TABLE OF CONTENTS

This mandatory functional series document is available online at http://engstandards.lanl.gov.
It derives from P342, Engineering Standards, which is issued under the authority of the Conduct of Engineering program at the Laboratory.

RECORD OF REVISIONS

Rev	Date	Description	POC	OIC
0	11/17/03	Initial issue.	Tobin Oruch, *FWO-DO*	Gurinder Grewal, *FWO-DO*
1	10/27/06	Administrative changes including contract reference updates at transition.	Mel Burnett, *FME-PSE*	Kirk Christensen, *CENG*
1 Chg1	1/10/07	Added 5.1.H on common-cause failure of site systems.	Mel Burnett, *FME-PSE*	Kirk Christensen, *CENG*
2	2/23/11	Eliminated App A etc. in lieu of APs; update for 1189; was F1030.3	Tobin Oruch, *CENG*	Larry Goen, *CENG*
3	9/29/14	Changes for DOE O 420.1C and G 420.1-1A	Tobin Oruch, *CENG*	Mel Burnett, *CENG*

Please contact the ESM Nuclear POC for interpretation, variance, and upkeep issues.

F1030.70 NUCLEAR

1.0 APPLICATION OF CHAPTER

A. This chapter contains requirements that shall be followed in the design and construction of Hazard Category 1, 2, and 3 nuclear facilities -- both new construction and major modifications.[1]

Note: The use of the term facility in this section follows the definition of nuclear facility in 10 CFR 830 and includes process (programmatic) systems and activities.[2]

1. Activities associated with end-of-life (e.g., D&D) may be exempted from certain DOE O 420.1 requirements if adequately justified by approved safety analysis;
2. For projects that are Hazard Category 1, 2, and 3 nuclear facilities or include major modifications thereto, the requirements in DOE-STD-1189 shall be fully implemented.
    a. The following documents must be submitted: Safety Design Strategy (CD-1), Conceptual Safety Design Report (CD-1), Preliminary Safety Design Report (CD-2), Preliminary Documented Safety Analysis (CD-3), and Documented Safety Analysis with Technical Safety Requirements (CD-4). For major modifications, the Conceptual Safety Design Report (CSDR) and the Preliminary Safety Design Report (PSDR) may either be separate documents or be subsumed within the Preliminary Documented Safety Analysis. The need to maintain the CSDR and PSDR as separate documents shall be based on the design development phases. Projects with conceptual and/or preliminary design phases shall develop the corresponding safety documentation.[3]

B. *This chapter helps ensure that nuclear activities and facilities are designed and constructed to prevent accidents and mitigate consequences; yet are efficient, convenient, and adequate for good service; minimize the generation of radioactive and mixed wastes; and are maintainable, standardized, and adequate for future expansion.*

C. *This chapter, along with other chapters of the Engineering Standards Manual, implement design requirements and guidance in DOE O 420.1C, Facility Safety, and its guide DOE G 420.1-1A, Nonreactor Nuclear Safety Design Guide for use with DOE O 420.1C, Facility Safety and (2) along with containing additional requirements.*

D. Follow additional requirements specific to nuclear design elsewhere in the ESM (*primarily Chapter 5—Structural, Chapter 6—Mechanical, Chapter 7—Electrical, and Chapter 10-Hazardous*).

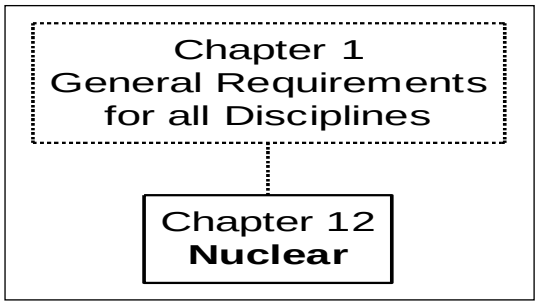
WARNING: Failure to comply with the DOE O 420.1-based requirements in this chapter could result in civil and criminal enforcement under the Price-Anderson Amendments Act because 10CFR830 invokes 420.1C. LANL cannot wavier 420.1 requirements without formal NNSA concurrence.

