*.

CHAPTER 2 FIRE

1.0 CONSENSUS CODES AND STANDARDS

A. Follow requirements of Chapter 1, *General*; Chapter 16, *Building Code Program*; and codes and standards referenced therein.

B. Comply with IBC-2021 and all applicable NFPA codes and standards including the following editions*: (Requirement T-2001)

1. International Fire Code (IFC) – 2021 Edition, including its Appendix B
2. NFPA 1, Fire Code – 2021 Edition
3. NFPA 101, Life Safety Code – 2021 Edition

* The applicable codes and standards will not be limited to those in this list. Refer to the above-adopted codes to determine appropriate referenced standards and editions and submit for LANL approval. LANL requires compliance with the requirements of applicable NFPA standards in addition to IBC and IFC requirements.

4. For fire protection of air-conditioning and ventilating systems, NFPA 90A requirements apply in lieu of those of the IBC and Uniform Mechanical Code (UMC).
5. For fuel gas and LP gas, see TSM Chapter 17.

C. LANL Definition of “Public Way”: LANL property, in general, is only accessible to badged employees and not accessible to the public. To aid in the design of compliant means of egress elements, the definition of “Public Way” at LANL is as follows: “Any street, alley, parking lot, or other parcel of land open to the outside air leading to a street, either accessible to the public or to any LANL badged employees, and which has a clear width and height of not less than 10 feet and is accessible to emergency responders.”

D. The TSM 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. Where multiple codes and standards overlap, comply with the most stringent unless dictated otherwise by LANL Engineering Services – Fire Protection Engineering (ES-FPE).

F. Electric Vehicle Supply Equipment/EVSE (charging stations): Follow relevant NFPA standards and DOE’s latest “Office of Environment, Safety, and Health (NA-ESH) Interim Safety Guidance for Electric Vehicles and Electric Vehicle Supply Equipment” (successor documents when issued), e.g., its Sections V, VI, and VII.B. (webposted with TSM). If any of the provisions that are phrased as ‘should’ cannot be complied with, written permission from the Fire Protection and the Electrical POCs is required.

G. LANL Std Detail ST-G4090 is available to facilitate design.

2.0 AUTHORITY HAVING JURISDICTION

A. The LANL Fire Marshal serves as the technical authority for fire protection and life-safety related DOE Orders, and codes and standards as assigned by the DOE/NNSA Los Alamos Field Office. (Requirement T-2002)

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

C. Engineering Services – Fire Protection Engineering (ES-FPE) serves as the LANL Fire Marshal designee as assigned by the LANL Fire Marshal.

D. ES-FPE 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 may lead to a determination that this TSM is not applicable, and that the HPR criteria invoked by the full LANL Engineering Standards Manual (ESM) are applicable. (Requirement T-2003)

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. (Requirement T-2004)

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.* (Requirement T-2005)

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 features.
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 where necessary to protect areas where laying of hose lines is problematic because of ventilation, security, or other reasons.
7. Fire detection and alarm systems in accordance with NFPA 72, *National Fire Alarm and Signaling Code*, and as modified within this Section.

8. Special fire extinguishing systems for unique hazards or occupancies in accordance with the applicable NFPA standard.

B. Prepare a fire protection design analysis (FPDA) when required by subsection below to document compliance with the applicable fire protection and life safety requirements and criteria. (Requirement T-2006)

1. An FPDA is required where any of the following conditions exist:

   a. New facilities exceeding 5,000 sq ft of floor area or a maximum possible fire loss (MPFL) exceeding $7.93 million[1],

   b. Where a modification to an existing facility:

      1) Increases floor area above 5,000 sq ft,

      2) Increases MPFL above $7.93 million,

      3) Is classified as an IEBC Level 3 Alteration,

      4) Includes an addition greater than 1,500 sq ft, or

      5) Includes a change in occupancy to a higher hazard category of occupancy when greater than 1,500 sq ft.

   c. New facilities or modifications introducing unusual or significant life safety hazards,

   d. New facilities or modifications introducing high hazard contents, processes, and occupancies (e.g., Group H occupancy classifications, flammable liquid dipping operations, or high-pile storage areas greater than 500 sq ft), or

   e. When directed by ES-FPE.

2. The FPDA shall be prepared by a fire protection engineer.

3. Prepare the FPDA in the conceptual or early preliminary design phase, deliver unsigned/unsealed document no later than 30% design maturity/review (update/issue with subsequent design submittals), and finalize/issue no later than close of final design.

4. Discuss the following minimum fire protection provisions (both as-required and as-provided characteristics):

   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. If applicable, analysis of highly-protected-risk (HPR) criteria 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.

[1] Per TSM Attachment 1 Rev1. Check it for escalations issued since that publication.

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. Identification of 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. Design documentation shall include specifications that are tailored to suit individual project scope and design requirements. A complete set of specification divisions appropriate for the scope of work shall be provided. (Requirement T-2007)

D. Provide calculations per the applicable NFPA standard 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. (Requirement T-2008)

2. Preliminary and detailed hydraulic calculations for automatic sprinkler systems and other fire suppression systems. (Requirement T-2009)

3. Occupant-load and egress-capacity calculations. (Requirement T-2010)

4. For fire alarm systems, battery load, voltage drop, and line resistance calculations. (Requirement T-2011)

5. Supporting calculations for special hazard, smoke removal, and other fire protection systems. (Requirement T-2012)

E. Provide drawings 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. (Requirement T-2013)

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, fire-resistant joints, fire extinguishers, and other relevant details. (Requirement T-2014)

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. (Requirement T-2014)

4. Fire protection drawings detailing the 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. (Requirement T-2015)

5. Fire alarm drawings detailing the fire alarm and fire detection system, 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 requirements for design documentation, shop drawings, and record of completion documentation. (Requirement T-2016)

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 be prepared by NICET-certified technicians in Fire Alarm Systems or Water-Based Systems Layout (Level III or Level IV), unless approved otherwise by the LANL Fire Marshal. (Requirement T-2017)

Guidance: Fire protection and life safety features, devices, and criteria should be included in all other discipline drawings to clearly demonstrate compliance and coordinate different structures, systems, components, and trades. (Requirement T-2018)

4.0 BUILDING CONSTRUCTION

A. Construction type shall be noncombustible, at a minimum IBC Type II-B / NFPA 220 Type II (000). Exception: Buildings under 5,000 square feet with LANL ES-FPE approval. (Requirement T-2019)

B. Roof coverings shall be IBC Class A. Metal deck roof systems shall meet the requirements of Class I construction as defined in FM Global Loss Prevention Data Sheets 1-28R, *Roof Systems*, and 1-31, *Panel Roof Systems*. (Requirement T-2067)

C. Fire barriers shall be provided to protect vertical openings, the means of egress, separate occupancies, create control areas, limit property loss to $547 million[2] per fire area, protect from exposure hazards, and separate hazardous areas; as required by the IBC/IFC, NFPA 101, and other applicable codes and standards. (Requirement T−2020)

D. Label fire-resistance and smoke leakage rated assemblies (e.g., fire walls, barriers, and partitions) and smoke barriers and partitions above removable ceilings; below raised floors; and in mechanical, electrical, and similar spaces not normally occupied. (Requirement T-2021)

E. Protect openings, penetrations, and joints in fire-resistance and smoke-leakage resistance assemblies with an appropriate listed firestopping 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 provided in the IBC, and NFPA codes and standards are permitted. See also Chapter 4 for additional expectations. (Requirement T-2022)

F. 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, maintain a 50-foot-wide space around buildings clear of trees (several isolated trees may be acceptable), and thin the next 50 feet beyond. In less heavily forested areas, less clearing/thinning may be acceptable. Consult LANL Fire Marshal for guidance. (Requirement T-2024)

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 TSM Ch. 3 requirements. (Requirement T-2023)

B. Design fire protection water supplies to provide minimum manual fire flow, as required by NFPA 1 and IFC Appendix B, and the most demanding fire suppression flow and pressure, non-concurrently. (Requirement T-2024)

C. Design fire protection water supplies to meet the following combined demands for a period of not less than two hours: (a) hydraulically most demanding sprinkler system; (b) 500 gallons per minutes (gpm) for fire hose streams (Ordinary Hazard Group II and higher); and (c) uninterruptable domestic and process demands. (Requirement T-2061)

D. Fire protection water service from a combined water supply source shall enter the building and be controlled separately from potable/domestic water. (Requirement T-2025)

E. Fire hydrants, fire department connections, test headers, hose valves, and similar hose connections shall be National Hose (NH) thread. (Requirement T-2026)

F. Fire hydrants shall: (Requirement T-2027)

[2] Per TSM Attachment 1 Rev1. Check it for escalations issued since that publication..

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 4-1/2” diameter 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;
5. Be located such that hose runs from hydrants do not exceed 300 feet to all exterior portions of the facility;
6. Be provided (at least one) not more than 150 feet from the fire department connection; and
7. Be on branch line not more than 300 feet long.

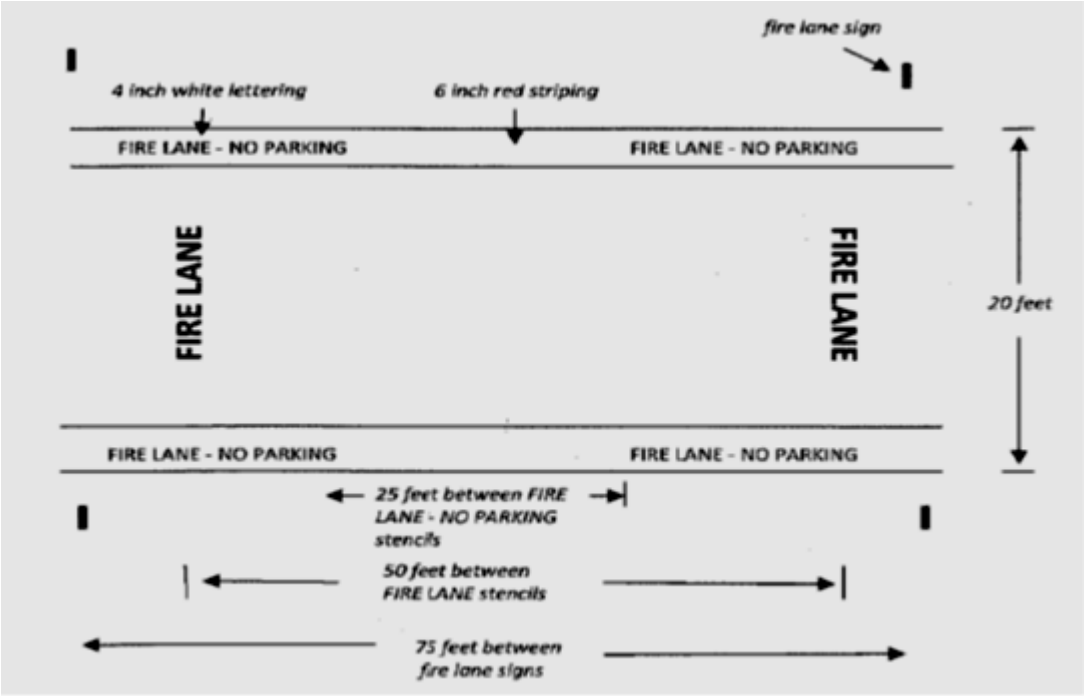
G. Fire department access roads shall:

1. Have a minimum inside turning radius of 30 feet, a minimum outside turning radius of 50 feet (Requirement T-2028), and support a fire apparatus with a total weight of 83,500 pounds and an axle weight of 63,000 pounds. (Requirement T-2029)
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. (Requirement T-2030)

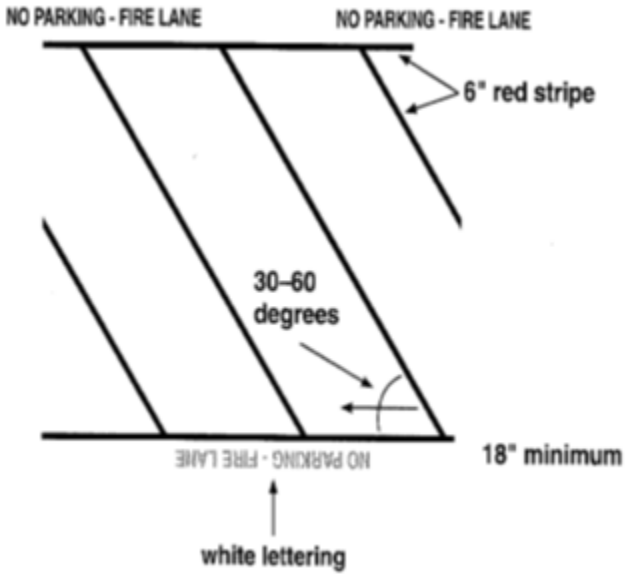
H. Mark fire lanes on both sides – unless permitted otherwise – with signs, curb markings, road surface markings, or a combination thereof as follows: (Requirement T-2031)

1. Signs shall be metal construction, 12 inches wide by 18 inches high, reflective, with red lettering on a white background. Signs shall state one of the following:
   a. FIRE LANE – NO PARKING
   b. NO PARKING – FIRE LANE
2. Mount signs 7 feet above the road surface, at both ends of the fire lane, and at a maximum 50-foot interval. The interval may be increased to 75 feet when combined with curb or roadway markings.
3. Paint curbs red along the entire length with “FIRE LANE – NO PARKING” in 4-inch high, white letters at a 25-foot maximum interval.
4. Road surface markings shall consist of “FIRE LANE – NO PARKING” in 4-inch, white letters inside the stripe at a 25-foot-maximum interval along the edge of the road. This shall be supplemented by either:
   a. Option 1: 6-inch-wide red stripes along the edges of the roadway and collinear with the letters. In the roadway “FIRE LANE” in 10-inch high, red or white letters marked at 50-foot intervals, and

oriented to be read from the direction of fire department arrival as shown immediately below.



b. Option 2: Letters along edges of the roadway and outlined, diagonal hatching in the roadway between. The outlined, hatching consists of 6-inch red stripes along the edges of the road and diagonal stripes between the edges at 18-inch spacing and angle between 30 and 60 degrees as shown below.



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

A. Provide automatic sprinklers when required by the applicable codes and standards, and for all facilities greater than $7.93M[3] 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. (Requirement T-2032)

B. Design: (Requirement T-2033)

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 will not change in the future.
3. Provide a minimum hose stream allowance of 250 gpm, unless NFPA 13 specifies a greater quantity for the specified protected hazard or occupancy.
4. Hydraulic calculations shall include a design pressure margin of 10% or 10 psi, whichever is greater.
5. 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.
6. The classification of the standpipe system and proposed configuration shall be approved by ES-FPE in consultation with the Los Alamos Fire Department.
7. A hydrant flow test can be requested via a LANL Facility Service Request for Utilities and Infrastructure (UI) and ES-FPE.

C. Detailed design drawings (e.g., 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. Title II (i.e., architectural-engineering preceding construction start) design drawings for automatic sprinkler and other water-based systems shall, at a minimum, include: (Requirement T-2034)

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.

[3] Per TSM Attachment 1 Rev1. Check it for escalations issued since that publication.

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.

E. 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. Provide a drain to direct nuisance flows to a sanitary floor drain and catastrophic releases to the exterior of the building. Refer to manufacturers' flow curves to determine maximum discharge rate based on supply pressure or on-site pressure, whichever is greater, and size drainpipe accordingly. An air gap must be maintained between the backflow preventer relief valve opening and any discharge piping. The air gap must be at least twice the dimension of the effective opening of the relief valve; but in no case less than 1 inch. (Requirement T-2035)

F. For forward-flow testing of backflow preventers, provide a test valve header at an accessible location on the exterior of the facility. (Requirement T-2036)

G. Provide minimum clearances around system riser alarm valves of 12" rear, 20" sides, and 36" front. (Requirement T-2037)

H. The top of the alarm valve shall be no higher than 72" above the finished floor. (Requirement T-2038)

I. Provide dry-type sprinkler heads instead of dry-pipe or heat-tracing, whenever possible. New anti-freeze systems and subsystems shall not be installed without prior approval of the LANL Fire Marshal. (Requirement T−2039)

J. 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. (Requirement T-2040)

K. Sprinkler system air vents shall be piped 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. (Requirement T-2041)

L. LANL has standardized on manufacturer/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. (Requirement T-2042)

1. Potter PS10 Pressure Waterflow Switch
2. Potter 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 PAV Automatic Air Vent or Potter PAAR Automatic Air Vent with Drip Pan
7. FEBCO LF880V Backflow Preventer or Wilkins 475V Backflow Preventer

7.0 FIRE DETECTION AND ALARM SYSTEMS

A. 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. 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 must be connected by three CAT 5E telecommunication cables run from the DACT location to the telecommunications service entrance room in the building. (Requirement T-2043)

B. Provide fire detections and alarm systems when required by the applicable codes and standards. Always provide fire alarm systems when automatic sprinkler systems, or other fire protection systems or emergency control functions, are provided (for monitoring and supervision). (Requirement T-2044)

C. Provide documentation for fire alarm designs, installation, and testing. Comply with NFPA 72 requirements for design documentation, shop drawings, and completion evidence.

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. (Requirement T-2045)

E. Title II (i.e., performance and/or design) drawings for fire alarm shall, at a minimum, include the following features where applicable: (Requirement T-2046)

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 (e.g., fire alarm riser diagram).
10. Preliminary input/output sequence of operation matrix.

F. Fire alarm control panels (FACP) and associated components shall be an addressable EST4 or Notifier NFS2-640 model. (Requirement T-2047)

G. Locate the FACP in a temperature and humidity-controlled area at the main entrance to the building. (Requirement T-2048)

H. Provide 20% spare capacity on notification appliance voltage drop calculations to allow for future system modification. Provide backup battery capacity equal to or greater than 24 hours of normal (standby) FACP operation plus 5 minutes of system operation in full alarm mode. Provide 25% spare backup-battery capacity within calculations. (Requirement T-2049)

I. Specify FACP with an LED annunciator/switch card providing the ability to disable emergency control functions, individually, and notification appliances. (Requirement T-2050)

J. Provide surge-suppression devices in fire alarm power circuits, RS-232 network lines, RS-485 network lines, initiating device circuits, and notification appliance circuits entering or leaving a facility (due to frequent lightning activity). Surge-suppression devices shall be readily accessible from the finished floor level. Provide DITEK-120SRD for devices having a 120 VAC supply circuit, and DITEK-DTK-2MHLP Series for 24 VDC circuit. (Requirement T-2051)

K. Provide manual transfer switch and capability for hook-up of portable generator in the normal power circuit for FACP and remote power-supply panels. Acceptable models are Reliance Pro/Tran Signa C20A1N or Reliance Model Easy/Tran CSR201, unless otherwise approved by the LANL Fire Marshal. (Requirement T-2052)

L. Provide a standard 125VAC receptacle within 6 ft of the FACP to support connection of a laptop computer for fire alarm testing and troubleshooting purposes. (Requirement T-2053)

M. Fire alarm systems shall include manual fire alarm initiation, occupant notification, emergency services notification, and supervision of suppression systems. Design signaling line circuits (SLCs) as Class A, B, or X as determined by the FPDA or other appropriate design documentation. (Requirement T-2054)

Guidance: NAC and SLC circuits should 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. (Requirement T-2055)

N. Provide horns or speakers for audible signaling. Public mode signaling is required in occupiable areas, except bathrooms provided with strobes, stairwells, and elevator cars, where private mode signaling is permitted. Document average ambient sound pressure levels for all areas, based on use, occupancy, HVAC design, equipment, and other factors. (Requirement T-2056)

O. Provide visual signaling in 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. (Requirement T-2057)

P. Interface the fire alarm system 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. (Requirement T-2058)

Q. Provide red EMT for interior fire alarm raceways for power-limited circuits, unless otherwise approved by the LANL Fire Marshal. Note: fittings, conduit bodies, junction boxes, and device boxes are not required to be red. (Requirement T-2061)

R. Provide color coding for fire alarm wiring as follows:

Black, Red, or Blue	120 Vac (Ungrounded Conductor – Match Existing)
White	120 Vac Neutral Wire (Grounded Conductor)
Green	Equipment Grounding Conductor
Blue (-) / Yellow (+)	Negative/Positive Connection for Notification Appliance Circuits
Gray (-) / Violet (+)	Negative/Positive Conventional Alarm IDC
Black (-) / Red (+)	Negative/Positive Auxiliary Circuit Connections
Black (-) / Red (+) T/S	Negative/Positive for SLC or Speaker Circuit

CHAPTER 3 CIVIL AND UTILITIES

LANL-only Note: Variance approvals to Chapter 3 material may qualify for use of VAR-10773, Civil/Utilities VAR & CIR SMPO Authority Delegation.

1.0 GENERAL CIVIL REQUIREMENTS (G10-30)

A. Site Modification and Environmental Review: Civil design and construction shall comply with applicable federal and state laws, regulations, and standards; and national consensus codes and standards. This includes, but is not limited to: ABA, NPDES stormwater permitting, EISA Section 438, Clean Water Act 404/401 requirements, NMDOT Standard Specifications, AASHTO criteria, ACI 318, AWWA standards, and the MUTCD

B. Site modification and utility tie-ins shall be submitted by LANL IPT through the PAR system or Engineering Services Request (ESR) and reviewed and approved by ES-UI.

1. Proposed utility connections and routing must be shown on the civil site plan and submitted to the Engineering Services -Utilities and Infrastructure (ES-UI) System Engineering Group for review and approval prior to construction. All utility ties must follow Standard Utility Tie-In & Disconnect Procedure (UIDO-PROC-60-00-018).

   a. The EOR shall identify any conflicts with known underground utilities through evaluation of pothole data.

   b. The EOR shall gain ES-UI approval for any proposed vertical or horizontal crossing that does not meet Table G20-1 located in Section 4.0 of this chapter.

   c. Prior to commencing with potholing or excavation activities, LANL IPT shall submit a request for an excavation permit (EXID). Refer to OSH ISH-FSD-003 Potholing Procedure for underground line potholing requirements.

   d. When construction occurs near environmental monitoring wells or sensitive groundwater areas, coordinate design and field activities with EPC-CP's Groundwater Protection Program to establish appropriate buffer distances and controls (if applicable).

2. For any construction that crosses, disturbs, or works within a water course (defined bed and banks with evidence of periodic flow):

   a. Project scope and location shall be analyzed through the Project Activity and Review (PAR) in the Integrated Review Tool (IRT) input to the tool based on EOR provided drawings, impact quantities, and technical documentation.

   b. LANL Environmental Compliance Programs (EPC-CP) shall identify the need for Clean Water Action Section 404 and 401 permitting.

c. If applicable, LANL EPC-CP will prepare and submit the Section 404 Dredge and Fill Permit application to the U.S. Army Corps of Engineers.

d. If applicable, LANL EPC-CP will prepare and submit the Section 401 Water Quality Certification from the New Mexico Environment Department.

e. The EOR shall clearly show the watercourse on drawings and identify required BMPs and excavation/fill quantities.

3. Projects must consider environmental impacts early in planning. Environmental and resource compliance shall be documented through the Project Activity Review (PAR) process, which addresses NEPA, Cultural Resources, Biological Resources, and Groundwater Protection requirements in coordination with the Environmental Protection and Compliance (EPC-CP) organization. Refer to VAR-10468-R1 *Revised Stormwater Material* for complete stormwater compliance design requirements. Note that site-specific stormwater requirements may be imposed through the Project Activity and Review (PAR) in the Integrated Review Tool (IRT) that vary from standard ESM/TSM requirements based on stormwater master plan documents produced by ES-UI Stormwater Engineering and EPC-CP Stormwater.

   a. Stormwater Compliance. Projects greater than one acre require NPDES permits.

   b. Projects >5,000 sq. ft. must meet EISA Section 438 standards.

   c. Conduct hydrologic analysis using industry standard methodologies such as the Rational Method, USDA Technical Release 55, SWMM, and/or HEC methodology to compute peak flows from drainage areas and size drainage structures, designing for a 25-year return storm unless otherwise required.

For projects under EISA Section 438 jurisdiction, perform hydrologic analysis using the following site-specific rainfall totals:

Table 1. Design Storm Rainfalls Totals

Meteorological Station	Period of Record (yrs)	95th Percentile (inches)	2-year/24-hour (inches)	25-year/24-hour (inches)	100-year/24-hour (inches)
TA-06	32	0.86	1.30	2.40	2.95
TA-49	32	0.89	1.08	2.65	3.42
TA-53	30	0.80	1.00	2.01	2.50
TA-54	30	0.82	1.05	2.52	3.25
NCOM (north community)	26	0.85	1.22	2.38	2.95
• These totals are the official design-storm rainfall depths for LANL hydrologic and stormwater designs.					

Meteorological Station	Period of Record (yrs)	95th Percentile (inches)	2-year/24-hour (inches)	25-year/24-hour (inches)	100-year/24-hour (inches)
• The 95th percentile storm is used for EISA §438 water-quality (GI/LID) sizing. • The 2-year/24-hour storm applies to NPDES CGP compliance for temporary sediment basins. • The 25-year/24-hour storm is the minimum design storm for flood-control conveyances (e.g., storm drains, weirs, swales, and roadside ditches, etc.). • The 100-year/24-hour storm is required for sites in a 100-year flood plain or critical facilities • Use nearest station, and most-conservative one when roughly equidistant					

C. Design Documentation

Required drawing types shall include, as applicable, plans, profiles, sections, and detail sheets for grading and drainage, roadway improvements, retaining walls, storm drainage, sanitary sewer, water distribution, dry utilities and other utilities not otherwise listed, traffic control, and erosion control.

Design information on drawings may include: hydraulic/energy grade lines on profile sheets for open channel and pressure systems, earthwork quantities, roadway geometry data (curves, super-elevations, etc.), sight-distance analysis, design vehicle data for turning movements, and typical roadway and pavement sections):

1. Construction Drawings
    a. Submit completed, scaled plan sets .
    b. Must meet LANL Building Permit Submittal and requirements listed herein.
2. Site Plan (Civil)
    a. North arrow, facility/project boundary, streets, buffers, setbacks.
    b. Proposed/existing structures and utilities (water, sewer, electric).. Break out Utility Plan separately for clarity if needed.
    c. Site circulation and access points including service routes and points of connection.
    d. Turning analyses for designated design vehicles.
    e. Required and accessible parking per TSM Ch. 4.
    f. Topographical survey where applicable.
3. Landscaping
    a. Reference Chapter 4 for Site Development and Landscaping requirements.
4. Plans and Profiles
    a. Prepare plan and profile sheets for all major site utilities and improvements, including but not limited to:
        1) Water (domestic and fire protection), storm drain, sanitary sewer, gas, chilled-water, and recycle/recovery loops.

2) Electrical and communications conduit runs (overhead and underground), duct banks, and large raceway pulls.

3) Roadway and paving improvements, including utilities within roadways.

4) Service laterals.

b. Use expanded vertical scale, show continuous alignment with break lines, and identify existing utilities.

c. Stationing shall run left to right

d. Add supplemental views or details as needed for clarity.

5. Grading and Drainage

a. Identify impervious surfaces.

b. The grading design shall provide existing and proposed contours at an interval of 1’ for minor contours and 5’ for major contours. Intervals can be modified by the EOR based on needs for legibility, provided the legend is updated appropriately. Spot elevations should be provided to identify key site features.

c. Label slopes, cuts/fills, and wall elevations. Provide retaining wall profile sheets for walls exceeding 4’ in height or 25’ in length.

d. Label easements and maintenance areas.

6. Stormwater Management

a. Stormwater calculations by NM PE.

b. Pre- and post- development runoff comparison.

c. Identify storage type (detention, retention, infiltration).

d. Demonstrate drainage dissipates within 24 hours.

e. Show all stormwater features and capacities.

7. Floodplain Requirements

a. Delineate 100-year floodplain (1% chance).

b. Use EPC floodplain maps or certified site data

8. Erosion & Sediment Control

a. Short- and long-term BMP per LANL Storm Water BMP Manual (LA-UR-11-10371 or successor).

b. SWWP required if NPDES permit applies.

c. Identify permanent stabilization measures.

D. Surveying

Survey work shall be performed or supervised by a New Mexico Registered Professional Land Surveyor. Accuracy shall match the survey category and importance of work. Survey categories and tolerances are summarized below:

1. Order AA-B: For geodetic and deformation control, accuracy 1:10 million or better.
2. Order 1 & 2: Property and control surveys; accuracy 1:50,000 to 1:100,000.
3. Order 3: Topographic and construction surveys; accuracy 1:10,000 minimum.

E. Benchmarks and control monuments shall be referenced to NAD 83 and NGVD 29. Permanent monuments require metal caps with engraved IDs and protective bollards in traffic areas. Survey data must be submitted to LANL UI Utility Mapping Department (UMAP) for GIS integration. Coordinate surveys with LANL UI Utility Mapping Department.

2.0 SITE PREPARATION (G10)

Variance from this subsection may be allowed by chapter POC written direction.

A. Earthwork. Minimize site disturbance, preserve vegetation, balance cut and fill volumes.

1. Earthwork shall include clearing and grubbing, topsoil stripping and stockpiling, excavation, trenching, backfilling, subgrade preparation, placement of engineered fill, utility bedding, soil compaction, moisture conditioning, and grading to achieve specified contours and tolerances.

B. Grading

1. Ensure drainage away from structures with a minimum slope of 1.0 ft. over 10 ft. (Requirement T-3007).
2. Natural soil slopes should not exceed a 2:1 ratio (2 horizontal to 1 vertical).
3. Finish slopes may exceed 2:1, if recommended by a geotechnical engineer.
4. Undisturbed volcanic tuff slopes should not exceed a 1:6 ratio (1 horizontal to 6 vertical). (Requirement T-3008). Slope stabilization is required for proposed slopes 4:1 or steeper.

C. Subgrade preparation

1. Treat the top 6–12 inches beneath foundations, slabs, and pavement by scarifying, moistening, and compacting to 95% density.
2. Unsound areas must be replaced with structural backfill. Elevation tolerance is ±0.05 feet per 10 feet. Finish slopes may exceed 2:1 if recommended by a geotechnical engineer. (Requirement T-3008).
3. Minor structural foundations, such as individual footings and equipment pads, shall be supported on one of the following:
   a. Undisturbed natural soil,
   b. Compacted fill, or
   c. Controlled low-strength material (CLSM) (e.g., flowable fill).

1) CLSM shall be placed per IBC Section 1804.7

4. For major/critical structural foundations (e.g., building slabs-on-grade foundations, mat foundations), the EOR is responsible for providing subgrade preparations requirements in coordination with the geotechnical engineer's recommendations, as applicable.

D. Compaction Standards. Compact to 95%, or 90% of maximum dry density as determined to ASTM D1557; adjust based on soil type and use case. (Requirement T-3009)

1. If competent volcanic tuff is encountered, it is exempt from the 95% compaction requirement; only the fill above needs to meet the required compaction standard, as determined by the EOR.

2. Compaction shall be performed using appropriate mechanical means to achieve specified densities. The allowable deviation from optimum moisture content is ±2%. Material that is too wet shall be dried or replaced; material that is too dry shall be moistened and uniformly mixed before compaction.

3. Maximum dry density and optimum moisture content shall be determined by ASTM D1557. Field density may be verified using ASTM D6938 (nuclear gauge, ASTM D1556 (sand cone), or equivalent approved methods. Field moisture content may be determined by ASTM D6938 or ASTM D2216.

4. For minor shallow foundations (footings, equipment pads), the EOR may use engineering judgement to determine when formal 95% compaction testing is required, considering loading conditions and site-specific factors.

5. Major or critical foundations shall be compacted to 95% maximum dry density (ASTM D1557) unless the geotechnical engineer recommends otherwise based on soil type and use case.

E. Sieve Analysis. Perform sieve analysis to classify soil gradation and verify suitable for compaction or fill material. (Requirement T-3009).

1. Engineered fill shall conform to ASTM D6913.

2. Engineered fill used beneath buildings, slabs, pavements, and structures shall:

a. Consist of clean, non-plastic granular soil free organics and debris.

b. Maximum particle size of 2 inches.

c. Plasticity Index (PI) ≤10.

d. Gradation requirements:

1) 100% passing the 2-inch sieve,

2) 40-100% passing the ¼-inch sieve, and

3) 25-45% passing the No. 200 sieve.

3. Basecourse aggregate shall conform to ASTM D4318, with ASTM D4718 in conjunction with ASTM D1557 if necessary.
4. Basecourse aggregate shall be clean crushed stone or gravel, free of deleterious materials, meeting the following gradation:
    a. 100% passing the 1-inch sieve,
    b. 80-100% passing the ¾-inch sieve,
    c. 30-60% passing the No. 4 sieve,
    d. 20-45% passing the No. 10 sieve, and
    e. 3-10% passing the No. 200 sieve.
    f. Liquid Limit ≤ 25 and PI ≤ 6.
5. Crushed stone shall conform to ASTM C33.
6. General fill shall conform to ASTM D2487 and be compacted per ASTM D1557.
7. Embankment fill shall consist of clean on-site or imported soil with less than 2% vegetation, debris, or deleterious material, and meet the following gradation and plasticity limits:
    a. 100% passing 2-inch sieve.
    b. 75-100% passing ¼-inch sieve.
    c. 60-85% passing No. 10 sieve.
    d. 30-45% passing No. 200 sieve.
    e. Fraction passing No. 200 ≤ 0.667 x fraction passing No. 40.
    f. Plasticity Index (PI), 10-20.
    g. Determine gradation per ASTM D6913/D7928 or AASHTO T-88.
    h. Compact to 95% maximum dry density (modified proctor).
8. Bedding and Backfill Requirements.
    a. General. Bedding and backfill shall support utilities and culverts uniformly and prevent settlement, displacement, or damage. Remove soft, unstable, organic, or saturated soils and replace with compacted suitable material. Do not place bedding or backfill on frozen or unstable subgrade.
9. Utility Trench bedding shall conform to ASTM D2321 or ASTM C33 and meeting the following requirements: (Requirement T-3021).
10. Pipe bedding shall consist of clean sand free of organics, meeting the following gradation:
    a. 100% passing the 3/8-inch sieve and
    b. 0-10% passing the No. 100.
    c. Be placed in uniform lifts not to exceed 8-inches (loose thickness)
    d. Be moisture-conditioned as needed to achieve compaction.

e. Be compacted to the specified density before the next lift is placed.

f. Backfill shall not be placed over frozen, saturated, or unstable subgrade.

g. Minimum 6-inches of bedding beneath utilities.

h. Compact bedding to 90% maximum dry density (modified proctor).

11. Bedding for Culverts (HW/D-Based Requirements)

a. Bedding requirements for culverts shall be based on height-of-water above the pipe (HW/D):

1) HW/D >1.5 (detention berms): use embankment fill as bedding.

2) HW/D ≤ 1.5 (culverts under roadways): use base course as bedding.

3) Maximum bedding particle size shall be:

4) HDPE culverts: ≤ 1.5 inches.

5) Corrugated metal pipe (CMP): ≤ 3 inches.

6) Be placed in uniform lifts not to exceed 4-inches (loose thickness)

7) Provide a minimum of 6-inches of bedding beneath the culvert. Remove rock, soft, spongy, or unstable materials and replace with suitable compacted material. Compact bedding 90% percent maximum dry density (modified proctor).

3.0 SITE IMPROVEMENTS (G20)

A. Concrete: Construct exterior sidewalks, curbs, gutters, curb ramps, utility pads, drive pads, and other concrete structures with air-entrained concrete, f'c = 4000 psi. (Requirement T-3031)

B. Road Design (Requirements T-3032 through T-3037)

1. Design, including temporary traffic control, shall conform to the following standards:

a. AASHTO GDHS, A policy on Geometric Design of Highways and Streets.

b. AASHTO GBF, Guide for developing Bicycle Facilities.

c. AASHTO RSDG, Roadside Design Guide. (Requirement T-3011)

d. ITE TEH, Traffic Control Engineering Handbook [Institute of Transportation Engineers, ite.org].

e. MUTCD, Manual on Uniform Traffic Control Devices, latest edition (http://mutcd.fhwa.dot.gov. (Requirement T-3014)

2. Where applicable, refer to New Mexico DOT Standard Specifications for Highway and Bridge Construction including their latest modifications (supplemental specifications and special provisions). (Requirements T-3010 and T-3012)
3. Fire department access-related requirements are given in Chapter 2.
4. Roadway asphalt paving shall consist of a minimum of 4 inches of plant-produced hot-mix asphalt (HMA) on top of a minimum of 8 inches of aggregate base course on prepared subbase. Parking lot paving shall consist of a minimum of 3 inches of plant produced hot-mix asphalt (HMA) on to of 8 inches of aggregate base course on prepared subbase. Compaction requirements shall be indicated in the 32 1216 Asphalt Paving Specification section.
5. Portland Cement Concrete Pavement: Use design criteria outlined in the NMDOT, Standard specifications in the structural design of Portland Cement concrete pavements. (Requirement T-3013)
6. Curb and Gutter. Provide curb and gutter per LANL standard detail ST-G2010-2 for all internal arterial and collector, roadways within LANL boundaries Consult ES-UI Transportation Engineer for roadway classifications.
7. Road Classification. Design roadway elements according to LANL functional roadway classification:
    a. Arterial Roads: East Jemez Road (Diamond Drive to NM 4), West Jemez Road (NM 4 to Diamond Drive), Pajarito Road (Diamond Drive to NM 4), and Diamond Drive (Los Alamos Canyon Bridge to Pajarito Road).
    b. Collector Roads: Pecos Road, Anchor Ranch Road, La Mesita Road, Two-Mile Mesa Road, Mercury Road, R-Site Road, Eniwetok Drive, TA-22 Connection Road, Puye Road, Sigma Road, Bikini Atoll, West Road, and Pajarito Road (West Jemez to Diamond Drive).
    c. Road design criteria, geometry, and access requirements shall reflect the designated roadway classification.
8. Intersection Design
    a. Intersections at Arterial or Collector Roads shall be designed to accommodate a WB-50 design vehicle unless otherwise approved.
    b. Where the site function warrants (e.g., warehouse, shipping/receiving, freight logistics, fire access), design to accommodate a WB-67 design vehicle (73.5-ft overall length)
    c. Approach grades on the minor leg shall not exceed 4% for at least 50 feet from the edge of the traveled way.
    d. Crown reduction through intersections shall not exceed 50% of the standard roadway crown while maintaining positive drainage.

e. Turning radii, sight distances, and lane configurations shall conform to applicable AASHTO criteria.

f. Water blocks are required at site entrances to prevent stormwater run-off from being conveyed into LANL facilities from roadways.

9. Temporary Traffic Control

a. Traffic control plans shall be prepared or approved by a Professional Engineer (PE) with Professional Traffic Operations Engineer (PTOE) credentials and shall be submitted to the LANL Traffic Engineer for review and approval.

b. Temporary traffic control shall be inspected daily for visibility, placement, and safe operation; deficiencies shall be corrected promptly.

c. Maintain a traffic-control log documenting inspections, conditions, and any adjustments made during constructions.

d. Maintain a traffic-control log documenting inspections, conditions, and any adjustments made during constructions.

e. Traffic control devices shall comply with the MUTCD.

C. Accessibility. Conform to ABA and Public Right-of-Way Accessibility Guidelines (PROWAG) for compliant sidewalks, streets, crosswalks, curb ramps, pedestrian signals, on-street parking, and other components of the public right-of-way. (Requirements T-3040 and T-3041)

D. Landscaping. See Chapter 4.

E. Electric Vehicle Supply Equipment (EVSE): Refer to Chapter 2.

4.0 SITE CIVIL/MECHANICAL UNDERGROUND SYSTEMS (G30)

A. Structures shall not be sited within 10 ft of an existing underground line, nor new lines routed within 10 feet of an existing structure. New lines to new buildings shall approach perpendicularly.[1] (Requirement T-3018)

1. Water Lines. Provide a minimum of 4 ft of cover for freeze protection except irrigation systems with automatic drain valves. Refer to LANL MS 33 1000 for detailed water system requirements.

a. Provide metering in accordance with LANL ESM Chapter 14, Att. 2 – Utility Metering Requirements.

2. Cathodic Protection

a. Required for underground metallic piping; consult LANL ES-UI for specifications.

b. Design cathodic protection systems in accordance with applicable NACE standards, including corrosion evaluation and required protection criteria.

[1] Clearances: For LANL IPT: Regarding variance authority for this and many other matters in this chapter, see VAR-10773, *Civil/Utilities VAR & CIR SMPO Authority Delegation*).

c. Coordinate cathodic protection design with the LANL Utilities Corrosion Specialist, including the determination of:

1) System type (impressed current or sacrificial anode).