Note: Guidance statements are in *italics* or are otherwise clearly indicated

[1] DOE O 420.1C. See Chapter 1 Section Z10 (*App A)* for definition of major modification.
[2] 10 CFR 830 Sec. 803: *Nuclear facility* means a reactor or a nonreactor nuclear facility where an activity is conducted for or on behalf of DOE and includes any related area, structure, facility, or activity to the extent necessary to ensure proper implementation of the requirements established by this Part
[3] DOE O 413.3B CRD (Att 1), Item 13

E. **This entire chapter is also applicable to programmatic structures, systems, and components (SSC) unless specifically noted otherwise.**

F. The hierarchy and the organization of the ESM for this chapter is depicted below:



2.0 ACRONYMS AND DEFINITIONS

Design Agency	The organization performing the detailed design and analysis of a project or modification
Design Authority	The person responsible for the final acceptability of and changes to the design of a system or component and its technical baseline (typically the manager of engineering or his designee)
DBA	design basis accident
DC	design criteria
DSA	Documented safety analysis means a documented analysis of the extent to which a nuclear facility can be operated safely with respect to workers, the public, and the environment, including a description of the conditions, safe boundaries, and hazard controls that provide the basis for ensuring safety [10 CFR 830.3]. **Note**: DSAs may take the form of safety analysis report (SAR), basis for interim operation (BIO), or health and safety plan (HASP). The process involves production of a hazards inventory (HI), preliminary hazards analysis (PHA) and HA, and – for Haz Cat 2s and 3s – an accident analysis (AA).
ESM	Engineering Standards Manual
Facility	Normally at LANL, facility is a synonym for "real property and installed equipment." RP&IE is the land, improvements on the land such as buildings, roads, fences, bridges, and utility systems and the equipment installed as part of the basic building construction that is essential to normal functioning of a building space, such as plumbing, electrical and mechanical systems. This property/equipment is also referred to as institutional or plant and was formerly known as Class A. [from DOE Order 4330.4B] **In the context of this chapter, however, facility refers to the definition of nuclear facility in 10 CFR 830 that includes process (programmatic) systems and activities.**
FDD	facility design description
Hazard Category	The DOE-STD-1027 category as governed by SBP 111-1, *Facility Hazard Categorization and Documentation*
ITS	Important to safety (here, those defense in depth SSCs that are not SC or SS).

ML	management level, defined by AP-341-502, Management Level Determination.
NPH	Natural phenomena hazards include seismic (earthquake), wind, volcanic eruption and ash fall, lightning strikes, range fires, snow loads, and extreme temperatures.
non-reactor nuclear facility	Means "those facilities, activities or operations that involve, or will involve, radioactive and/or fissionable materials in such form and quantity that a nuclear or a nuclear explosive hazard potentially exists to workers, the public, or the environment, but does not include accelerators and their operations and does not include activities involving only incidental use and generation of radioactive materials or radiation such as check and calibration sources, use of radioactive sources in research and experimental and analytical laboratory activities, electron microscopes, and X-ray machines." (10 CFR 830.3)
PDSA	preliminary documented safety analysis
priority drawings	Priority drawings include the small set of "upper-tier" design drawings that are necessary to support the safe performance of facility operations, maintenance, and design activities within the facility's approved safety envelope. These drawings typically include piping & instrumentation diagrams, emergency evacuation maps (e.g., floor plans), and electrical one-lines. [AP-341-405, *Identification and Control of Technical Baseline in Operating Facilities.]*
Programmatic/ PP&PE	A synonym for Personal Property and Programmatic Equipment. PP&PE is equipment used purely for programmatic purposes, such as reactors, accelerator machinery, chemical processing lines, lasers, computers, machine tools, etc., and the support equipment dedicated to the programmatic purpose. This property/equipment is also referred to as organizational, research, production, operating or process and was formerly known as Class B. [DOE Order 4330.4B]
Safety Class (SC) SSC	*Safety class structures, systems, and components* means the structures, systems, or components, including portions of process systems, whose preventive or mitigative function is necessary to limit radioactive hazardous material exposure to the public, as determined from safety analyses. [10 CFR 830: § 830.3 Definitions.]
Safety SSC	A term meaning safety class, safety significant, and safety-impacting ML-1 and ML-2 SSCs; any of these could potentially impact worker or public safety or the environment if they failed.
Safety Significant (SS)	Structures, systems, and components which are not designated as safety-class SSCs but whose preventive or mitigative function is a major contributor to defense in depth and/or worker safety as determined from safety analyses. [10 CFR 830] As a general rule of thumb, safety-significant SSC designations based on worker safety are limited to those systems, structures, or components whose failure is estimated to result in a prompt worker fatality or serious injuries or significant radiological or chemical exposures to workers. The term, serious injuries, as used in this definition, refers to medical treatment for immediately life-threatening or permanently disabling injuries (e.g., loss of eye, loss of limb). The general rule of thumb cited above is neither an evaluation guideline nor a quantitative criterion. It represents a lower threshold of concern for which safety-significant SSC designation may be warranted. Estimates of worker consequences for the purpose of safety-significant SSC designation are not intended to require detailed analytical modeling. Considerations should be based on engineering judgment of possible effects and the potential added value of safety-significant SSC designation. [DOE G 420.1-1]
SDD	System design description. Required format in DOE-STD-3024, DOE Standard Content of System Design Descriptions
SSC	structures, systems, and components