2) Isolation requirements.

3) Test station locations.

4) Bonding and electrical isolation needs.

d. Incorporate cathodic protection into utility design where soil resistivity, pipe material, coating type, or operating conditions indicate elevated corrosion risk.

e. Identify required locations for electrical isolation, corrosion monitoring, and test stations in design drawings.

3. Working within five (5) feet of underground lines:

a. Whenever practical, underground lines shall be de-energized, isolated, and tagged out.

b. Potholing shall be performed at all utility crossings , alignment changes, and as required to confirm depth and horizontal position of existing underground lines unless otherwise specified by the approved pothole plan. Vacuum excavation shall not be used within Potential Release Sites (PRS). Unknown or unlocated utilities require immediate work stoppage until evaluated. Potholing shall be performed per FSD OSH-ISH-FSD-003, *Potholing Procedures.*

c. Do not use mechanical excavating equipment within 5 ft of marked, non-potholed underground line until authorized by PIC or designee.

1) Expose and confirm the utility location by hand or vacuum excavation before mechanical digging. Pothole at crossings, alignment changes, and as needed to verify depth and alignment.

2) After utility is fully exposed and marked, mechanical excavation may proceed only with authorization and must maintain vertical and horizontal clearances consistent with Table G20-1. A spotter shall be present when equipment operates near the exposed utilities.

3) Protect or support exposed utilities. Stop work immediately if an unmarked utility is found and secure the area until evaluated.

4) A competent person shall inspect excavations daily; test the atmosphere before entry where hazardous conditions may exist.

4. Underground Line Clearances: Conform to Table G20-1 as shown:

Table G20-1. Underground Utility Line Minimum Clearance

Relation-ship	Utilities	Required Clearance (inches)
• **Clearance between the outside surfaces of the lines at closest point** • **Electrical means medium voltage (e.g., 4160V and 13.2kV)**		
Vertical Crossing (close at a single point)[1]	Electrical to electrical[2]	12
	Natural gas and any utility	
	Open telecommunications[3] and any utility (including electrical)	
	Electrical to any (except electrical or open telecom)	24 12 if at least one line is protected via sleeve or, less preferred, concrete
	Water, sewer (including force main)[4], or storm drain crossing each other	
	Steam, hot water, or RLW – to any utility	24
Parallel (for any distance)[1]	Electrical to electrical[2]	12
	Natural gas to water or force main	
	Open telecom to open telecom[3]	
	Electrical to open telecom	24
	Sewer (4”) to sewer	
	Sewer (incl force main) to storm drain	
	Storm drain to storm drain	
	Water to water	
	Electrical to water, sewer (incl. force), or storm drain	36
	Electrical and RLW	60
	Natural gas and any non-pressurized utility	
	Sewer main or sewer >8 feet deep and any utility	
	Steam or hot water and any utility	

1. Non-metallic piping requires 20’ min. parallel clearance from steam/hot water; vertical crossings prohibited
2. Three (3) inches permitted if concrete-encased
3. For secure communication line clearances, consult LANL ESM Chapter 18 Secure Communications, or its POC
4. Sewer located below potable water where feasible; where not, provide pipe sleeving for 10’ on either side of crossing.

5. Underground Piping Systems.

   a. Use tracer wire, APWA color-coded identification tape, and thrust blocks; ensure all systems pass pressure testing. (Requirements T-3015 and T-3017)

b. Warning Tape: Use non-detectable plastic warning tape consisting of high visibility, APWA color-coded, continuously printed, inert fiber reinforced polyethylene for direct burial service.

1) Minimum width of 6-inches, minimum thickness of 4.0 mil, and tensile strength of at least 1500 psi.

2) Install the tape 12-inches below finished grade and directly above the buried utility, ensuring the tape is continuous and undamaged before backfilling.

6. Tracer Wire: 12 AWG copper clad steel, insulations of HDPE minimum 30 mil thickness rated for direct burial. Insulation color shall meet the APWA color code for buried utilities. (Requirement T-3016).

a. Install the wire continuously between test stations without splices and without direct contact with the buried pipe.

b. Provide tracer wire test stations at grade at intervals not exceeding 200 feet, each containing an uncut 18-inch loop of wire.

c. Visually inspect the tracer wire system before backfilling and verify electrical continuity after installation.

7. Potable Water. Conform to IAMPO UPC, AWWA guidelines and EPA regulations, and requirements of LMS 33 1000, *Water Utilities*. Combined potable/fire water must also meet National Fire Protection Association (NFPA) and International Fire Code (IFC) standards (see also Ch. 2 herein).

a. Design distribution system to maintain a minimum residual pressure of 20 psi at ground elevation for a period not less than 2 hours; adhere to New Mexico Drinking Water Regulations.

b. Provide a minimum cover of 48-inches over buried potable water piping unless otherwise approved.

c. Use ductile iron pipe under roadways or where structural loading or site conditions require metallic pipe.

d. Provide a minimum 4-inch potable water service line for permanent buildings unless otherwise approved by the LANL UI Water System Representative.

e. Provide minimum 6-inch diameter fire protection main.

8. Fire Hydrants. Provided throughout LANL for fire protection from structural and wildfires. Coordinate with LANL Fire Protection Group for new or relocated fire hydrants.

a. Hydrants shall be provided so that hose runs from hydrants to all exterior portions of a protected building are under 300 feet. Hydrants should be accessible on a designated fire apparatus route and should not be closer than 40 feet from a building. If site constraints make it difficult to meet this minimum distance, consult LANL Fire Protection for an appropriate hydrant location.

b. All fire department connections, including sectional and sprinkler control valves, utilized on designated fire protection lines shall include a UL/FM tag indicating type. Where required, the valves shall be supervised with locks or tamper indicating supervisory devices. Shut-off valves for the fire hydrants maybe be listed as non-indicating valves with approved marked valve boxes.

c. Provide a single tie-in to the water main when a fire protection system is required. Tie the potable water service line into the fire line upstream of the post indicator valve (PIV or PIVA) and backflow preventer. Provide a shut-off valve and valve box in the potable water line. Install backflow preventer as close as possible to the water tie-in within 25 feet.

9. Sanitary Sewer. Follow the IAMPO UPC; AWWA guidelines; and ASCE Publication 37–*Design and Construction of Sanitary and Storm Sewers*.

10. In areas with an office and industrial mix, the population of the contributing area should be determined and the design flows calculated to be 25 gallons per capita per day, minimum. (Requirement T-3025).

a. Curvilinear sewers are not recommended and must be approved by the LANL UI Group Wastewater system representative. (Requirement T-3026)

b. Sewer Piping and Installation Requirements:

1) Use ductile iron under roadways or where required for structural or load considerations.

2) Gravity sewer piping shall maintain continuous, uniform slope without fittings or angled joints.

3) Minimum cover over sanitary sewer piping is 48-inches.

4) Tie-ins to existing LANL sewer infrastructure will be performed by the LANL UI Group; coordinate with LANL STR.

5) A completed and approved Waste Profile Form (WPF) must be on file for all contributing wastewater streams prior to tie-in.

c. Manholes.

1) Provide manhole systems, frames, and covers manufactured by firms listed on the Listing of LBO-Approved IBC Testing, NDE, and Inspection Agencies; Fabricators; and Products, or submit alternate manufacturers for review and approval by the LANL LBO per LANL ESM Chapter 16, Section IBC-FAB prior to installation.

2) Provide precast concrete manhole sections per ASTM C478, approved precast septic tanks per ASTM C1227, and approved fiberglass or HDPE septic/holding tanks as per the Drawings.

3) Provide castings conforming to ASTM A48/A48M, Class 30B. (Requirement T-3042)

d. Lift Stations (only where gravity flow is not feasible):

1) Coordinate lift station design, location, and configuration with the LANL UI Wastewater Representative.

2) Lift station depth shall not exceed 16 feet from finished grade to wet-well floor unless approved by UI.

3) Use interior package lift stations for single-building installations when practical; exterior lift stations shall comply with LANL Civil Standard Details (ST-G3020 series) and LMS Section 33 3000, *Sanitary Sewerage Utilities*.

4) Provide duplex pumping with alternating duty cycles. Pumps shall handle 3-inch solids, operate without overloading across the pump curve, tolerate at least 15 starts per hour, run dry without damage, and be removed without entering or dewatering the wet-well.

5) Provide redundant level sensing, high-level alarms, and remote alarm notification capability.

6) Exterior stations shall provide all-weather maintenance access and bollard protection where exposed to vehicle traffic.

7) Wet wells shall have corrosion-resistant lining and safe access features appropriate for wastewater environments.

8) Provide means for portable bypass pumping downstream of the plug valve.

9) LANL UI Group shall perform acceptance inspection, alarm/control verification, and tie-in to the sanitary sewer system.

11. Fire Protection Systems. Size to satisfy necessary demand (ref. Ch. 2 and consult LANL Fire Protection). Locate lines and hydrants in accordance with Ch. 2 Fire.

a. Do not meter fire lines (detector check valves are not required).

12. Potable water and fire sprinkler water systems supply lead-ins shall not be run under building; risers shall be inside building within 3 ft of exterior wall. (Requirement T-3023).

13. Steam/Condensate.

    a. Steam Piping: Piping systems above 15 psig, upstream of the first shutoff valve, must comply with ASME B31.1. Systems below 15 psig must comply with ASME B31.9 or B31.3.

    b. Provide metering in accordance with LANL ESM Chapter 14, Att. 2 – *Utility Metering Requirements*.

    c. For new buildings in TA-3 using the site steam system, see Ch. 6 *Mechanical*.

    d. Cast iron is not permitted. (Requirement T-3028).

14. Condensate Piping: Condensate piping outside of the building that returns to a central steam plant shall comply with ASME B31.1, *Power Piping*.

15. Natural gas (building external) shall be designed to 49 CFR 192, *Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards*. Refer to ASME B31.8 for design guidance, as appropriate. (Requirement T-3029).

    a. Comply with LMS Section 33 5100, *Natural Gas Distribution*, including no-substitution PE piping and installation method.

    b. Provide metering in accordance with LANL ESM Chapter 14, Att. 2 – *Utility Metering Requirements*.

16. Industrial Waste. Conceptual and final design for on-site treatment and disposal systems must be approved by LANL's Solid Waste Operations Group and the LANL UI Group. See Ch. 6, *Mechanical*.

    a. Process Liquid Waste. Refer to Chapter 6, *Mechanical*.

CHAPTER 4 ARCHITECTURAL

1.0 ARCHITECTURAL DESIGN PHILOSOPHY

Guidance: 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. Adhering to a world-class working environment the Laboratory aims to revitalize and enhance its facilities and infrastructure, intending to improve and maintain the functionality, safety, security, appearance, and life-cycle efficiency of the built environment.

A. LANL's basic development goals are fully described in the *Site & Architectural Design Principles*. This includes its Chapter V, Guidelines for Architectural Design, to support stylistic cohesiveness, building façade color and material consistency within the planning area in which the facility is located. (Requirement T-4001) Projects may also refer to the "LANL Sustainable Design Guide," if available.

2.0 CODES AND STANDARDS

A. Comply with those required by Chapter 1–General. In addition, follow:

1. Architectural Barriers Act (ABA).[1]
2. Follow Chapter 14, Sustainable Design.

LANL: Basis for above site-specifics is Requirement T-4002.

3.0 DESIGN DELIVERABLES

A. Prepare Life Safety Floor Plan identifying egress routes compliant with IBC Chapter 10 Means of Egress; code analysis compliant to IBC/IEBC; and NFPA 101, *Life Safety* Code, criteria, and requirements. (Requirement T-4002)

4.0 DESIGN REQUIREMENTS

A. **Fire Stopping:** Provide listed firestopping systems at all penetrations, joints, and openings in fire-resistance-rated assemblies. Installations shall maintain the required fire-resistance rating, smoke tightness, and continuity through concealed spaces and transitions. Identify required fire-resistance ratings and UL-listed assemblies by identified wall types on the drawings. Systems shall be coordinated across all disciplines, installed by qualified installers, accessible for inspection prior to concealment, and documented during installation and on record drawings.

1. Refer to Chapter 2 for additional selection and installation requirements.

[1] ABA is for Federally funded structures (e.g., LANL) and very similar to ADA. Guides detailing the ABA-to-ADA differences are available. See Chapter 3 for accessibility in public rights-of-way (e.g., PROWAG). When modifying facilities, the ABA requirement that 20% of the construction budget be spent on "the accessible path of travel" if barriers still exist does not apply if the facility or the area under reconfiguration is not considered public (in which case a person may only enter with a LANL badge or escorted by a person with a LANL badge). Few LANL spaces are public-use, perhaps only badge offices and other unbadged areas of Otowi, the Research Library, and the Bradbury Science Museum.

B. **Sound Attenuation:** Provide at penetrations, joints, and openings in acoustically rated assemblies to maintain required acoustic performance. Identify required STC ratings and acoustically rated assemblies on the drawings. Attenuation systems shall remain continuous through concealed spaces and transitions, be coordinated across all disciplines, and be documented on record drawings. Attenuation shall meet project-specific acoustic performance requirements and comply with ASTM E90, ASTM E413, and applicable IBC STC provisions.

C. **EIFS:** The use of exterior insulation and finish systems is acceptable if the Design Agency incorporates adequate protection measures to protect the system from pedestrian damage and landscaping maintenance up to a height of 7 feet above grade. Terminate above grade with J-bead. *Where practical, protect EIFS from the elements by projections (e.g., canopies, verandas, cantilevered stories above, etc.)*. Special inspection is required. (Requirement T-4003)

D. **Elevators and other lifts:** Structures of two or more stories, regardless of occupancy type, shall have at least one elevator serving every floor level. At least one such elevator shall accommodate a 24”x84” ambulance stretcher in its open, horizontal position. The Design Agency (EOR) is responsible for determining the appropriate type of elevator for the project. *The requirements and scoping documents should not specify the elevator type unless there are unusual circumstances that warrant LANL as a necessity for the ~~owner and~~ institution, such as requiring a freight elevator.*

1. Design to meet ASME A17.1, NFPA 70, and IBC (including Chapter 30 and A117.1).
2. Cab size shall follow code requirements unless user needs warrant a larger cab; flooring must meet radiant flux code minimums.
3. Provide a hole-less, hydraulic, passenger elevator when 2–4 stories. When the facility is five stories or higher, and a traction elevator is provided, regenerative (energy capturing) features are not allowed. (Requirement T-4004)
    a. Only petroleum-based oils shall be used with hydraulic elevators. (Requirement T-4005)
    b. Do not provide a sump (hole) or sump pump unless specifically required by code. When provided, sump cover shall be flush with elevator pit floor and support 400 lbs. without deflection. (Requirement T-4006)
    c. Machine-room-less (MRL) elevators – The main power and car lighting disconnecting means, along with the smoke and heat detector contacts, shall be located inside the MRL control space. (Requirement T-4007)
    d. Elevator motor controls shall be non-proprietary. The disconnecting means shall be located within sight of the motor controller. (Requirement T-4008)

e. The primary and alternate emergency recall levels shall be approved by the LANL fire marshal (or designee) and incorporated into the elevator control system.

f. Elevators with access to areas subject to weather, such as rooftops and parking garages, shall include a vestibule at the top landing and lower floors where the entrance is subject to weather (all floors if possible or SoW requires). Where entrances are not protected by a vestibule, sills shall be raised to prevent water intrusions. (Requirement T-4009)

Guidance: Special attention to detail while forming/pouring elevator pits is essential, especially for MRLs. Dimensions should be double-checked by LANL inspectors.

E. **Roofing:** Install cool roofs unless determined uneconomical by life-cycle cost analysis. For low-slope applications, only PVC and styrene-butadiene-styrene (SBS) or atatic-polypropylene (APP) modified bitumen systems are acceptable. For mid- to high-slope applications (> 2:12), use metal panel roofing. Other types of roofing systems (e.g., TPO) may be used when approved in advance by the Chapter 4 POC. Refer to Chapter 2 for fire-resistance requirements. (Requirement T-4010)

F. **Roof access:** Hatches with an extending ladder with a ‘safety-up post’ is the default expectation. Where not practical, extended stairways to a penthouse are preferred over fixed vertical ladders. Ships ladders or alternating tread stairs may be used in constrained areas with prior approval of chapter POC and AHJ. For buildings with multiple roof levels, access must be provided for equipment maintenance, with over-the-parapet ladders preferred. (Requirement T-4011)

G. **Locksets:** 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. LANL will supply and install Best 7−pin changeable cores. (Requirement T-4012)

H. **Signage/Room Numbering** (Requirement T-4013)

1. Signs

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

1) Interior Signage for New Buildings: New buildings shall utilize the LANL-designated interior signage system. Sign types, materials, finishes, and layouts shall conform to the LANL Standard Sign Catalog (available from POC or CEA-MP) and associated standard details (future). No substitutions are permitted unless approved by POC.

2. Interior Signage for Renovations and Additions: Projects involving renovations or additions that require new or modified interior signage shall either match the existing Vista System signage if currently installed

in the building, or upgrade affected areas to the LANL-designated signage system.

3. Projects are not required to upgrade signage throughout the entire existing building unless specifically directed by the project scope or LANL FOD.

    a. Floor loading: For each floor or portion thereof designed for live loads exceeding 50 psf, such design live loads shall be conspicuously posted in that part of each story in which they apply, using durable signs.

    b. Assembly: Every room or space that is an assembly occupancy shall have the occupant load of the room or space posted in a conspicuous place, near the main exit or exit access doorway from the room or space, for the intended configurations.

    c. Exterior wayfinding signs designating buildings are to be provided following LANL Standard Details ST-G2040-4, and 10 1405, Exterior Signage.

    d. 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.

4. Room Numbering

    a. A four-digit room numbering scheme will be provided by LANL after a conceptual floor plan is developed, received, and LANL-approved. (Send conceptual drawings to fpr_team@lanl.gov to assign numbering scheme)

    b. Room Numbering should comply with ESM Ch. 4 Architectural, Section C – Interiors, Appendix A – Room Numbering.

I. **Plumbing Fixtures:** Minimum plumbing fixture counts shall satisfy the scope of work and the Project code of record. When modifying existing buildings, coordinate with the Architectural POC for existing occupant loads and requirements.

1. Materials and equipment shall be commercial, not residential, grade. (Requirement T-4017)

Guidance: At time of writing, Chapter 1's "most stringent" rule dictated that the UPC counts, and not the NM Admin Code's reduction of same nor just the IBC, must be followed. Project circumstances may warrant exceeding even the UPC, and the users' input should be sought.

J. **Single-occupant restroom:** For new facilities, additions that add restrooms, reconfiguration of existing restrooms (an IEBC Level 2B Alteration), or for IEBC Level 3 Alterations: (Requirement T-4018)

1. Wherever separate multi-occupant restroom facilities are provided, at least one (1) single-occupant restroom facility shall also be provided.

    a. Locate in the same general area as the multi-occupant facilities to the extent practical (wayfinding signage as appropriate).

b. Such restrooms shall also comply with ABA provisions and signage shall reflect the single-occupant and ABA characteristics.

c. Amenities provided in multi-occupant restrooms shall also be provided in single-occupant 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% single-occupant equaling 100% of the total occupant load served.

e. Alternative ratios to above or other outcomes based on unique project circumstances require LANL Building Official approval.

K. **Room Size and System Furniture:** These guidelines ensure consistency across LANL in room design and system furniture planning. When designing these spaces, follow the LANL Furniture Standards (internal, will be provided) to ensure room sizes align with established furniture guidelines while maintaining occupancy loads in compliance with building occupancy requirements. (Requirement T-4019)

1. General Space Planning

a. Room sizes shall be determined based on operation and functional needs, occupancy load, and code requirements.

b. Designs must consider efficient workflow, accessibility, and flexibility for future modifications.

c. Life safety is the top priority when determining minimum clearances and circulation paths around fixed equipment, furniture, and furniture systems within buildings. Egress routes must comply with IBC, NFPA 101, and accessibility requirements.

d. A/V infrastructure shall be integrated into the design to support user needs, ensuring appropriate power, data connections, blocking for equipment, and acoustics for effective communication and presentations.

2. Office and Workspaces

General Planning Guidance: Recommended room sizes and workspace configuration identified in this section are intended as planning targets to support space utilization and consistency across facilities. Final room sizes, office assignments, and configurations may be adjusted based on existing facility constraints, security requirements, mission priorities, occupant density goals, managerial responsibilities, and available square footage. These recommendations shall not be interpreted as guaranteed entitlements to specific office type, size or configuration.

a. Executive Office (Lab Director): A private office with a recommended size of 250 SF or larger. The final dimensions shall be based on user needs, including furniture requirements, meeting needs and sufficient circulation space.

b. Executive Office (Senior Leadership): Recommended 10’ x 10’, or as required to accommodate user needs, system furniture, accessibility, and proper circulation.

c. Typical Office: Recommended 9’ x 9’, or as required to accommodate user needs, system furniture, accessibility, and proper circulation.

d. Private Workstations: Recommended 6’ x 7’ (open/no door) and 8’ x 7’ area per workstation, with allowance for partitions, storage, ergonomic clearances, and circulation.

e. Open Workstations/Hoteling: Recommended 6’ x 6’ area per workstation, with allowance for partitions, storage, ergonomic clearances, and circulation.

f. Shared Office: Recommended 6’ x 6’, per occupant, providing sufficient space for system furniture, circulation, and collaboration. Shared offices are encouraged in high-density or space-contained environments.

g. Office Allocation Prioritization: Private offices should be prioritized for Division Leader and Deputy Division Leaders, with final allocation subject to management responsibility based on operational needs, supervisory responsibilities, and space availability.

3. System Furniture: If the Design Agency is responsible for incorporating furniture or furniture systems into the design, they must adhere to the LANL Furniture Standards for selecting system furniture, wall panel heights, workstation layouts and configurations.

4. Collaboration and Support Spaces

a. Conference Rooms: Provide a suggested minimum of 15 net SF per occupant. The room size shall be determined based on occupant load factors. Conference rooms may also serve as multipurpose spaces, including break rooms, collaboration areas, and training rooms. Provide audiovisual equipment and supporting infrastructure to meet user and operational requirements.

b. Break Rooms: Recommended size of 150 SF or as required by occupant load. The room shall provide adequate clearances for appliances, seating, and circulation.

5. Any proposed upgrade, reconfiguration, or change in use that results in a calculated increase in occupant load, equipment density, or operational demand shall trigger engineering evaluation of associated building systems and life safety requirements. This assessment shall verify the adequacy of existing infrastructure and identify required upgrades necessary to maintain compliance with applicable code, life safety, and mission requirements.

L. **Site Development and Landscaping**

1. Follow ESM Chapter 4 reference *Site & Architectural Design Principles* document for landscaping requirements. When implementing site improvements and adding landscaping, ensure coordination with Civil Chapter 3 for additional requirements related to site modifications including grading and drainage.
2. The design must maintain continuity and incorporate site planning, plant selection, irrigation efficiency, and long-term maintenance to promote aesthetics, habitat, and resilience of the campus. Landscaping shall contribute to stormwater management, erosion control, reduction of heat-island effect, and improve the physical landscape.
    a. Plant list (species, size, quantity).
    b. Walls, fences, mulches, and open-space features.
    c. Irrigation and exterior lighting plans, including dark-sky compliance.
3. Seeding recommendations are updated regularly, and the design shall follow current guidelines and LANL-EPC environmental compliance requirements to ensure sustainability and regulatory adherence. Refer to LANL Master Specification (LMS) Section 32 9219.
4. Site factors for planting, seeding, and sodding may exist separately or in various combinations. Design shall consider the following factors for landscaping and or re-vegetation of construction areas:
    a. Drainage
    b. Topography
    c. Soils
    d. Climatic data
    e. Existing Vegetation
    f. Security Requirements
    g. Pedestrian Circulation
5. When directed by SoW or LANL architect, include physical barriers for protection of landscape elements from autos or snow removal (e.g., concrete curbs, pipe barriers, fencing, etc.)

    LANL: Basis for above site-specifics is Requirement T-4020.

M. **Off-Street Parking Requirements** (Sizing Parking Lots)

1. Parking Space Calculations
    a. Off-street parking requirements for new buildings, building additions, and associated parking facilities shall comply with the ICC 2021 International Zoning Code (IZC), Section 801: Off-Street Parking Requirements (and Table 801.2.1 Off-Street Parking Schedule), or the version corresponding to the current adopted

edition of the IBC as a basis for design. Base parking on the building's Use and gross floor area.

b. This standard shall be applied for all projects unless otherwise addressed by the statement of work.

c. For shared parking lots, the total required parking count shall be calculated based on the combined requirements of all buildings or occupancies served by the lot.

LANL: Basis for above: LANL does not maintain its own zoning code and the campus functions under its designated Authorities Having Jurisdiction (AHJs) and Site Planning.

2. Accessible Parking Requirements

a. The number and type of accessible parking spaces shall comply with IBC 2021 Table 1106.2 Accessible Parking Spaces, or the table from the edition currently adopted by LANL.

b. Accessible spaces shall be located, sized, and striped in accordance with IBC requirements, ICC A117.1, and all applicable federal accessibility guidelines.

N. **Temporary and Relocatable Structures**

1. See this topic in TSM Chapter 16.

CHAPTER 5 STRUCTURAL

1.0 COMMERCIAL DESIGN AND ANALYSIS REQUIREMENTS

This Chapter provides the minimum requirements for the structural design and construction of new and existing commercial (i.e., non-nuclear) structures, systems, and components (SSCs). These include nonbuilding structures[1], nonstructural components[2] and, as applicable, programmatic equipment[3].

Such design and construction shall be performed in accordance with the International Building Code (IBC), the International Existing Building Code (IEBC), and the structural standards referenced therein. All provisions of the 2021 IBC not specifically referenced herein shall be applied as written in the code. Modifications to the 2021 IBC and ASCE 7-16 provisions contained herein are intended to address LANL site-specific requirements. Where conflicts arise between the 2021 IBC or ASCE 7-16 and the TSM, the TSM prevails. Unless noted otherwise, section numbers included in this TSM chapter refer to the 2021 IBC.

Where this chapter modifies the 2021 IBC and/or ASCE 7-16 as indicated below, comply with the stated action:

- **[Addition]** – Add a new section, including a new section number, not shown in the 2021 IBC or ASCE 7-16.
- **[Deletion]** – Delete the referenced 2021 IBC or ASCE 7-16 section or a noted portion of a section.
- **[Replacement]** – Delete the referenced 2021 IBC or ASCE 7-16 section or a noted portion and replace it with the narrative shown.
- **[Supplement]** – Add the narrative shown as a supplement to the narrative in the referenced section of the 2021 IBC or ASCE 7-16.

2.0 IBC CHAPTER 16 STRUCTURAL DESIGN

A. **Table 1604.5 Risk Category of Buildings and Other Structures.** [Supplement]

Add the following text at the end of footnote b. (Requirement T-5001)

A facility Explosives Safety Site Plan, approved by the LANL DOE Field Office, constitutes an analysis of the quantity-distance relationships for the quantity of explosive materials permitted in the facility to ensure there is no threat to the

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[1] Nonbuilding structures include structures in IBC Occupancy Classification Groups H, F, S, U and others included in ESM Chapter 16 IBC-GEN in-scope tables, and ASCE 7. For specific details regarding the type of SSCs under the scope of ASCE 7 seismic and wind design requirements, refer to ASCE 7 Sections 11.1.2 and 26.1.1. ASCE 7 Chapter 15, as referenced by IBC 1613.1, includes seismic design requirements for self-supporting nonbuilding structures. Examples include pipe racks, storage racks, earth retaining structures, chimneys, stacks, tanks, and vessels to name a few. It is important to note that certain nonbuilding structures are outside the scope of IBC and ASCE 7. These include vehicular bridges, electrical transmission towers, hydraulic structures, buried utility lines and their appurtenance and nuclear reactors.

[2] ASCE 7 Chapter 13, referenced by IBC Section 1613.1, includes seismic design requirements for nonstructural components that are permanently attached to structures. These components include architectural, mechanical, electrical, and piping systems (MEP).

[3] Anchorage and bracing requirements for programmatic equipment (e.g., specialized tools, machinery, and equipment that are not facility, utility, infrastructure or environmental program related) are specifically addressed in Section 9.0 of this TSM Chapter.

ASCE 7 Chapter 26, as referenced in IBC Section 1609.1.1, includes wind design requirements for building structures, nonbuilding structures, and nonstructural components within the scope of the IBC.

public from blast pressures, fragments, or noise. Upon approval of same by NA−LA, these facilities may be taken as Risk Category II[4].

B. **Section 1607 Live Loads**

1. **1607.1.1 Live loads posting** [Addition]

   The Structural Engineer of Record (SEOR) is required to clearly indicate in floor plan drawings the areas with live loads greater than 50 psf (e.g., using keyed notes). (Requirement T-5002)

2. **1607.11.5 Experimental explosion loads**. [Addition]

   a. Reactions from experimental explosion containment structures, due to explosions within them, shall be considered live loads that act concurrently with floor and roof live loads and that have a load factor of 1.0 for both strength design and allowable stress design. (Requirement T-5003)

   b. External loads from experimental explosions shall comply with DOE-STD-1212 Section 7.2 and shall be considered live loads that act concurrently with floor and roof live loads and that have a load factor of 1.0 for both strength design and allowable stress design. (Requirement T-5004).

C. **Section 1608 Snow Loads**

1. **1608.2 Ground snow loads.** [Replacement]

   The ground snow load to be used in determining the design snow load for roofs shall be 30 psf. (Requirement T-5005)

D. **Section 1609 Wind Loads[5]**

1. **1609.1.1 Determination of wind loads**. [Replacement]

   Replace the second sentence of the first paragraph with the following:

   The basic design wind speed, V, and the exposure category shall be as indicated in Section 1609.[6] (Requirement T-5006)

2. **1609.3 Basic design wind speed.** [Replacement]

   The basic design wind speed, V, for the determination of wind loads shall be as follows: (Requirement T-5007)

   a. 99 mph for Risk Category I,

   b. 104 mph for Risk Category II, and

   c. 110 mph for Risk Category III, and

   d. 115 mph for Risk Category IV.

[4] This exemption only considers effect of explosives on assignment of Risk Category. Risk Category may be greater than RC II for other reasons such as operability during or after seismic events, mission importance and security.
[5] Wind and Seismic Detailing guidance: Structures with wind demands/effects greater than seismic demands/effects (i.e., “governed” by wind load) shall meet the seismic detailing requirement and limitations of IBC and ASCE 7 as required per IBC Section 1604.9.
[6] For photovoltaic (PV) wind design, refer to SEAOC reports PV2-2012 and PV2-2017.

3. **1609.4 Exposure category**. [Replacement]

   The exposure category shall be taken as Exposure C for each wind direction considered. (Requirement T-5008)

E. **Section 1612 Flood Loads**

1. **1612.3 Establishment of Flood hazard areas.** [Replacement]

   All canyons within LANL boundaries shall be considered flood hazard areas, the design flood elevations shall be determined in accordance with Section 1612.3.1. (Requirement T-5009)

2. **1612.3.1 Design flood elevations.** [Replacement]

   Replace the first paragraph in **Section 1612.3.1** with the following:

   To determine the design flood elevations, the engineer of record is required to do one of the following: (Requirement T-5010).

F. **Section 1613 Earthquake Loads**

1. **1613.2.1 Mapped acceleration parameters** [Replacement]:

   The parameters S_S and S_1 shall be determined using the ASCE Hazard Tool, Standards Version: ASCE/SEI 7-16.

   a. **1613.2.5 Determination of seismic design category** [Supplement]

      The use of Seismic Design Category (SDC) C is permitted for structures that meet the requirements of IBC Section 1613.2.5.1.

2. **1613.4 Amendments to ASCE 7.** [Addition]

   a. **1613.4.1 Siting**. Modify ASCE 7 Section 11.8.1 to read as follows:

      11.8.1 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. (Requirement T-5011)

   b. **1613.4.2 Design Approach to Commercially Fabricated Buildings Used in Multi-State Jurisdictions.** Refer to Section 6.0 of this chapter for applicable requirements.

   c. **1613.4.3 Nonstructural Components Exempt from Seismic Design.** Modify ASCE 7 Section 13.1.4, Numerals 1 and 2 to read as follows[7]: (Requirement T-5012)

      1) Furniture except for cabinets as noted in ASCE 7 Table 13.5-1[8].

[7] 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.
[8] Cabinet-like furniture is not exempt (e.g., relatively tall, narrow, and heavy components/equipment, such as some safes and shelves).

2) Temporary[9] or movable components/equipment[10].

d. **1613.4.5 Restraint of Non-Facility Equipment (e.g., Programmatic, Utilities, Infrastructure, Environmental Remediation)**. Refer to Section 9.0 of this chapter for applicable requirements.

G. **Section 1617 Accidental Blast Loads.** [Addition]

1. Permanent explosive facilities shall comply with DOE-STD-1212 Section 7.1. (Requirement T-5013). When evaluating for accidental blast load (A_B), A_B shall replace E (earthquake load) in the load combination equations. (Requirement T-5014). All potential blast effects shall be considered including blast overpressure, gas pressure, fragments, and ground shock. (Requirement T-5015).

a. The design of all new facilities containing explosives, or those that can be affected by detonation (inadvertent or planned) of explosives, shall comply with DOE-STD-1212 Section 7.5.[11] (Requirement T-5016)

b. The above requirements also apply to significant (e.g., IEBC Alteration Level 3) modifications of facilities containing explosives, or of facilities that can be affected by detonation (inadvertent or planned) of explosives. (Requirement T-5017)

H. **Section 1618 Minimum Antiterrorism Structural Design Measures.** [Addition]

Structural design measures for progressive-collapse avoidance and window protection presented in DOD UFC 4-010-01 shall be considered for those buildings where there is a credible terrorist threat (Requirement T-5018). LANL Physical Security (PS) Division shall specify (to the LANL Project Manager) whether these minimum antiterrorism measures are to be implemented; see also LANL ESM Chapter 9, Facility Protection and Security. (Requirement T-5019)

I. **Section 1619 Dynamic Loads and Supports for Vibrating Machinery.** [Addition] (Requirement T-5020)

1. Machinery foundations shall be designed in accordance with ACI 351.2R-10 *Report on Foundations for Static Equipment*; ACI 351.3R-18 *Report on Foundations for Dynamic Equipment*, equipment manufacturer's recommendations, and published design procedures and criteria for dynamic analysis.

2. If equipment manufacturers' vibration criteria are not available, the maximum velocity of movement during steady-state normal operation shall be limited to 0.12 inch (3.0 mm) per second for centrifugal machines and to 0.15 inch (3.8 mm) per second for reciprocating machines.

[9] Temporary components are those that remain in place for 3 years or less (defined in the Conduct of Engineering Glossary).
[10] Movable components/equipment that are expected to remain in place for periods of 3 years or longer, should be considered permanent for the purposes of this section. Non-permanent anchorage such as detachable cable restraints, chains, brackets, and similar alternatives are acceptable restraint options for these items. Contact the ESM Ch. 5 POC for guidance.
[11] Per DOE-STD-1020 Section 2.2.5, it is permissible to use DOE-STD-1212 to satisfy the provisions of 10 CFR Part 851. This portion of "1020" also refers to 29 CFR Part 1910.109.

3. For centrifugal machinery greater than 500 horsepower, support structures or foundations shall be designed for the expected dynamic forces using dynamic analysis procedures.

   a. For grade-mounted centrifugal machinery 500 horsepower or less, unless specified otherwise by the equipment manufacturer, and in the absence of a detailed dynamic analysis, the foundation weight shall be designed to be at least three times the total machinery weight. Weight of a grouted equipment skid can be considered part of the foundation weight for this provision.

   b. For reciprocating machinery greater than 200 horsepower, support structures or foundations shall be designed for the expected dynamic forces using dynamic analysis procedures.

   c. Unless specified otherwise by the manufacturer, for grade-mounted reciprocating machinery 200 horsepower or less, in the absence of a detailed dynamic analysis, the foundation weight shall be designed to be at least five times the total machinery weight. Weight of a grouted equipment skid can be considered part of the foundation weight for this provision.

   d. The allowable soil-bearing or allowable pile capacity for foundations for equipment designed for dynamic loads shall be a maximum of half of the normal allowable for static loads.

   e. The maximum eccentricity between the center of gravity of the combined weight of the foundation and machinery and the bearing surface shall be 5% in each direction.

   f. Unless otherwise specified in the subcontract documents, if equipment manufacturer's frequency criteria are not available, structures and foundations that support vibrating equipment shall have primary modes of natural frequency that are outside the range of 0.80 to 1.20 times the exciting frequency.

3.0 IBC CHAPTER 17 SPECIAL INSPECTIONS AND TESTS

Refer to LANL ESM Chapter 16 Building Code Program for related amendments to this and other IBC chapters with structural content.

4.0 IBC CHAPTER 18 SOILS AND FOUNDATIONS

A. **1803.5 Investigated Conditions.** [Supplement]

Add the following text at the end of **Section 1803.5.12**, Numeral 1: (Requirement T-5021)

An acceptable approach for obtaining such seismic earth pressures on foundation walls (i.e., exterior embedded building walls or basement walls) is to use of the Simplified Method presented in ASCE 4-16 Section 8.2.2. Similarly, for earth retaining walls such pressures can be obtained using the Mononobe-Okabe approach in accordance with ASCE 4-16 Sections 8.3 and C8.3, provided that the wall displacements required to develop the active earth pressure can be justified without loss of wall function.

B. **Section 1808 Foundations**

1. **1808.1 General.** [Supplement] (Requirement T-5022):

Permanent buildings and similar structures shall have a permanent foundation (e.g., full perimeter support, rodent-excluding, no trailer skirting, etc.). Permanent is anything not Temporary (which is defined in the Conduct of Engineering Glossary).

Exception: For non-temporary relocatable buildings (as defined in LANL ESM Chapter 16, Section IBC-GEN)[12], 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.*

*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.** [Replacement]

Replace numeral 1 with the following:

Extending below the ground surface to a depth of 36”. (Requirement T-5023).

5.0 IBC CHAPTER 19 CONCRETE

A. **Section 1901 General**

1. **1901.3 Anchoring to concrete** (Requirement T-5024):

1901.3.1 Post-installed anchors. [Addition]

Post-installed anchor design shall provide for limited anchor relocation (at least ± 1 inch) to facilitate anchor installation (Requirement T-5025). Due consideration shall be given to the location tolerances of the anchors to avoid interferences with reinforcement in concrete.

Post-installed anchors shall be qualified for use in cracked concrete under earthquake loads in accordance with ACI 355.2 or ACI 355.4, as applicable. Additionally, the intended use of the product in the field must align with the USES and CONDITIONS OF USE requirements provided in the corresponding qualification or evaluation report (e.g., ICC ESR or IAPMO ER).

Exception: Seismic-related provisions are not applicable to anchoring that is seismically-exempt per Section 2.0.F.2.c of this chapter.

[12] 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 ESM Ch 16 IBC-GEN on temporary facilities, relocatable buildings, and prefabs.

B. **Section 1904 Durability Requirements**

1. **1904.3 Mass Concrete** [Addition] (Requirement T-5026):

a. 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.*

b. The Construction Documents shall designate those portions of the structure, or concrete placement that are to be treated as mass concrete. The Project Specification Section (e.g., 03 3001, *Reinforced Concrete*) shall adopt the ACI 301, Section 8 requirements. The Structural Engineer of Record (SEOR) shall review the project-specific version of Section 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.

1) 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.

2. **1904.4 Concrete Mix Design** [Addition]

LANL Master Specification Section 03 3001 is an acceptable approach to satisfy 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.

C. **Section 1905.1.9 ACI 318, Section 7.6.1.1.** Modify ACI 318, Section 7.6.1.1 to read as follows (Requirement T-5027): [Addition]

1. **7.6.1.1** A minimum area of flexural reinforcement, $\mathbf{A_{s,min}}$, of $\mathbf{0.0018A_g}$ shall be provided. The total quantity of $\mathbf{A_s}$ shall be adequate to develop a factored load at least 1.2 times the cracking load calculated on the basis of $\mathbf{f_r}$ as given in 19.2.3.

6.0 IBC CHAPTER 21 MASONRY

(Requirement T-5028)

A. **2101.2.2 - Allowable Stress Design** [Addition]

Masonry must be designed as reinforced unless the element is isolated from the structure so that vertical and lateral forces are not imparted to the element.

B. **2101.2.3 - Strength Design** [Addition]

Masonry must be designed as reinforced unless the element is isolated from the structure so that vertical and lateral forces are not imparted to the element.

C. **2101.2.4 - Empirical Design** [Addition]

Do not design masonry according to the empirical method.