3.0 ESTABLISHING TECHNICAL REQUIREMENTS AND DESIGN CRITERIA

A. Design personnel shall work to produce designs to best meet the technical requirements of the design criteria and functional and operational requirements, and not begin until these requirements are properly documented. Conversely, design elements over and above or not required by the DC and functions and requirements documents shall not be included without an approved baseline change authorization.[4]

B. Should a nuclear reactor be sited at LANL, follow all applicable DOE mandates.[5]

C. *Guidance: As the design progresses the design criteria should be further refined and made specific to the SSCs if not already so. For instance, safety and non-safety SSCs will have different standards applied.*

4.0 MAINTAINING TECHNICAL REQUIREMENTS DOCUMENTS AND DESIGN CRITERIA DURING DESIGN

A. The project management and/or design team shall employ a design and construction phase configuration management program to maintain consistency between the technical baseline (including system requirements and performance criteria), the design documentation, and the as-built conditions.[6]

B. *Project documentation should be validated against the actual physical configuration and manufacturer's documentation of facility and process SSCs during design and again during construction.*[7]

C. When required by ESM Chapter 1 Section Z10, originating personnel, project management personnel, and/or design personnel shall develop and maintain appropriately detailed FDD, SDDs, priority drawings and other critical drawings and documentation during the design and construction process. The FDD and SDDs shall be started during conceptual phase; *it is recommended they be started at pre-conceptual phase. Further guidance: The FDD and SDDs should adequately reflect the requirements contained in the draft safety analysis (which is still changing). SDDs are a good way to start documenting system purpose, functional requirements, applicable codes and standards, system interfaces etc. as the Process Flow Diagrams and design development is started. This information is very important for reviewers. Usually it is beneficial to the design agency to put at least functional requirements, applicable codes and standards under change control prior to start of the preliminary design in order to minimize late changes to system requirements by the customer. This activity should directly support facility safety basis development and documentation.*

D. *For projects with over $200k design cost, the design requirements should be incorporated into an equipment database that correlates each SSC with the SSC grade, the design requirements, technical topics involved, and associated documentation.*[8]

---

[4] To produce an effective design efficiently, the requestor must establish the most basic criteria at the outset of the process since these have a major effect on how design is performed. Failing to do so can result in costly rework or a tendency for schedule-driven design compromises.

5 This is not anticipated, thus requirements for same and mention of Haz Cat 1 facilities have been excluded from the ESM for the most part.

[6] DOE O 420.1C

[7] Ibid

[8] DOE-STD-1073

E. *System and Process Boundaries: The boundaries for each system and process should be established in such a manner as to contain the components necessary to satisfy the design requirements for that system or process. See ESM Chapter 1 Sections 210 and 220.*

F. *Specific Equipment List: On the basis of the equipment scope criteria and the assignment of SSC grades, the specific SSCs included in the CM program should be identified. Ref: AP-341-404, Master Equipment List.*

G. Establishment of Design Basis: The basis for design decisions, whether inclusions or exclusions, shall be formally established and documented, and correlated with the design and/or the function and other design requirements (e.g., RCD, FRD).

1. *A technical management review should be performed to determine the adequacy of the design basis. If the design basis is not fully documented, not accurate, or not complete, it should be reconstituted to the extent identified by the design reconstitution adjunct program.*
2. *The design basis for new or modified design requirements should be established and documented as these requirements are developed.*

5.0 NUCLEAR SAFETY DESIGN

5.1 General

A. Follow requirements and guidance in DOE O 420.1C, DOE G 420-1.1A, and LANL-adopted revisions of same.[9]

B. Interpret the IEEE® nuclear standards at LANL as follows:

- Substitute "safety class or ML-1 electrical" for "Class 1E."
- Substitute "facility" for "unit" and/or "station."
- Substitute "non-reactor nuclear or high hazard facility" for "nuclear power generating station."
- Substitute "normal power" for "preferred power".
- Substitute "safety systems" for "reactor trip system."