D. **2104.1.3- Shear Wall Construction** [Addition]

Construct shear walls using running bond only; stack bond construction is not permitted.

E. **2106.2 – Anchoring to Masonry** [Addition] (Requirement T-5029)

Anchors in masonry must be designed in accordance with TMS 402-16. Additionally, at least one of the following must be satisfied:

1. Anchors in tension are designed to be governed by the tensile strength of a ductile steel element.
    a. Anchors are designed for the maximum load that can be transmitted to the anchors from a ductile attachment, considering both material overstrength and strain hardening of the attachment.
    b. Anchors are designed for the maximum load that can be transmitted to the anchors by a non-yielding attachment.
    c. Anchors are designed for the maximum load obtained from design load combinations that include E, where the effect of horizontal ground motion, Q_E, is multiplied by Ω_o.

7.0 IBC CHAPTER 22 STEEL

A. **2205.1 – General** [Supplement] (Requirement T-5030)

Add the following to the end of the paragraph:

Design structural steel floor framing systems for vibration serviceability in accordance with AISC Design Guide 11.

8.0 COMMERCIALLY FABRICATED BUILDINGS USED IN MULTI-STATE JURISDICTIONS (DESIGN APPROACH)[13]

A. **Approval**

From a structural standpoint, approval is limited to the following vendors (others with LANL ESM Chapter 5 POC written permission): ARMAG, MSSI, and US Chemical (Requirement T-5031).

[13] A commercial building that is marketed nationally is termed “commercial building structure.” Typically, these are factory built, transported to the site on trailers, and anchored to engineered foundations. At LANL, the intended purpose for these is to serve as storage facilities, control facilities for experimental work, weather proofing structures for materials, equipment or piping systems, security portals for entry access, etc. They are sometimes occupied, but not continuously; the occupancy is limited for the special purpose of the facility. These structures have building geometries and framing systems that may be different from the broader class of occupied structures addressed in ASCE 7, Chapter 12. See ESM Ch 16 IBC-GEN Section 10.0 “Prefab Structure Requirements”.

B. **Applicability**

Commercially fabricated building-like structures designated as ML-4 that are not credited SSCs in nuclear or radiological safety documentation and are classified as Risk Category I, II, and III per ASCE 7 Table 1.5-1.

C. **Design** (Requirement T-5032)

1. Design and detail commercially fabricated building-like structures not classified as structural systems in ASCE 7 Chapter 12 in accordance with ASCE 7 Section 15.5 for nonbuilding structures similar to buildings, as required by ASCE 7 Section 11.1.3.

2. If a nationally marketed structure does not fall within the categories defined in ASCE 7 Sections 12.2 or 15.5, it shall be designed in accordance with ASCE 7 Section 15.6 for nonbuilding structures not similar to buildings. The default structure type listed in Table 15.4-2, *"All other self-supporting structures, tanks, or vessels not covered above or by reference standards that are not similar to buildings,"* shall be used.

9.0 RESTRAINT OF NON-FACILITY EQUIPMENT

Restraint (i.e., anchorage and/or bracing) of non-facility (e.g., programmatic) equipment is required in either of the following two conditions (Requirement T-5033):

A. When required by the manufacturer for normal operation.

1. If this is the sole reason restraint is required (i.e., seismic restraint per paragraph B below is not required), then the design does not need to follow TSM Ch. 5 if the manufacturer provides alternative design requirements (Requirement T-5034).

B. In all other cases, seismic restraint is required unless the equipment is "Seismically Exempt" per Section 2.0.F.2.c of this chapter (Requirement T-5035).

1. If seismic restraint is required, the design must comply with ASCE 7-16 Chapter 13 requirements. (Requirement T-5036)

2. An alternative method[14] may be proposed to the Structural POC for approval on behalf of the LANL Building Official, provided[15] (Requirement T-5037):

a. An analysis that indicates the interaction effects of the unrestrained equipment[16] are acceptable at the Design Basis Earthquake (DBE).

b. The equipment will be in an essentially unoccupied area[17] and is protected as such through administrative or engineering control.

[14] Acceptable and conservatively bias methods to evaluate sliding, rocking and uplift of rigid unanchored equipment is provided in ASCE 4-16, Chapter 11 and Attachment 11A.
[15] In all cases, per ASCE 7 C13.1.1, equipment must be anchored if it is permanently attached to utility services (e.g., electricity, gas, water).
[16] Seismic interaction is the physical interaction of any non-facility equipment with the structure or nearby items caused by relative motions from an earthquake. The interaction analysis should consider interaction effects due to rocking, swaying, overturning, sliding, impact, etc.
[17] 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).

c. Anchorage and/or restraint is not practical.

d. In an existing facility, unless the building is undergoing an alteration that involves the structural provisions of IEBC (2021) in Section 304; Chapter 5; or Sections 706, 805, or 906; it may be that the restraint can be designed to lesser requirements; see Existing SSC paragraph in TSM Ch. 16 (leading to LANL ESM Ch. 16, IBC-GEN App B, Code of Record/Structural material).

C. Both of the above conditions (i.e., 9.0.A and 9.0.B), also apply to equipment installed outside of a building (Requirement T-5038).

D. Seismic restraint of laboratory equipment inside of a building can be achieved using the restraint recommendations in FEMA E-74 Section 6.5 (Requirement T-5039).

10.0 STRUCTURAL LANL MASTER SPECIFICATIONS

A. Structural discipline LANL Master Specification templates contain materials, methods, and quality related content specific to LANL. Projects shall meet their requirements.

11.0 RECOMMENDED STRUCTURAL REFERENCES

The TSM webpage provides a list of structural references that offer guidelines, best practices, design examples, and recommendations to support compliance with the 2021 IBC and its referenced standards.

CHAPTER 6 MECHANICAL

1.0 GENERAL—DESIGN DOCUMENTATION

A. General

1. Provide documentation to include, but not limited to, the following (Requirement T−6001):

   a. Calculations: Note the source of each formula or method used, list assumptions and exceptions, and define units. Provide copies of tabulated data used. If a computer program is used (e.g., for HVAC sizing), provide input data in the calculation (Requirement T-6002).

2. 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 elevation (Requirement T−6003).

3. Piping System Calculations: Flow rates, pipe sizing with friction factors, velocities, expansion/contraction, and system equipment pressure drops for pump selection (Requirement T-6004).

4. 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 elevation correction for motor size is properly performed (Requirement T−6005).

5. Vibration Isolation/Sound Attenuation Measures: List uncorrected and corrected equipment criteria in the design documentation (Requirement T−6006).

6. Plumbing System Calculations: Provide for water supply and drainage fixture unit requirements, roof drainage, and makeup water requirements for mechanical systems (Requirement T-6007).

7. 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. (Requirement T-6008)

8. Include copies of catalog sheets showing equipment performance points for major equipment included in each system’s design (Requirement T−6009).

9. Mechanical rooms: provide layout complete with estimated equipment sizes, pipe routing, and sizing to LANL for approval prior to design completion (Requirement T−6010). Mechanical rooms shall be accessible from the exterior of the facility in new construction projects. Coordinate access control with project requirements to facilitate ease of maintenance.

10. Mechanical system design, materials, and construction shall meet ASHRAE 55, 62.1, and 90.1. ASHRAE 90.1-2019 compliance to be documented per Chapter 14 (e.g., ComCheck). (Requirement T-6011).

B. HVAC Options – Life Cycle Cost Analysis (LCCA)

1. Unless another building design life is specified in the statement of work, select mechanical systems using a 40-year LCCA. Use first cost, utility costs, operating efficiency, maintenance, and unit replacement costs to determine the most life cycle cost efficient mechanical system. (Requirement T-6012).

2.0 GENERAL—EQUIPMENT/PIPING IDENTIFICATION

A. General

1. For fume hoods and other local exhaust ventilation systems, label exhaust fans with a permanent printed label indicating fan design static pressure, RPM, and motor current. The data for these labels is to be supplied by the test, adjust, and balance (TAB) agency (Requirement T-6013).

3.0 GENERAL—SOUND CONTROL

A. General

1. Specify that equipment (fans, chillers, VAV terminal units, air handling units, etc.) complies with the sound rating of the applicable standards of the Air Conditioning, Heating and Refrigeration Institute (AHRI) or the Air Movement and Control Association (AMCA) (Requirement T-6014).

2. For mechanical equipment, provide sound power (preferred) or sound pressure levels for all eight octave band center frequencies from 63 to 8000 Hz (Requirement T-6015).

3. For sound control materials, specify sound transmission loss (TL) capabilities and/or sound absorption coefficients, depending on the material. State TL in decibels (dB) and octave band center frequencies for both (Requirement T−6016).

4. Seal penetrations through walls, floors, and ceilings (Requirement T-6017).

B. Acoustical Design

1. The following criteria are acceptable for mechanical system noise levels in normally occupied spaces, as measured during unoccupied times (NC=Noise Criteria; RC=Room Criterion) (Requirement T-6018).

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 violating the silencer manufacturer's installation instructions (Requirement T-6019).

2. Select silencers for the lowest possible static pressure drop, while still providing the specified insertion loss; specify to have a certified dynamic insertion loss (DIL) in decibels for the critical frequency or frequencies of concern, not less than the calculated requirement (Requirement T-6020).

3. Where conditions prohibit the use of acoustic fill used in conventional silencers, use packless duct silencers (Requirement T-6021).

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."

2. The equipment vibration severity rating for vibration on equipment structure or bearing caps shall be "slightly rough" or better per ASHRAE Applications Handbook (*Chapter 49 Figure 42 in 2023) (*Requirement T−6022).

5.0 PIPING—CROSS CONNECTION CONTROL

A. Backflow Preventers (BFPs)

1. Locate building and fire protection BFPs inside the building, when possible, to prevent freezing and facilitate maintenance. (Requirement T-6023).

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 (Requirement T-6024).

b. Locate outside BFPs above ground in heated enclosures (e.g., "Hot Boxes") set on concrete pads and protect units from freezing; Civil Standards POC must approve outside installations in heated enclosures (Requirement T-6025).

2. Provide parallel BFPs if building water supply cannot be interrupted in critical systems (Requirement T-6026).

B. Temporary Buildings[1]

1. Provide a pressure-reducing valve (PRV) with a check valve in the potable water service line to each temporary building (trailer, transportable, Armag, etc.) as required to limit to 80 psig. (Requirement T-6027).

[1] Defined in Conduct of Engineering Glossary

2. Refer to Mechanical, ST-D2020-2, Sheet 2, for PRV detail (Requirement T−6028.

6.0 EMERGENCY SHOWERS AND EYE WASH STATIONS

A. For tempered water for emergency showers and eyewashes, provide a prepackaged, fully engineered and tested, mixing valve assembly furnished by the manufacturer of the emergency equipment, per ANSI Z358.1-2014. Provide equipment that is capable of a discharge temperature of 80–100°F. Design for 85°F delivery temperature. (Requirement T-6029).

B. Drains are not required to be provided for eye washes, safety showers, or combination installations, and not routed to sanitary drains or storm drains. 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 15 min.) for a single installation; sampling of collected water will determine appropriate disposal path (Requirement T-6030).

7.0 PLUMBING—GENERAL

A. 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°F to control the pump. Use a timeclock to save energy during off-hours (Requirement T−6031).

Guidance: In installations where hot water use is fairly continuous 24/7, do not use a pump.

B. Minimize the number of floor drains in equipment rooms to prevent possible contamination (oil, etc.) transfer to the sanitary sewer system (Requirement T-6032).

C. Route drain piping from equipment close to walls or equipment to minimize tripping hazards (Requirement T-6033).

D. Isolation valves shall be installed to facilitate maintenance.

E. Refer to Chapter 4 for fixture count direction.

8.0 PIPING—STORM WATER

A. General

1. Design roof drain system for 2.25 inches of rainfall in a 1-hour period (Requirement T-6034).

   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 (Requirement T-6035).

2. Provide concrete splash blocks, river rocks, or similar, under down spouts to prevent ground erosion. (Requirement T-6036).

9.0 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 required elevation correction and consideration that there is a good possibility of sizable diversity in demand (Requirement T-6037).

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. (Requirement T−6038).

3. Provide a commercial oil/water separator 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 no-loss drain valve. Refer to the compressed air piping drawings referenced below for details (Requirement T-6039).

B. Elevation (Altitude) Correction

1. Derate the compressor free air delivered from what is listed in the manufacturer's catalog data to account for elevation and temperature[2] (Requirement T-6040).

C. System Components

1. Aftercooler: Equip each compressor with an aftercooler sized to provide a 5–20°F approach temperature (Requirement T-6041).

2. Air Dryers: Use a refrigerated air dryer (35–38°F pressure dew point) when the compressed air system's ambient temperature is always 40°F and above. For portions of the system below 40°F ambient temperature, use a regenerative air dryer (-40°F pressure dew point) (Requirement T−6042).[3]

Note: Heatless regenerative air dryers typically consume 5–18 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°F) or humid locations (Requirement T-6043).

4. Air Intake Filter: Equip the compressor inlet with a filter to remove dirt from the air (Requirement T-6044).

5. Receiver: Equip each compressed air system with a receiver tank to dampen pulsations; equip with a pressure gauge, safety relief valve, and drain valve, and an NBIC Numbered and Registered tank (Requirement T-6045).

6. Mechanical Air/Water Separator: Provide separators with the compressor package to remove water that has condensed in the aftercooler of the compressor (Requirement T-6046).

7. Sound Attenuation: For applications requiring low noise (below 85 dBa), specify a sound enclosure for a rotary screw compressor or intake

[2] Rule of thumb is a 30% deration, but this could vary by a few percentage points based on the design pressure of the compressed air system.
[3] Prevents condensate freeze-up

filter/silencers and/or mufflers for reciprocating compressors (Requirement T−6047).

D. Outdoor Installations

1. Specify a compressor that is factory-rated for outdoor use down to 5°F (Requirement T-6048).

2. To protect the unit from weather and freezing, equip the compressor with the following (Requirement T-6049):

a. TEFC motors and NEMA 4 controls, starters, and pressure switches.

b. Heaters as recommended by manufacturer.

c. Watertight intake filters.

d. Heat-trace air/water separators, receivers, and condensate drain piping.

10.0 HVAC—ELEVATION/CLIMATIC CRITERIA AND HEAT GAIN EQUATIONS

A. See Chapter 1 for elevation, latitude/longitude, barometric pressure, air density, and air density ratio values.

B. Heating Degree-Days (annual mean): 6219 at 65°F base; 2680 at 50°F base (Requirement T-6050).

C. Cooling Degree-Days (annual mean): 2187 at 50°F base, 272 at 65°F base (Requirement T-6051).

D. Correct Q for elevation. Values for 7500 feet (*suitable for many locations/situations*) are (Requirement T-6052):

$$Q \text{ (sensible heat)(Btu/hr)} = 1.08 \times 0.76 \text{ (@W = 0)} \times \text{cfm} \times \Delta t$$

$$Q \text{ (latent heat)(Btu/hr)} = 0.68 \times 0.760. \times \text{cfm} \times \Delta W \text{ (gr.)}$$

$$Q \text{ (total heat)(Btu/hr)} = 4.50 \times 0.76 \times \text{cfm} \times \Delta h$$

Where:

cfm = Air flow Rate, cubic feet/min.

ΔW (gr) = Humidity Ratio Difference, gr. water/lb. dry air.

Δh = Enthalpy Difference, Btu/lb. dry air.

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

Δt = Temperature Difference, degrees F.

E. For HVAC system sizing/design, use data in the 2021 ASHRAE Fundamentals Handbook (WMO#723654), which is based on weather data from the Los Alamos Airport. (Requirement T-6053).

1. 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 above.

11.0 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. It is the responsibility of the Engineer to select equipment to meet the requirements at LANL's 7,500-foot elevation; correct (adjust) catalog data before applying it in the design. *Guidance is available in LANL ESM Chapter 6 D30HVAC* (Requirement T-6054).

1. Derate air-cooled equipment (e.g., chillers, coils, condensers, cooling towers, VAVs, VFDs) for elevation (Requirement T-6055).

2. Derate boilers, furnaces, and gas-fired heat exchangers in a similar manner.

B. Indicate only the calculated, actual operating parameters (capacity, static pressure, cooling/heating loads) required at 7500 ft elevation 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/on same*.

C. Obtain equipment selection data from the equipment manufacturer to back up equipment selections (Requirement T-6056).

12.0 CHEMICAL WATER TREATMENT

A. Provide chemical treatment for water in HVAC systems (e.g., steam, hot water, heating, chilled water systems, cooling tower systems) to address LANL's higher-than-neutral pH and silica scaling problems (Requirement T-6057).

13.0 HVAC—COILS – HEATING/COOLING

A. General

1. Provide Air Conditioning, Heating, and Refrigeration Institute (AHRI)-certified heating and cooling coils for central station HVAC units and field built-up systems (Requirement T-6058).

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 (Requirement T-6059).

3. Limit air velocities of wet coils (these both cool and dehumidify) to values that prevent water carryover into the ductwork (Requirement T-6060).

14.0 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 the mixed air to 55°F degrees within one hour while maintaining minimum outside airflow requirements (for buildings with Building 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) (Requirement T-6061).

2. Operate face and bypass coils with constant steam or water flow. Do not modulate flow (Requirement T-6062).

3. Provide a sensor in the discharge air stream to maintain a constant discharge air temperature, regardless of variations in inlet air temperature (Requirement T-6063).

B. Design

1. Design coils that serve 100 percent outside air systems for an entering air temperature of -10°F. For steam coils, oversize condensate-return piping to handle large condensate flow at startup (Requirement T-6064).

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 (Requirement T-6065):

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.

c. Steam coil with properly designed control valve, steam trap with check valve, and vacuum breaker.

15.0 HVAC—DESIGN TEMPERATURES

A. Outdoor (Requirement T-6066)

1. Winter: 5°F dry bulb

2. Summer: 89°F dry bulb, 60°F wet bulb

B. Indoor (Dry-Bulb) (Requirement T-6067)

1. Cooling:

a. General Comfort: 75°F.

b. Mechanical/Electrical Rooms: Follow LANL ESM Mechanical Section D30, Ventilation.

2. Heating:

a. Office/Laboratories: 72°F (general comfort)

b. Mechanical Rooms: 50°F

c. Storage Space (unoccupied): 55°F

d. Warehouses: 50°F

e. Kitchens: 60 degrees F

f. Change Rooms: 75 degrees F

Note: Program requirements may require different indoor design temperatures.

16.0 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) (Requirement T-6068).

1. Provide humidity monitoring system to automatically adjust building conditions as appropriate.[20] (Requirement T-6069)

Guidance: Humidity control is typically not practical for general comfort because of the dry Los Alamos climate.

B. When humidity is added to a space, provide analysis (to prevent condensation) on where dew point temperatures will occur for exterior walls, roofs, and windows (Requirement T-6070).

C. Provide humidification units with a deionized water or a reverse osmosis system; Mechanical POC and FOD approval required for other sources.[4] Consult with humidifier representative for water quality requirements (conductivity in micro-ohms) (Requirement T-6071).

D. When using a mechanical cooling system for dehumidification, install the heating coil downstream of the cooling coil to provide reheat (Requirement T-6072).

17.0 HVAC—PUMPS

A. Provide redundant pumps for chilled water and heating hot water systems. Operate pumps in a lead/standby configuration (Requirement T-6073).

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 (Requirement T-6074).

C. Provide a steam-powered pump when steam condensate must be moved to a higher elevation or great distances (Requirement T-6075).

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.

18.0 HVAC—SYSTEM DESIGN

A. Design systems having refrigerants to the mechanical code required by LANL ESM Chapter 16, IBC-GEN (Att. A), including provisions for toxicity and flammability.

B. 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 LANL ESM Chapter 19 Communications Section D6010 Data Communications for additional HVAC requirements for such rooms (Requirement T-6076).

[4] 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.

C. Hazard Confinement Standards for HVAC Systems: Follow Table D30GEN-3 in LANL ESM Chapter 6.

19.0 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 (Requirement T-6077).
2. Design low-temperature heating hot-water systems for a maximum of 140° degrees F supply temperature. (Requirement T-6078)
3. For 100% outside air systems, use hydronic heating. Steam, electric-resistance, and other methods are only allowed with Mechanical POC permission (Requirement T-6079).
4. Electric-resistance heating systems shall not be used for space heating, except where proven to be life cycle cost effective. (Requirement T-6120)
5. Exceptions:
   a. Where the total capacity of all electric-resistance heating systems serving the entire building is less than 10 percent of the total design output capacity of all heating systems serving the entire building.
   b. Where the total capacity of electric-resistance heating systems serving the building is no more than 5 kW.
   c. Where an electric-resistance heating system serves an entire building that:
      1) Has a conditioned floor area no greater than 5,000 square feet; and
      2) Has no mechanical cooling, and
      3) Is in an area where natural gas is not available, and an extension of a natural gas system is impractical.
   d. Where electric resistance heating is used to pre-heat outside air in a 100% outside air system and a heat pump system is the primary source of heat.
      1) Consult vendor for performance data that indicates minimum outside air temperature for changeover from heat pump operation to heat pump/electric resistance heating operation.
      2) Electric resistance heater shall be provided with modulating control.

e. Where an electric-resistance heating system supplements a heating system in which at least 60 percent of the annual energy requirements is supplied by site solar or recovered energy.

1) Where the electric-resistance heating system supplements a heat pump heating system, and the heating capacity of the heat pump is more than 75 percent of the calculated design heating load.

2) If electric-resistance heat is used in packaged equipment, first stage of heating shall be a heat pump.

6. When using TA-3 Powerhouse steam, design for incoming temperature of 400 deg F and 85 psig with ability to handle 80 psig operating pressure for equipment capacities. Civil POC may grant variance to this (Requirement T-6080).

7. 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 (Requirement T-6081).

8. Entry vestibules: Provide a source of heat to prevent freezing of water on floor and reduce cold drafts in lobbies during peak use times (Requirement T-6082).

9. 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 (Requirement T−6083).

10. Stairwells: Provide a thermostatically controlled source of heat to prevent freezing of water on floor or in fire suppression system standpipes (Requirement T-6084).

20.0 HVAC—BOILERS

A. 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 (Requirement T-6085).

B. See TSM Chapter 17 for pressure safety requirements related to boilers and boiler installations.

C. Provide boiler water treatment (Requirement T-6086).

D. Provide a low-NOx burner system, with a maximum NOx emission of 30 ppm, on gas-fired boilers. (Requirement T-6087).

E. Provide boilers with minimum refractory (Requirement T-6088).

F. Stacks: Design per the boiler manufacturer’s requirements; e.g., do not exceed maximum stack weight on boiler, required draft at flue outlet, etc. (Requirement T-6089)

1. Route gas vents to atmosphere above roof; minimize roof penetrations. Provide a separate vent line for each fuel train component. (Requirement T-6090).
2. Provide vent caps on boiler stacks to keep rain, birds, and debris out of the stack. (Requirement T-6091).

G. Where required, provide two or more boilers with the determination of the proportion of load each will handle based on energy, redundancy, and maintenance requirements. *Guidance examples* (Requirement T-6092)*:*

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.
3. When designing systems for multiple boilers, configure the piping to allow a primary/secondary pumping configuration, using redundant pumps on the secondary loop. Provide a dedicated primary pump for each boiler.

H. On boilers with power burners, provide a temperature indicator on the boiler exit breaching (Requirement T-6093).

21.0 HVAC—COOLING

A. General

1. Design cooling systems using mechanical vapor compression equipment (direct expansion coils or chillers) when close (better than +/- 5°F) temperature control in the space is required. (Requirement T-6094)

22.0 HVAC—COOLING TOWERS

A. Select cooling tower based on the following: (Requirement T-6097)

1. Ambient wet bulb temperature (AWB), 65 degrees F.
2. Tower operation at elevation per TSM Chapter 1 Section Z10

Note: elevation correction required

B. Select the following, based on project requirements:

1. Supply condenser water temperature leaving cooling tower (LWT).
2. Return condenser water temperature entering cooling tower (EWT).
3. Approach temperature (LWT-AWB).
4. Range temperature (EWT-LWT). 6095

23.0 HVAC—BUILDING THERMOSTATIC ZONES

A. Permanent Partitions (floor-to-ceiling): Provide the following minimum thermostatic zones (Requirement T-6096):

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 (Requirement T-6097).

24.0 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 (Requirement T-6098).

B. Base selection on air flow, noise criterion (NC) level, air pattern, throw, mounting height, face velocity, pressure loss, aesthetic, etc., requirements (Requirement T-6099).

C. Provide an integral opposed-blade damper only when a manual-balancing damper cannot be installed in the branch duct (Requirement T-6100).

D. Provide drainable blade louvers with bird-screen for outside air intake and discharge louvers to provide proper drainage of snow and rainwater (Requirement T-6101).

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 (Requirement T-6102).

E. Connect outside air ducts for building makeup air systems directly to a fan system. Do not use mechanical rooms as air plenums (Requirement T-6103).

F. Provide flexible connections immediately adjacent to the suction and discharge ends of moving equipment, e.g., fans, AHUs, etc. (Requirement T-6104)

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 (Requirement T-6105).

H. Route trunk ductwork parallel to building walls to conserve ceiling space and allow for future utilities (Requirement T-6106).

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 (Requirement T-6107).

J. Paint visible interior duct surfaces behind air terminal units flat black as required where reflection (dark rooms), or aesthetics is a concern (Requirement T-6108).

25.0 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 to the following (Requirement T-6109):

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.

26.0 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 (Requirement T-6110).

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 (Requirement T-6111).

27.0 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.[5] (Requirement T-6112)
2. Exhaust restrooms and janitor’s closets at a rate of not less than that specified in ASHRAE Standard 62.1 (Requirement T-6113).

28.0 HVAC—SUPPLY AIR INTAKES

A. Locate intakes at least 24 inches above grade to prevent intake of snow (Requirement T-6114).

29.0 MATERIAL QUALITY

A. Equipment and materials shall be commercial (not residential) grade.

[5] Filter class per ASHRAE Handbook HVAC Systems and Equipment, 2024

CHAPTER 7 ELECTRICAL

1.0 SITE-SPECIFIC REQUIREMENTS

A. Elevation Effects (Requirement T-7001)

1. Diminished dielectric strength of air

   a. Use 600V contacts for 480V power circuits (Requirement T-7002)

2. Provide medium-voltage equipment with a BIL of 110kV (at sea level) to achieve a BIL of 95kV at 7500 feet (Requirement T-7003).

3. Diminished cooling

   a. Must derate equipment accordingly (Requirement T-7004)

B. Solar heat gain = 110 W/ft^2 (direct sunlight) (Requirement T-7005)

C. Lightning protection (Requirement T-7006)

1. If structure houses explosives, lightning protection is required

2. For all other structures, perform calculations per NFPA 780 Annex L. If these calculations recommend lightning protection, LANL requires it.

   a. Ground strike rate: 3 / km^2 / year

3. When determined to be required, 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 Lightning Protection Institute (LPI) Standard LPI-175, *Standard for the Design – Installation – Inspection of Lightning Protection Systems*. Soil Rho: 225^{o}C-cm/W (Requirement T-7007)

4. Install lightning ground ring around structure, five feet from the foundation and three feet below grade. Locate at least six feet from any ground electrode on an electrical or communications system. Connect LPS ground ring to the electrical system grounding electrode at a single location, outside the building.

D. Ambient earth temperature of 20°C (68^{o}F) outside the perimeter of a heated building. (Requirement T-7008)

E. Ambient earth temperature of 30°C (86^{o}F) inside the perimeter of a heated building. (Requirement T-7009)

F. Utility: 15kV distribution system[1] The 15kV distribution system is the responsibility of LANL-UI. (Requirement T-7010)

1. When overhead, no structures shall be sited within 25’ of either side of such powerlines so a 50’ right-of-way is maintained. For temporary

[1] 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.

structures, ES-UI may allow placement within this zone (e.g., if removable within a short period).

2. To obtain available fault current: faultcurrent@lanl.gov (Requirement T-7011)

3. Service point is as follows: (Requirement T-7012)

   a. Pad-mount transformer: at the secondary lugs of the utility transformer, unless otherwise indicated by LANL-UI.

   b. Pole mount transformer or transformer bank: The splices that are immediately outside the weatherhead, unless otherwise indicated by LANL-UI.

G. Provide door-in-door panelboards. (Requirement T-7012).

H. Install labels on receptacles and light switches indicating circuit number and panelboard. (Requirement T-7013).

I. Rodent proofing. (Requirement T-7014).

1. Seal cable entries and plug unused conduits entering 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.*

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.

J. Buck/boost transformers may only be used with the permission of the electrical standards point of contact. (Requirement T-7029)

K. Feed buildings with 480/277 volts. (Requirement T-7015)

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.

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

3. 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.

L. Engine-Generator Set

1. Use natural gas generators unless diesel is required by the project.

   Note: NFPA 70 has three classifications for generators: Emergency, Legally Required Standby, and Optional Standby. NFPA 110 has level 1 and level 2. Level 1 is roughly equivalent to NFPA "Emergency." Level 2 is roughly equivalent to NFPA 70 "Legally Required Standby." "Optional

Standby" has no associated level in NFPA 110 and, therefore, is not in the scope of NFPA 110, and is not considered life safety. Most of the generators at LANL are optional standby. Contact the electrical standards POC if the project thinks the generator is anything but optional standby.

2. Generators shall be connected to facilities with three-pole transfer switches (unswitched neutral); four-pole transfer switches may only be used with the permission of the electrical standards POC.

M. UPS installations (Requirement T-7016)

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.

3. 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. The UPS and the bypass transformer must have a label applied stating "No system bonding jumper at this location. System bonding jumper is in external maintenance bypass switch".

N. Identification and labelling

1. Provide engraved-laminate nameplates on all equipment (Requirement T-7017).

2. Provide incident energy information per NFPA 70E, *Standard for Electrical Safety in the Workplace* (Requirement T-7018).

O. Separately derived system

1. System bonding jumper must be installed at transformer location instead of first disconnect (Requirement T-7019).

P. Trenches for Electrical Systems (Requirement T-7030)

1. Utility Duct Banks (15kV)

   a. Concrete-encase duct banks in trenches and include a 4/0 bare copper conductor within it. Tracer wires are not required.

2. Low Voltage Trenches (Electrical Power 600 volts and below)

   a. Concrete encasement is not required, and a 4/0 bare copper conductor must not be installed. Tracer wires are not required.

   b. Warning tape must be placed in the trench at least 12 inches above the duct bank and at least 6 inches below grade.

   c. Use reinforced thermosetting resin conduit (RTRC) for the risers into equipment.

3. Telecommunications Trenches

   a. 4/0 bare copper conductor must be run.

Q. Locations above 40cal/cm^2:

1. Provide remote operation of circuit breakers (Requirement T-7020).
   a. Plug-in umbilical cord or pendant
   b. Remote control panel
2. Provide permanently mounted absence-of-voltage tester (e.g., Graceport test point) on the line- and load-side of OCPD[2] in these locations. (Requirement T-7022).

R. Pedigree: Use equipment listed by a NRTL3, where available. Unlisted equipment, if it contains an electrical circuit over 50 VAC or 100 VDC, must be approved by the AHJ before use (Requirement T-7021).

S. Use IEEE 8414 motors whenever possible (Requirement T-7022).

T. Receptacles: For enclosed offices, conference rooms, and similar interior spaces, provide one receptacle outlet on each wall plus additional receptacle 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 supplying receptacles. (Requirement T-7023).

U. Electric Vehicle Supply Equipment (EVSE): Refer to Chapter 2 for this topic.

2.0 SUSTAINABILITY

A. Provide remotely monitored (e.g., SCADA, EES, or BAS) metering for electrical service when structure > 5,000 ft^2 (Requirement T-7024).

1. Follow ESM Ch. 14 Attachment 2 - *Utility Metering Requirements* and contact umetering@lanl.gov for specifications on meter type and installation.

B. Use LED lighting

1. Design facility to comply with applicable energy codes and Federal Purchasing Requirements, including FEMP-designated products (Requirement T-7025).
2. Exterior lighting shall comply with the New Mexico Night Sky Protection Act (NSPA) and shall not have a color temperature higher than 2700 deg K. For further information see LMS 26 5600.

[2] Overcurrent Protection Device. Either circuit breaker or set of fuses
[3] Nationally Recognized Testing Laboratory; e.g., UL, FM, TUV, CSA
[4] 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

A. Provide a LANL yellow network connected building automation system (BAS) for new and existing facilities as follows: (Requirement T-8001)

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 (e.g., 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 manufacturer stated in LANL Master Specification Section 25 5000 with no substitutions allowed. (Requirement T-8002)

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. (Requirement T-8002)
2. High/low duct pressures that can damage ductwork or building structures. (Requirement T-8003)
3. Fire alarm shutdown when required by code. (Requirement T-8004)
4. Also hardwire other safeties needed, not provided as part of the HVAC equipment, that protect equipment, property, or personnel. (Requirement T-8005)

D. Control cabinets used for BAS shall:

1. Be designed to contain voltages no greater than 50V. (Requirement T-8007)
2. Be shown on floor plans. (Requirement T-8006)
3. Have power sources dedicated to BAS, if power is not supplied by the controlled HVAC equipment. (Requirement T-8007)

E. BAS power sources shall be of the NEC Class 2 type and use resettable breaker protection if providing greater than 40VA. Reset shall be accessible without exposing voltages greater than 50V. (Requirement T-8008)

F. Allowable type of BAS interface for mechanical equipment will be determined based upon the facility HVAC F&ORs.

1. Situations with tight temperature, pressure, humidity tolerances, or airflow control and complex sequence of operations require direct full control of air handling equipment from a LANL standard control system. (Networked integration is not allowed due to the complex sequence of operations).

2. Chillers, boilers, pump skids, and other support equipment that makes up the complete HVAC system are allowed to use network integration control.

3. When using HVAC packaged or 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. Below are the two options for proof of integration, FIC and FIT. In either case, mechanical specifications for HVAC equipment must be modified to specify this type of integration.

    a. Factory Integral Controls (FIC)

        1) The integral digital controls (IDC) of the unit must use native BACnet MS/TP as its interface. No bridges built into the unit or otherwise, may be used to convert the protocol used. (Exception: Equipment that uses Modbus for communication may be used but is not the preferred protocol.)

        2) The list of integration points for the HVAC equipment must be provided at the design review phase of the project. Points in the list must CLEARLY define the following:

            a) The direction of data flow for the point.

            b) The data format for the point.

            c) Specifics about how the point affects the system or what data the point is providing about the system.

            d) When control points are of the MSV type (MSI or MSO) the meaning of the indexes must be stated.

            e) If special points are to be provided by the vendor to meet the required sequence of operation, these points shall be clearly identified as non-standard points.

        3) A detailed wiring diagram of the equipment must be provided at the design review phase of the project. The wiring diagram shall show external control wiring connections as well as internal wiring of the unit so that adequacy of the controls can be evaluated.

        4) A sequence of operations for the IDC must be provided at the design review phase of the project. This must be project specific. A generic sequence of operations for the equipment is unacceptable.

    b. Factory integration Test (FIT)

        1) Specification for the control system must be modified to make it clear to the control contractor that they must work

with the HVAC equipment manufacture/supplier to accomplish the integration.

2) A factory acceptance test of the integrated system must be performed prior to delivery of the HVAC equipment to LANL. A LANL I&C design engineer must approve the test plan, witness the test performance, and approve the results of this test.

(LANL: Basis for above is Requirement T-8009)

G. Special systems that must be monitored and generate alarms upon detection of failure by the BAS include, but are not limited to (Requirement T-8010):

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, or
5. Non-fire life safety systems (e.g., oxygen, refrigerant, or hazardous gas monitoring).

H. Sensors connected to the BAS must be adequate to remotely monitor and diagnose controlled equipment failures and shall include (Requirement T-8011):

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 non-HVAC internal system controls (e.g., an air dryer)
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; use hard−wired points for such. (Requirement T-8012)

J. Implement night-setback in all BAS control systems, independent of whether it is required for the current operation. It may be disabled for 24/7 applications but must be easily re-enabled when needed (Requirement T-8013).

K. Follow requirements of Sections in Div 25 of the LANL Master Specifications for BAS installations, edited to the project requirements (Requirement T-8014).

L. Non-fire life safety system (e.g., oxygen, refrigerant, or hazardous gas monitoring) design must be reviewed by ESM Ch. 8 POC or Alternate POC.

2.0 HAZARD CONTROL SYSTEMS

A. Processes or operations that involve significant hazards shall be evaluated though a HAZOP process. If protection required to mitigate the hazards to an acceptable level includes the use of a safety instrumented system (SIS), such as

for ML-3, design per ESM Ch. 8. These may include, but are not limited, to these hazard categories (HCs): Accelerator, Biological, Chemical (4 levels), Explosives, Firing Range, or Nature of Process (with otherwise being "Standard Industrial Hazard," which means under the thresholds in Figure A-1 of DOE-HDBK-1163-2020, *Integration of Hazards Analyses*).

Chapter 9 SECURITY

Follow ESM Chapter 9 and associated LANL Master Specifications and Std. Details.

Chapter 10 HAZARDOUS PROCESS

When hazardous materials will be used in the structure, follow ESM Chapter 10 and relevant requirements elsewhere in the ESM.

Chapter 11 RADIATION PROTECTION

N/A, out of scope.

Chapter 12 NUCLEAR

N/A, out of scope.

CHAPTER 13 WELDING, JOINING, & NONDESTRUCTIVE EXAMINATION (NDE)

1.0 WELDING GENERAL

A. Welding, joining, and NDE design, detailing, and work activities must comply with the codes and standards established by EOR (Engineer of Record) based on Chapter 1 herein.

1. It should be noted that most of the codes used by LANL require two levels of inspection, the fabricator/installer inspector (Subcontractor's inspector) and the Owners Inspector (LANL's inspector).
2. Design (e.g., Specifications) shall require individuals to submit evidence of satisfactory processes and qualifications as required by codes and standards.

B. Subcontractors performing welding in accordance with their internal QA procedures must submit evidence of satisfactory processes and qualifications as required by EOR.

1. When not required by Project Specification, at Subcontractor's option, they may weld in compliance with LMS Sections 01 4444 (offsite), 01 4455 (onsite), or LANL ESM Chapter 13 as applicable/appropriate.

C. For LANL self-performed, onsite welding, design shall establish the required codes and standards and employ LMS Section 01 4455.

Note: The Sections above help to ensure that submittals required for IBC Ch. 17 Special Inspection reviewers, and ASME B31 piping Inspectors, are available in the LANL records systems.

For questions, clarifications, and help, please contact the Welding SMEs.

2.0 WELDING – DESIGN AND CODE COMPLIANCE

A. Welding Symbols and Joints

1. Utilize AWS A2.4 for welding symbols and AWS A3.0 for standard welding terms and definitions.

3.0 PROJECT PLANNING AND EXECUTION (WELDING AND NDE)

A. Early Planning Guidance

1. Develop a comprehensive welding plan during the early phases of the project, addressing:
   a. Required welder and inspector qualifications
2. Procurement of filler metals and consumables
3. Equipment needs
4. WPSs that cover base metals and weld processes planned for project.
5. Scheduling of welding activities
6. Storage and issue requirements of welding filler materials

7. Quality control measures
8. NDE requirements.

B. Procurement and Control of Filler Materials

1. Specify and procure in accordance with project requirements.
2. Implement proper storage and handling procedures.
3. Control materials, limiting access only to trained and approved personnel.
4. Verify proper filler materials as listed on selected WPS before use.

C. Quality Control

1. Establish hold points for inspection and verification of welding activities.

Guidance: It may be beneficial for parties with QA responsibilities to conduct regular audits of welding activities to ensure compliance with procedures and standards.

4.0 NON-DESTRUCTIVE EXAMINATION (NDE)

A. NDE shall be performed by service providers listed on the LANL LBO Approved Listing. (Requirement T-16001)

1. If the desired NDE service provider is not listed, ensure that the NDE POC (noted in listing p. 1) is contacted early in the project to perform the assessment.
   a. Assessment is based on ASTM E543.
   b. ISO 17025 or Nadcap certification for a given location normally qualify an organization for listing in lieu of a full assessment. Other national or international certification will be considered on a case-by-case basis.