---

9 See also 420.1C FAQs; e.g., Q- 4: What does the following mean regarding the use of the 420 Guide?

> *DOE G 420.1-1A provides an acceptable method to meet the requirements stated in this chapter. DOE O 251.1C requires that any implementation selected must be justified to ensure that an adequate level of safety commensurate with the identified hazards is achieved.* [DOE O 420.1C, Attachment 2, Chapter I, Section 3.b.(8)]

A: "Justify" means to document a defensible technical basis for any alternative approach to the requirements and methods of the Order and its guidance documents; DOE Order 251.1C, *Departmental Directives Program*, dated January 15, 2009, states:

> *(1) Provide an acceptable, but not mandatory means for complying with requirements of an Order or rule. Note: Alternate methods that satisfy the requirements of an Order are also acceptable. However, any implementation selected must be justified to ensure that an adequate level of safety commensurate with the identified hazards is achieved.* (DOE O 251.1C, Section 5.d. Guides.)

Adequate level of safety is equivalent to "adequate protection," which is defined as those measures that permit a facility to operate safely for its workers and the surrounding community (see Deputy Secretary Poneman letter, July 19, 2012). Adequate protection is achieved when all necessary measures are being taken in a manner that is consistent with applicable requirements and regulatory process. Adequate protection in design is achieved by meeting Departmental requirements with regard to the design of engineered safety systems and controls, which protect workers and the public from normal operations and possible accidents.

- Ignore nuclear-reactor-specific terms such as "reactor transient", "fuel cladding", "reactor coolant",
- Substitute "confinement" for "containment."

C. Consider the guidance in applicable DOE Standards including DOE-STD-1132, Design Considerations.

5.2 Reliability

A. *A Reliability, Availability, and Maintainability (RAM) program should be established per best available guidance and graded as to the complexity and hazards of the facility. Some useful resources:*[10]

- http://www.sre.org—Society of Reliability Engineers.
- MIL-HDBK-470A, Designing and Developing Maintainable Products and Systems
- DOD-HDBK-791, Maintainability Design Techniques
- IEEE 352, IEEE Guide for General Principles of Reliability Analysis of Nuclear Power Generating Station Safety Systems
- *Introduction to Reliability Engineering*, Lewis (at LANL Research Library)
- Eberling, Charles E. *An Introduction to Reliability and Maintainability Engineering*, McGraw-Hill, 1997.

B. Procurement: Follow the requirements of 10 CFR 830 Subpart A in the procurement of all nuclear safety SSCs.

1. Document supplier quality and receipt inspection requirements. *These should state what will be inspected, how this will be performed, and who will perform.*
2. Safety Class, Safety Significant, ML-1, and ML-2 items imposing ASME NQA-1 requirements requires use of suppliers from the Institutional Evaluated Supplier List **(**IESL**)** *(internal only)* and/or use of a commercial grade dedication process (see AP-341-703, *Item Dedication*).
3. *In most cases, components used in DOE nonreactor nuclear facilities will be commercial grade (off the shelf); that is, they will not be from NQA-1 qualified suppliers. Therefore, safety SSC quality standards can either be design based or achieved through testing, vendor control, and inspection.*[11]
4. *See references in ESM Chapter 1 Section Z10 (Z1020).*

6.0 DESIGN/SAFETY ANALYSIS INTEGRATION FOR PROJECTS (GUIDANCE)

A. This section (6.0) supplements DOE-STD-1189 regarding how the design and safety analysis processes interface for nuclear facility projects. The discussion is for a new facility or modification using the DOE O 413.3 Critical Decisions. Most modification projects to existing facilities will follow a slightly different process and must also consider:

1. The existing SSCs that might be impacted,

[10] DOE G 420.1-1A
[11] Ibid

2. The existing safety basis that will need to be kept current, the transitional states that may be achieved during construction if the facility is to remain fully or partially operational during the modification, and

3. The unplanned operational or construction upsets that might have an adverse effect on workers or the public.

B. *LANL Project Management Directorate documents address many of the deliverables discussed in this section and should be used where required or applicable. Guidance on design steps at various project phases, including integration of design and safety, is also contained in DOE O 413.3, Project Management for the Acquisition of Capital Assets – and DOE O 430.1, Real Property Asset Management.*