B. Require the following in the Specification as submittals (LMS 01 4525 is a good template) and review promptly and carefully to ensure that project complies:

1. Verify the practice for qualification and certification of personnel meets the code or standard requirement, typically ASNT SNT-TC-1A.
2. Ensure that personnel are properly qualified and certified in accordance with the practice above, including current visual acuity.
3. Ensure NDE procedures are reviewed and approved by the service provider Level III before use.
4. Obtain/review examination reports in a timely manner, signed and dated by appropriately certified personnel.
5. For final project record, procedures, personnel certification records, and test reports must be appropriately organized and transmitted to LANL. (Requirement T-16001)

C. Methods

1. Specify appropriate NDE methods based on code requirements and project specifications. Guidance: Common methods include visual inspection, radiographic testing, ultrasonic testing, magnetic particle testing, and penetrant testing. Given the wide variety of capabilities of the

different NDE methods, and particularly the techniques within those methods, it is strongly suggested to consult the LANL NDE SME (named here) to determine the appropriate method and specific technique if it is not explicitly stated by the Code or Standard.

CHAPTER 14 SUSTAINABLE DESIGN

Exceptions, clarifications, and guidance (including its References and Resources) — and abbreviations & definitions not in the Conduct of Engineering Glossary — may be found in LANL ESM Chapter 14 and utilized here. There may be additional exclusions and exceptions not contained there, so consulting the Chapter POC is also highly recommended.

1.0 PRODUCT SPECIFICATION AND PROCUREMENT

A. When specifying and procuring products or services for construction, compliance with the following statutory programs is required:

1. EPA Comprehensive Procurement Guidelines (CPG) Program
2. USDA BioPreferred ® Program
3. ENERGY STAR® Program or Federal Energy Management Program (FEMP)
4. EPA SNAP Program.

B. When both an EPA-designated item and a BioPreferred item could be used for the same purposes, and a product that meets both is not available, select the EPA-designated item.

C. If a product or service cannot be obtained due to any criteria below, then project may submit a written justification to seek exemption from the statutory program requirements.[1]

1. not available within a reasonable schedule,
2. unreasonable price (initially over 10% more, or higher life-cycle cost), or
3. fails to meet reasonable performance requirements.

For further guidance on product categories see LANL ESM Chapter 14, Attachment 1 and *https://sftool.gov/greenprocurement*.

LANL: Basis for above site-specifics is Requirement T-14001.

2.0 BUILDING DESIGN

A. The required energy efficiency standard for all projects is ASHRAE 90.1-2019.

B. New construction (buildings and additions of all sizes) shall meet Federal energy efficiency standards. (Requirement T-14002)

1. Meet ASHRAE 90.1-2019 and, if life cycle cost effective, achieve energy consumption levels at least 30% below ASHRAE Baseline Building 2019. If 30% reduction is not life-cycle cost effective (LCCE), modify building design to achieve the highest level of energy efficiency, that is LCCE.
2. Calculations shall include the building envelope and energy consuming systems as specified by ASHRAE 90.1 (e.g., space heating/cooling, ventilation, service water heating, lighting, receptacle, and process loads,

[1] Per FAR Clause 23.103(a)(2)). For approval, contact Contracting Officer (LANL ASM Procurement Specialist) for C.1 or C.2, and applicable Standards POC for C.3.

except for energy-intensive process loads that are driven by mission and programmatic/operational requirements).

3. Determine energy consumption for both the ASHRAE Baseline Building and proposed building using the Performance Rating Method (Appendix G, ASHRAE 90.1). Provide LANL with the ASHRAE Std. 90.1 Performance Based Compliance Form at 30% design completion. Calculate the percentage of improvement shall as follows:

   Percentage improvement = 100 x (1-PCI/PCIt), where:

   PCI = Performance Cost Index calculated per (90.1-2019, Section G1.2)

   PCIt = Performance Cost Target calculated by formula in (90.1-2019, Section 4.2.1.1)

4. When energy consumption (all sources) is less than 12.7 kBtu/GSF/yr, ASHRAE Performance Rating Method modeling is not required. However, a simple calculation estimating annual energy use shall be provided by 30% design completion to LANL Chapter 14 and Mechanical SMEs for concurrence. Provide a COMCheck report by 90% design completion to these same LANL SMEs demonstrating compliance with mandatory provisions of ASHRAE 90.1-2019. No documentation of any kind is needed for facilities without external power or only lighting.

C. Buildings, including additions, larger than 5,000 gross square feet shall:

1. Meet 18 core and 9-out-of-12 non-core criteria from the latest Guiding Principles for Sustainable Buildings (GP) or successor and accomplish performance tracking and reporting to Chapter 14 POC. If a specific criterion is deemed not LCCE, LCC calculations are required, and performance tracking and reporting are still required. Buildings are exempt from this requirement if they are to be unoccupied, to use less than 12.7 kBtu/GSF/year total energy usage from all sources, and to use less than an average of 2 gal/day of water. (Requirement T-14003)

D. For new buildings with a total project cost greater than that identified in TSM Attachment 1 (approximately $4M), follow LANL ESM Chapter 14 and any variances posted with it and this TSM regarding Limiting On-site Fossil Fuel-Generated Energy Consumption.

Note: Implementation of this, based on 10 CFR 433 Subpart B, Clean Energy rule will not occur before Sept 1, 2026. If and when it is effective, a revision of ESM Chapter 14 should include new material on same (that material is not included in ESM Chapter 14 Rev. 13).

E. New buildings, or buildings which are part of a phased project, with total estimated cost greater than $50M, shall:

1. Meet or exceed U.S Green Building Council LEED (v4 or later) Gold certification unless an approved waiver (or similar document) from the NNSA Project Management Executive is obtained through the formal

process. Parking structures, exclusively process and power-generating buildings, and distribution systems are exempt. (Requirement T-14005)

a. For LEED: The design agency is responsible for ensuring that LEED Minimum Project Requirements are met, and for registering, submitting documentation, and ensuring certification through GBCI including costs related to registration and certification. (Contact Chapter POC prior to registration to check for potential LEED Master Campus eligibility.)

2. If over 25,000 GSF, be designed to operate without producing greenhouse gas emissions and designed to minimize water use and waste from building operations. (Requirement T-14006)

F. For laboratories, follow LANL ESM Chapter 14 requirements for same.

G. Remodels, Renovations, and Modernizations

1. Follow the same criterion as new buildings in sections 2.0.A and C–F above. (Requirement T-14008)

2. Exception: Renovations and building alterations (including new systems and equipment) below the cost and size limits defined in sections 2.0.C–E above must meet ASHRAE 90.1-2019. A “change in space conditioning” or “change of occupancy or use” which results in an increase in demand for energy must follow ASHRAE 90.1-2019 Section 4.1.1.5.

3. Sum costs of subsequent, sequential remodel, renovation, and modernizations to determine applicability of fossil fuel-generated energy requirement. Consult ESM Ch. 14 and any amendments (e.g., VARs) for additional requirements.

H. Metering

1. Follow LANL ESM Chapter 14, Attachment 2 - Utility Metering Requirements.

CHAPTER 15 COMMISSIONING

1.0 GENERAL

A. *Guidance: LANL will self-perform or contract with an experienced commissioning (Cx) provider (commissioning agent, CxA) who is independent of the project design, construction, and operations team. The CxA will direct 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 in accordance with this chapter. LANL typically provides TAB. A project may elect to subcontract this activity; however, this decision should be coordinated with the LANL commissioning authority in project planning and scoping.*

2.0 DESIGN AGENCY

(REQUIREMENT 15-0002)

A. Develop clear and complete design intent documentation.

1. Provide detailed sequence of operations for all heating, ventilation, and air conditioning (HVAC) equipment.
2. Provide detailed sequence of operations with on/off durations for lighting control systems.
3. Provide detailed sequence of operations for any other specialty systems which may have control functions.
4. Provide pressures, airflows and waterflows for HVAC systems to allow testing, adjusting, and balancing (TAB) to be performed.
5. Provide test ports, balance dampers in air systems and balance valves in water systems to allow TAB to be performed.

B. Develop clear and concise process-system descriptions and test-acceptance criteria (e.g., ranges, tolerances) and include in the construction documents such that commissioning plans and acceptance procedures can be developed and executed.

C. Include in project equipment specifications requirements for

1. equipment startup to be provided by manufacturer’s qualified representative as required.
2. submittals from manufacturers for installation, operations, and maintenance data on equipment as required.
3. vendor provided training on equipment to LANL operations and maintenance personnel as required.

D. Develop project specific commissioning specifications addressing requirements of the constructor for inclusion in the design package. Base commissioning specification on American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Guideline 0.

E. Develop project-specific TAB specification and include in the design package. Base the TAB specification on the National Environmental Balancing Bureau (NEBB) standards. TAB provider will be contracted by LANL, not Construction Subcontractor.

F. Work with CxA on developing a list of equipment submittals which are to be reviewed by CxA during the construction phase.

G. Provide technical support during Title III to resolve requests for information generated during the commissioning process including procedure development and acceptance testing.

H. Provide technical support during Title III to resolve test deficiencies found during the acceptance testing phase of the project. This may include serving as the subject matter expert in approving the LANL test deficiency report forms.

CHAPTER 16 BUILDING CODE PROGRAM

1.0 GENERAL

A. This chapter applies to subcontracted design, demolition, and construction. LANL in-house design and construction shall follow LANL ESM Chapter 16 – Building Code Program.

B. Since LANL is an autonomous jurisdiction including permitting authority (e.g., LANL Building Official/LBO and other AHJs), LANL processes for design review, permitting, inspection, and certificate of occupancy shall be followed.

1. LANL projects must ensure ESM Chapter 16 compliance through the SOW, if applicable, and be the interface for all AHJs interactions. (Requirement T-16001).

2.0 DESIGN PROFESSIONAL IN RESPONSIBLE CHARGE (DPIRC) DUTIES

A. **New SSCs:** Design structures, systems, and components (SSCs) per the International Building Code (IBC) and other model code and standard editions listed in LANL ESM Chapter 16, Section IBC-GEN, Attachment A LANL Building Code (LBC), excluding the NMAC if listed. The expected life span of new permanent facilities at LANL is 30–50 years, assuming regular maintenance and periodic system replacements during that time; design accordingly.

B. **Existing SSC Modifications:** Existing SSC modifications shall follow the International Existing Building Code (IEBC) edition listed and amended by LANL ESM Chapter 16, Section IBC-GEN, Attachment B LANL Existing Building Code (LEBC).

1. LANL-internal project scoping: Prior to performing significant renovation work on facilities, follow NIST GCR 11-917-12/ICSSC RP 8 (or DOE-mandated successor) to determine whether a seismic evaluation is necessary. If an evaluation is necessary, use RP 8 to establish the associated requirements, as well as mitigation requirements (if the evaluation indicates such is required).

C. **RDPIRC Designation Form:** Sign the Registered Design Professional in Responsible Charge (RDPIRC) Designation form acknowledging IBC-related duties as RDPIRC (LANL ESM Chapter 16, IBC-GEN, Form 3).

D. Test and Inspection (T&I) Requirements:

1. Clearly identify all required tests and inspections (T&I) necessary to verify design intent. These requirements shall be documented in the design deliverables, including:

   a. Specifications and/or drawings, and

   b. Applicable codes and standards invoked by reference.

2. Design documents shall define:

   a. Characteristics to be inspected,

b. Methods of inspection (including any sampling methods, when applicable), and

c. Acceptance criteria.

3. LANL ESM Chapter 16, IBC-IP, Attachment I, *Test and Inspection Summary (TIS) Template (Guidance)* may be used to prepare a summary of appropriate tests and inspections (e.g., if SOW or LANL IPT requires same).

4. When T&I requirements are unclear or incomplete in the design (e.g., in-process inspections required by the Authority Having Jurisdiction or ambiguous inspection requirements), DPIRC approval of the TIP may be used to document concurrence.

5. Designs should explicitly include jurisdiction-required (LANL) T&Is to avoid missed witness or hold points and uncertainty regarding acceptance criteria.

E. **SSI:** Develop statement of special inspections (SSI) when required by IBC 1704.3; see LANL ESM Chapter 16, Section IBC-IP, Attachment B for preferred template. SSIs need not be standalone for projects with very minimal Special Inspection (under ~6 inspection tasks) if the special inspection (SI) requirements are clearly conveyed by the drawings or sketches. *(Further, as noted by the SSI template and specifications, seismically exempt components such as post-installed anchors do not require SI (but do require inspection), and the drawings should be clear on this when they are present.)* (Requirement T-16002).

F. **Structural Observations:** Submit IBC-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 (Requirement T-16003).

G. **Changes:** Submit any revised occupancy or use categories [and IEBC alteration level(s) for existing building modifications] through LANL Project personnel (Requirement T-16004).

H. **Delegated design:** It is the DPIRC's responsibility to mandate and communicate applicable requirements of this document and the Subcontract to delegated sub-tier Subcontractors to ensure that the requirements are implemented in the Subcontractor's design submittal. The DPRIC is responsible for the adequacy of the delegated design. (Requirement T-16005)

I. **Title III/Construction Phase:** When DPIRC is retained for engineering services during construction, this includes managing design change control, as-built construction documents drawing and BIM model updates (where required by Subcontract), etc.

1. Design revision after permitting: LANL Permitting Authority re-approval through LANL Project Engineer 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) increase the scope (Requirement T-16006).

3.0 CONSTRUCTION SUBCONTRACTOR DUTIES

A. **QC Inspections and Testing**: Constructors are required to perform QC inspections and testing as required by their Subcontract. Such duties are addressed primarily in LANL Master Specification Section 01 4000, *Quality Requirements – Non-Nuclear* and the Test and Inspection Plan (TIP), when present (see below). Note, the LANL ESM Chapter 16, IBC-IP, Attachment I *Test and Inspection Summary (TIS) template* provides a generic list of T&Is, and if a project issues a TIS, it will have project-specific expectations.

B. **Third-Party Testing Agencies:** Ensure only LBO-approved third-party testing agencies are used (listed here). If preferred testing agencies are not on the approved list, subcontractor may submit the necessary data for evaluation (see ESM Chapter 16 Section IBC-TIA). Chief Inspector requires two (2) weeks lead time. (Requirement T-16007).

C. **Test and Inspection Plan**: Prior to commencement of the Work, the Constructor shall develop a plan identifying all required tests & inspections (T&I) — a TIP — and submit it for Design Agency and LANL review when required by the Integrated Project Team (IPT) or Section 01 4000, *Quality Requirements – Non-Nuclear.* (Requirement T-16008)

1. Appropriate minimum TIP content includes:
   a. Unique test or inspection ID (controlled by the Constructor).
   b. Brief description of the test or inspection.
   c. Identification of inspection or test as a witness or hold point.
   d. Entity responsible for performing each test and inspection (e.g., Subcontractor's Qualified Personnel, Subcontractor-engaged Third-Party Inspector, LANL Building Code Inspector, LBO-approved Special Inspector, Structural Engineer-of-Record).
   e. References to the applicable code, standard, and/or specification section requiring the test or inspection, including any sampling methods, when applicable.
2. For most projects, the TIP should be integrated into the project construction execution sequence/schedule (possibly filtered for the T&I tasks) — i.e., integrated with a Work Breakdown Structure (WBS) or within a 30-day look ahead to identify milestones/prerequisites for each test and inspection.
   a. For small projects for which a TIP is produced (e.g., when required by LANL ESM Chapter 16, Section IBC-GEN, Table IBC-GEN-3 Three-Tiered Graded Administrative Approach) — but that do not warrant a formal schedule or work breakdown structure, as determined by the IPT —T&I tasks may be documented in a standalone document, on drawings or sketches, or (if only a final acceptance test is warranted) a Post-Modification Testing form —

so long as such are reviewed/approved by Design Agency and LANL.

3. LANL will review and may add additional inspections and witness or hold points.
4. Maintain TIP current should scope or understanding of requirements change during execution.

D. **Additional QA/QC Processes:** Additional QA/QC processes may be implemented by the Constructor, Owner (LANL), IPT, DPIRC, LANL Building Official, LANL Chief Electrical Inspector, LANL Fire Marshal, and LANL Utilities to promote quality outcomes. *These discretionary activities, based on stakeholder judgment, should be documented in the Project Quality Management Plan, when applicable, and not necessarily in the TIS or TIP.*

E. **Offsite Fabricators:** Ensure LBO-approved offsite fabricators are used to perform certain structural safety affecting work without in-shop special inspection per IBC Chapter 17 (listed here). For approval of offsite fabricators not on the LBO-approved list, follow LANL ESM Chapter 16, Section IBC-FAB *Offsite Structural Fabricator Approval Process*. Submit any requests to LANL STR; Chief Inspector requires two (2) weeks' lead time. When LBO-approved fabricator is utilized, they must submit *Offsite Structural Fabricator Certificate of Compliance* (LANL ESM Chapter 16, Section IBC-FAB, Attachment B). (Requirement T-16009).

F. **Execution of Work:** Begin work when authorized. Construction work including offsite structural element fabrication work must not start until authorized by the LANL Building Code Program after evaluating that the project has complied with all necessary IBC and Building Program requirements. (Exceptions: grading, excavation, storm water protection, or D&D not affecting life safety/egress or requiring design may proceed) (Requirement T-16010).

Note: Regarding early work release, only the LANL Permitting Authority may authorize fabrication or installation at-risk (where inspection is not supported by approved construction submittals or design information), given sufficient justification.

G. **Inspections:** Constructors must follow the approved inspection plan(s) and, where applicable, submit LANL ESM Chapter 16, Section IBC-IP, Attachment H "Subcontractors Statement of Responsibility (with respect to Special Inspection)" (Requirement T-16011).

4.0 TEMPORARY AND RELOCATABLE STRUCTURES AND PERMANENT PREFAB STRUCTURES

A. Refer to ESM Chapter 16 Building Code Program, for requirements on temporary and relocatable structures, and permanent prefab structures.

Chapter 17 PRESSURE SAFETY

A. Pressure systems in the scope of the pressure safety program shall follow the requirements of this chapter. See P101-34, Pressure Safety (§3.2) "Pressure Systems (and Exclusions)" for the definition of a pressure system and types of piping systems excluded from the program. (Link is LANL internal; document or excerpt will be provided upon request to STR.)

B. For fuel gas and LP gas, use NFPA 54 and 58 respectively.

C. For the following scopes, comply with the latest edition as the American Society of Mechanical Engineers as design basis (Requirement T−17001):

1. ASME Boiler & Pressure Vessel Code (BPVC), except for Sections III, VI, VII, and XI
2. These ASME piping codes
   a. B31.1, Power Piping (TA-3, Building 22 only)
   b. B31.3, Process Piping
   c. B31.9, Building Services Piping

D. *Note: A Commercial Pressure Safety Project Guidance document to aid designers, design reviewers, and constructors is planned as a reference for the TSM (would/will be found with it here).*

Chapter 18 SECURE COMMUNICATIONS

Follow ESM Chapter 18 when this is applicable.

Chapter 19 COMMUNICATIONS

Follow ESM Chapter 19. Paging system is only required when indicated in the project requirements document.

Guidance Note for LANL when creating design requirements: Paging systems are typically not required for most non-nuclear projects. Project manager and project engineer shall ensure that appropriate FOD representatives and customers are consulted to determine applicability.

CHAPTER 20 SYSTEMS ENGINEERING

1.0 SCOPE AND APPLICABILITY

This chapter only applies to projects with Total Project Cost (TPC) of $34[1] million or more. Such projects shall apply a systems engineering approach commensurate with the risk, rigor, and extent of the project's programmatic and functional requirements.[2]

Chapter 20 is for capturing and controlling the basis of design.

Note: Engineering requirements are defined as requirements that the project, in agreement with the customer, has delegated to engineering, ensuring that they are verified at the end of the project. These include requirements decomposed or derived from delegated requirements.

A. The Design Agency and/or subcontractor shall support LANL's SE effort by performing A.1-3 below.

1. Provide a description of Design Agency's approach to the following SE tasks prior to the end of conceptual design.
2. Provide designs and, as appropriate, perform activities linked to and satisfying engineering requirements; contribute to LANL's crosswalk for same in Para C.3 below.
3. Provide testing, inspection, and commissioning requirements linked to and verifying engineering requirements, including through any design revisions/changes. See Para. C.3.

The remainder of this chapter is LANL responsibility.

B. Planning

1. Describe the SE approach in a plan[3] subject to approval by LANL Project Engineering Management or delegate.
2. The project shall identify engineering and other technical interfaces by the end of conceptual design. Complex projects should consider use of Interface Control Documents (ICDs). The ICD(s) should be revised at major milestones after preliminary design. (Requirement T-20002)
3. Use an SE tool [e.g., Magic Cyber Systems Engineering (née Cameo)] when TPC is $300 million or more. *Projects below this threshold should consider its use.*

2.0 DOCUMENTATION OF ENGINEERING REQUIREMENTS

A. Engineering requirements shall be established and documented in a requirements document subject to approval by LANL Project Engineering Management or delegate (e.g., PIE or Chapter 20 POC organization). (Requirement T−20003)

[1] At time of writing, $30 million was defined as the minor construction limit by 10 USC 6271.
[2] As guidance for this chapter (and for projects beyond the scope of the TSM), refer to ESM Chapter 20.
[3] For simpler projects, this might be addressed in the PEP; for complex ones, a standalone SEP is likely appropriate.

1. The engineering requirements shall address the key performance parameters, programmatic, performance, functional, operational, interface, and constraint needs. (Requirement T-20004)

   Note: See ESM Chapter 20 for a comprehensive list of potential documents. Requirement source types may exist in different forms and engineering judgement should be used when determining whether requirement sources or requirements themselves are pertinent.

2. Requirements shall be written in accordance with ISO 29148, *Systems and software engineering – Life cycle processes – Requirements engineering*, Section 5.2, *Requirements Fundamentals*.[4]

3. Provide documentation of traced, satisfied, and verified requirements. Such may be organized in separate matrices — Requirements Satisfaction Matrix (RSM) and Requirements Verification Matrix (RVM) — or a combined matrix (see Figure 20-1 below).

   a. Matrix(ces) shall include engineering requirements verbatim.

   b. RSM(s) shall be related to design documents (e.g., drawings) satisfying the engineering requirements in approved document databases and updated at each design review. LANL personnel shall ensure each requirement is met or satisfied in design phase by design outputs and/or design-phase activities. RSM(s) shall be completed before the design phase is complete.

   c. RVM shall be related to objective evidence (e.g., record drawings, testing in approved document databases) verifying the engineering requirements.

Req't ID	Requirement	Rationale	Traced to	Derived From	Satisfied by	Verified by
[Unique No.]	[Engineering requirement for which engineering is responsible]	[Reason the requirement was established and is needed]	[Organization(s) or position(s) that has authority over requirement]	[Document that results in (drives) the engineering requirement]	[Design document that portrays how the requirement will be fulfilled, ID SSC(s) as appropriate]	[Objective evidence that shows that the system fulfills the requirement]

Figure 20-1 Satisfaction/Verification Requirements Matrix (SVRM) (Sample)

[4] In addition, INCOSE-TP-2010-006-04| (VERS/REV:4 | 1 July 2023) *Guide to Writing Requirements* provides expanded guidance on the practice of requirements management and writing.

CHAPTER 21 SOFTWARE

1.0 SCOPE AND APPLICABILITY

The below applies primarily to subcontracted design or construction and refer to selected sections of LANL ESM Chapter 21. LANL in-house design and/or self-performed execution shall follow LANL ESM Chapter 21 in its entirety.

A. For all SSC software (controls hardware real-time), provide a listing of such locations/usage to LANL (for ML-4, LANL will satisfy required software quality program expectations); ref. section SOFT-GEN Software Summary (§2.3).

B. For ML-4, non-SSC (i.e., used in the design or analysis of SSCs), and "simple and easily understood" software (the results of the software can be easily confirmed through hand calculations), either (a) pre-verify the software for all future calculations with a bounding set of test cases and control its configuration, or (b) verify the software's calculation each time it is used by such a confirmatory method.

C. In addition, for either SSC or Non-SSC (analysis or design) ML-3 software (e.g., certain high-value, security, or environmental implications of failure beyond typical commercial), perform the following:

1. For agencies providing ML-3 analysis or design deliverables, the associated non-SSC software must be identified, categorized, and quality controlled at the appropriate stages in the design process per SOFT-GEN and other sections.

2. For SSC software (including reconfigurable firmware), the subcontractor shall serve as the software owner (SO) up to the point of turnover steps in SOFT-GEN and other sections (upon turnover, SO responsibility transfers to the LANL system engineer, who may assist with the above).

   The LANL FDAR is the responsible manager [SRLM] throughout the software life cycle; however, may delegate SRLM activities to the Design Agency or Constructor during development and/or implementation.

3. For any software designed specifically for LANL, the Subcontractor supplier must perform V&V per Section SOFT-V&V as part of the supplier's software product development.

D. Beyond A and B above, further compliance with this chapter is only required when specifically invoked by subcontract.

Note to LANL: Flow down of additional LANL ESM Chapter 21 requirements to the subcontractor should be discussed with the chapter POC and defined in the Statement of Work (SOW). Generally, for ML-3, additional requirements should be considered unless, perhaps, the subcontractor has an existing SQA program that has been evaluated and determined to be compliant and/or LANL is willing to assume responsibility for ensuring that chapter requirements are met prior to project completion.

REVISION RECORD

Rev	Date	Description	POC	OIC
0	05/27/2021	Initial issue.	Tobin Oruch, *ES-FE*	Jim Streit, *ES-DO*
1	12/23/2022	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*
2	12/24/2024	Updated to adopt IBC 2021. Chapter 5 aligned to ESM Chapter 5, Section II, Rev 13 incorporating VAR-10711 (updated seismic design parameters S_{Ds} and S_{D1}). Chapter 14 aligned to ESM Chapter 14, Rev 12.1. GLOS-COE-1 referenced vice App. A.	Tobin Oruch, *ES-FE*	Michael Richardson, *ES-DO*
3	03/31/2025	Major revision. Scope/Applicability expanded to generally match SD 413.3-7 ($100M, no nuclear/rad). Requirements added to address use with other hazards and general updating. Usage justification eliminated, canceling VAR-10466R1. Updates throughout. Att. 1 added for cost escalation. For LANL use, requirements were annotated and bases captured in associated spreadsheet.	Tobin Oruch, *ES-FE*	Michael Richardson, *ES-DO*
4	06/30/2026	Major revision, including: Chapter 1 - applicability cost and selected other restrictions deleted; restructured chapter. Chapter 3 - incorporated new material and shallow foundation subgrades from VAR-10737; added revised underground utility clearances. Chapter 5 - aligned with ESM Chapter 5, Section II, R14 thus incorporating VAR-10711-R1, SDC-1, SDC-2, and Non-nuclear SSCs Seismic Parameter Update; SDC-C Allowance. Chapter 14 - incorporated fossil fuel VAR-10727. Chapter 16 - incorporated Test & Inspection requirements per VAR-10761. Chapter 21 - aligned with ESM Chapter 21, Section SOFT-INTRO, R2.1. New Appendix B on document numbering and Appendix C on specifications. Requirements ID spreadsheet updated. Attachment 1 on cost escalations updated	Tobin Oruch, *ES-FE*	Michael Richardson, *ES-DO*

APPENDICES AND ATTACHMENT

APPENDIX A: DOCUMENTS IMPLEMENTED BY THE TSM

For reference purposes, this appendix documents the mandates/requirements that are generally satisfied through compliance with the TSM. Unless specifically required by the SoW or a chapter of this document, the documents listed below are not independently imposed on the TSM user and are not expected to be followed directly.

Code of Record

Unless provided by the LANL IPT, the Design Agency shall develop a project-specific COR list. The COR shall identify the key regulations (CFRs), codes, and standards applicable to the project design, construction and quality from the list below or derived from them including any additional requirements relevant to the project.

Guidance:

1. *The Triad/NNSA Prime Contract should not be included as part of the CoR.*
2. *For the applicable DOE orders and NNSA directives, the COR may identify them as "Other Documents Implemented" to document compliance without designating them as formal COR documents.*

DOE Standards

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

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

Code of Federal Regulations (CFRs)

The following CFRs apply but are not limited to: (Requirement T-0001)

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. 29 CFR 1910, *Occupational Safety and Health Standards*

E. 29 CFR 1926, *Safety and Health Regulations for Construction*

Triad/NNSA Prime Contract (LANL access only)

The Triad/NNSA Prime Contract, including Appendix B and all applicable incorporated requirements are implemented through the TSM. Key DOE Orders and NNSA Directives in the Triad/NNSA Prime Contract, Appendix B include:

A. DOE O 413.3B, Chg. 7, *Program and Project Management for the Acquisition of Capital Assets*

B. DOE O 414.1E, *Quality Assurance* (Contractor Requirements Document/CRD only)

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

D. NNSA SD 413.3-7, *Project Management for Non-Nuclear, Non-Complex Capital Asset Acquisition*

E. NNSA SD 430.1, *Real Property Asset Management* (including implementation of DOE O 430.1)

APPENDIX B: DOCUMENT NUMBERING SYSTEM

The LANL document numbering system below applies to engineering documents (drawings, calculations, specifications, reports, etc.).[1]

The External Design Agency/Subcontractor must employ one of the following options to implement the document numbering system in project engineering documents:

1. Adopt LANL document numbering system, or
2. Use a dual system, i.e., include both Subcontractor's and LANL's document numbers.

Format: **XXXXXX-TYPE-TA-BLDG-DIS-YYYY**

1. **XXXXXX**: LANL-provided unique alphanumeric number. This is the 6-digit Project Identification (PID) number, ESR number (e.g., 12345), C# (e.g., C12345), or 999999 if none exist. Use the same number in all engineering documents in a project.
2. **TYPE**: document type abbreviation per Table B2.
3. **TA**: 2-digit TA number. If the project involves multiple TAs (e.g., roads, utilities, walkways), use 99.
4. **BLDG**: 4-digit structure number. If the project involves:
   a. Multiple facilities, use MULT.
   b. Site utilities, use UTIL.
   c. Horizontal infrastructure (e.g., roads), use INFR.
5. **DIS**: discipline designator per Table B3.
6. **YYYY**: sequential number (e.g., 0001, 0002) but for drawings follow

[1] Based on numbering in the LANL CSM and EDRMS to facilitate retrieval (and former editions of LANL AP-341-402 *Engineering Document Management in Operating Facilities*; TA55 uses a slightly different syntax). TA-55 may adopt this appendix or use their own document numbering system. If/when this appendix is re-issued as a sitewide standalone document, it will supersede this appendix, in case of a conflict.

8. Table B*4*. See examples in Table B1.

Table B1: Document Numbering Examples

Document Number	Description
123456-CAL-51-0172-S-0001	Structural Calculation for TA-51 Bldg 0172
123456-RPT-51-0172-B-0001	Geotechnical Report for TA-51 Bldg 0172
123456-SPC-51-0172-ALL-0001	Specification Package for TA-51 Bldg 0172
123456-DWG-51-0172-S-1000	Structural Drawing Plan for TA-51 Bldg 0172 **(sheet sequential number per** Table B*4* **series)**
123456-SK-51-0172-S-0001	Structural Sketch for TA-51 Bldg 0172

Table B2: Document TYPE Abbreviations[2]

Abbrev.	Document Type
CAL	Calculation
DWG	Drawing
RPT	Report
SK	Sketch
SPC	Specification Package

Table B3: Discipline (DIS) Designator

(from LANL *CSM,* Section 200*,* R5.2*, §209.2.0* [based on National CAD Standard])

Acronym	Discipline
G	General
H	Hazardous Materials
V	Survey/Mapping
B	Geotechnical
W	Civil Works (user-defined)
C	Civil
L	Landscape
S	Structural
A	Architectural
I	Interiors
Q	Equipment (laboratory, food service, parking lot, site)
F	Fire Protection
P	Plumbing
D	Process (gloveboxes, fume hoods, process equipment)
M	Mechanical
E	Electrical
T	Telecommunications

[2] Other document types are less common in projects; contact ESM Chapter 1 POC for assignment if necessary.

Acronym	Discipline
J	Instrumentation & Controls
R	Resources
X	Other Disciplines (e.g., Safeguards & Security)
Z	Contractor/Shop drawings
O	Operations
ALL	Multi-discipline

Table B4: Sequential Number for Drawing Sheets

(from LANL *CSM,* Section 200*,* R5.2**,** *Table 210-1* [based on National CAD Standard])

Numbering Series	Description
0001 – 0999	General
1000 – 1999	Plans
2000 – 2999	Elevations
3000 – 3999	Sections
4000 – 4999	Large Scale Views
5000 – 5999	Details
6000 – 6999	Diagrams
7000 – 7999	Schedules
8000 – 8999	User Defined
9000 – 9999	3D Representation

APPENDIX C: LANL MASTER SPECIFICATIONS (LMS)

A. LMS Sections in the STD-342-200 collection are templates that include materials, methods, and quality requirements, many of which are specific to LANL. Projects are required to comply with LANL-specific provisions only when (1) a Section is explicitly invoked in the TSM, or (2) a product is specified as "no substitution".

B. The majority of LMS Sections that contain required LANL-specific provisions are identified in the tables below.

C. When developing a specification package, External Design Agencies are strongly encouraged to use the LMS Sections (available in SpecLink Cloud and Word format) as a baseline, as they incorporate all LANL-specific requirements and typically satisfy TSM design criteria. Alternatively, External Design Agencies may begin with their own CSI-formatted Sections and incorporate the required LANL-specific provisions in the LMS and TSM. LANL in-house design shall use all applicable LMS Sections. *If the project SOW specifies SpecLink Cloud use, it should include the details on access.*

D. When used, LMS templates must be tailored and edited for the specific project within the established boundaries (i.e., by LANL ESM Chapter 1, Section Z10, Attachment F). Key requirements include the following:

1. Include only the Section content necessary to execute the work so the design can be easily understood, procured, constructed, inspected, documented, warranted and maintained as intended under the subcontract.
2. Construction submittals shall be rigorously reduced to those required to meet Attachment F requirements or to support project success by pre-verifying key procurement and execution decisions.

E. Specification Sections

1. The design shall require compliance with the LANL-specific provisions contained in the LMS Division 01 templates in Table C1 or C2, as well as other division templates in Table C3.[3]
2. Include the Division 01 Sections identified in Table C1 or C2, as applicable to the project.

Table C1. LANL-produced designs: Required LMS Div 01 Sections

(* = specific notes follow table)

Section	Title
01 1117*	Work by Owner–Self Perform
01 3300*	Submittal Procedures
01 3545	Water Discharge Requirements

[3] Or ESM Chapter 1 POC-permitted commercial versions of LMS where applicable.

01 4000	Quality Requirements [CoE-approved commercial/conventional version may be used]
01 4455	Onsite Welding, Brazing and Joining Requirements
01 5705	Temporary Controls and Compliance Requirements
01 7823	Operation and Maintenance Data
01 8734	Seismic Qualification of Nonstructural Components (IBC)

Table C1 Notes

1. See TSM Appendix C text above the table for general requirements.
2. In-house design is typically self-performed, therefore, that case is addressed first in these notes. For in-house design that is not self-performed, specification package should be adjusted to align with the applicable subcontract and project requirements.
3. **01 1117 - Work by Owner–Self Perform**: Required for self-perform work. For subcontracted projects, include this Section only when LANL Construction will perform a significant portion of the work described in the specification package.
4. **01 2500 - Substitution Procedures**: Typically required only for competitively bid (e.g., design-bid-build). In other cases, substitutions are handled through submittal reviews and/or FCRs.
5. **01 3300** - **Submittals Procedures**: Include based on complexity of the work, at the discretion of the LANL design team, and considering the needs of the designer, SME, and inspection/QA, as reflected in LMS 01 3300 Attachment A, *Construction Submittal Log*.
6. **01 8113.13 - Sustainable Design**: Include only for LEED (generally large buildings).
7. The following Sections are **not included** in Table C1:
   a. 01 4115 – Pressure Safety Submittals
   b. 01 4216 – Definitions
   c. 01 4444 – Offsite Welding, Brazing and Joining Requirements
   d. 01 4525 – Nondestructive Examination (NDE) Requirements
   e. 01 4631 – Welding, Brazing and Soldering of ASME B31 Piping
   f. 01 4731 – Flange Assembly for ASME B31 Systems
   g. 01 6000 – Product Requirements
   h. 01 7700 – Closeout Procedures
   i. 01 7839 – Project Record Documents
   j. 01 9100 – Commissioning

   These are not required for self-perform work because the Conduct of Engineering Glossary addresses definitions; NDE requirements don't apply to self-perform work; LANL Construction follows its own procedures; and LANL designers and PEs are responsible for producing - and in some cases collecting - project record documents at closeout. For subcontracted work, include these as needed.

Table C2. External-Design Agency-produced designs: LMS Div 01 Sections with Required LANL-Specifics

(* = specific notes follow table)

Section	Title
01 1117*	Work by Owner–Self Perform
01 2500*	Substitution Procedures
01 3300*	Submittal Procedures
01 3545	Water Discharge Requirements
01 4000	Quality Requirements [CoE-approved commercial/conventional version may be used]
01 4216	Definitions
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 [LEED projects]
01 8734	Seismic Qualification of Nonstructural Components (IBC)

Table C2 Notes

1. See TSM Appendix C text above the tables for general requirements.
2. This table assumes the work will be subcontracted; if the work is predominantly self-performed, some Sections may not be required.
3. **01 1117** - **Work by Owner–Self Perform**: Required only when LANL Construction will perform a significant portion of the work described in the specification package (e.g., more than final utility tie-in activities)
4. **01 2500 - Substitution Procedures**: Typically required only for competitively bid (e.g., design-bid-build). In other cases, substitutions are handled through submittal reviews and/or FCRs.
5. **01 3300** - **Submittals Procedures**: Includes process for LANL to receive and review submittals, when required. Include this Section or incorporate its content and attachments, if Design Agency uses their own CSI-formatted Section.
6. **01 4000 – Quality Requirements**: Commercial version of Section may be shared by LANL IPT.
7. The following Sections are **not** i**ncluded** in Table C2. Include these, if needed.
   a. 01 4115 – Pressure Safety Submittals
   b. 01 4444 – Offsite Welding, Brazing and Joining Requirements
   c. 01 4455 – Onsite Welding, Brazing and Joining Requirements
   d. 01 4525 – Nondestructive Examination (NDE) Requirements
   e. 01 4631 – Welding, Brazing and Soldering of ASME B31 Piping
   f. 01 4731 – Flange Assembly for ASME B31 Systems
   g. 01 9100 – Commissioning

F. In addition to the LMS Division 01 Sections identified in Tables C1 and C2, Table C3 compiles Div 02–43 Sections that are required elsewhere in the TSM and

contain significant LANL-specific provisions that must be incorporated into the design.[4]

Table C3. Required LANL-Specifics in LMS Sections Beyond Div 01

Section	Title	Scope/Basis for inclusion in table
Structural (TSM Chapter 5)		
03 3001	Reinforced Concrete	Includes LANL pre-approved mixes available from the local supplier within a practicable travel distance.
Div 03–05	All in LMS collection	Include LANL-specific implementation of seismic design requirements
09 5100, 09 6900, 13 3419, 22 0548.16, 26 0548.16	Acoustical Ceilings Access Flooring Metal Building Systems Vibration and Seismic Controls for Mechanical Systems Seismic Controls for Electrical Systems	
Civil/Utilities (TSM Chapter 3)		
32 9219	Seeding	Acceptable seed mixes (ref. TSM Ch. 4)
33 1000	Water Utilities	No-substitution valves and tapping sleeves and inspection points
33 3000	Sanitary Sewerage Utilities	No-substitution Flygt pump and inspection points
33 5100	Natural Gas Distribution	No-substitution PE piping and installation method and inspection points
Building Control (TSM Chapter 8)		
Div 25	Integrated Automation series (all)	When a BAS is involved per TSM Ch. 8 I&C *(e.g., para. K)*
Security (TSM Chapter 9)		
28 0528	Pathways for Electronic Security	For greater than property protection areas, cable-in-conduit from field panels (e.g., in telecom room) to LANL- and subcontractor-furnished Argus devices at access-controlled doors.
28 1321	Administrative Access Control System Rough-In	Similar to Section 28 0528, but control wiring for property protection areas
32 3113	Chain Link Fences and Gates	Used for many remote and/or secure areas, along with Civil's G2040-1 Std Details

[4] As with many TSM requirements, this applies when a given SSC is within the project scope. The table is provided for convenience; however, if a Section is invoked elsewhere in the TSM but is not listed here—or is listed here but not specifically referenced elsewhere—it shall still be followed unless otherwise approved by the LANL Engineering Standards Team.

Section	Title	Scope/Basis for inclusion in table
Telecom (TSM Chapter 18 or 19)		
27 1000	Structured Cabling	Telecom infrastructure installations (basic)
27 1500.18	Classified Network Infrastructure Rough-In	In addition to Section 27 1000 when required per TSM Ch 18 for RedNet
27 3000	Voice Communications	Paging; very rarely required by SOWs