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F1030.60 HAZARDOUS PROCESS

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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 only. Organization and contract reference updates from LANS transition; 420.1A became 420.1B. IMP and ISD number changes based on new Conduct of Engineering IMP 341. Master Spec number/title updates. Other administrative changes.	Mike Clemmons, *FME-DES*	Kirk Christensen, *CENG*
2	9/29/14	Requirements changed to incorporate 420.1C, admin updates.	Lowell Christensen *ES-EPD*	Mel Burnett, *ES-DO*

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

F1030.60 HAZARDOUS PROCESS

1.0 APPLICATION OF CHAPTER

A. *This chapter helps ensure that explosive, biological, and other hazardous activities and facilities (including nuclear) are designed and constructed to prevent accidents and mitigate consequences; yet are efficient, convenient, and adequate for good service; minimize the generation of hazardous, radioactive, and mixed waste; and are maintainable, standardized, and adequate for future expansion. It does not address external (e.g., terroristic) chemical or biological threat defense [Security Chapter 9 (future) may address this].*

B. This chapter contains requirements that apply to design and construction, both new construction and modification of existing installations (i.e., this chapter does not require the modification of existing SSCs and projects underway to conform).[1]

C. *This chapter, along with other chapters of the Engineering Standards Manual, comprehensively implements requirements and guidance in DOE O 420.1C Facility Safety, and its guide, (1) DOE G 420.1-1, Nonreactor Nuclear Safety Design Criteria and Explosive Safety Criteria Guide for use with DOE O 420.1C Facility Safety, 2) DOE O 450.2, Integrated Safety Management, along with providing additional requirements.*

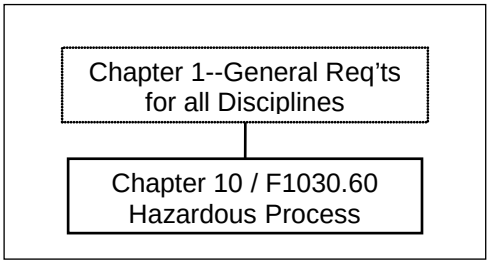
D. Use this chapter along with Chapter 8-I&C, Chapter 12-Nuclear, and other ESM chapters as applicable.

E. WARNING: Failure of nuclear facilities/activities to comply with the DOE O 420.1C requirements in this chapter could result in civil and criminal enforcement under the Price-Anderson Amendments Act because 10 CFR 830 invokes 420.1C. LANL cannot wavier 420.1C requirements without going through a formal process with NNSA (e.g., LASO) concurrence.

Note: Guidance statements are in *ITALICS* and follow the paragraph they support.

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

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



1 DOE O 420.1C, Section 4.1.

2.0 ACRONYMS AND DEFINITIONS

AHJ	Authority having jurisdiction
design agency	The organization performing the detailed design and analysis of a project or modification
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. **In the context of this chapter's nuclear-applicable sections, facility refers to the definition of nuclear facility in 10 CFR 830 and includes process (programmatic) systems and activities.**
hazard category	DOE-STD-1027 defines the hazard category for a facility. *Nuclear facilities will be Cat 1, 2, or 3.*
mixed waste	MW contains both hazardous waste (as defined by RCRA and its amendments) and radioactive waste (as defined by AEA and its amendments). It is jointly regulated by NRC or NRC's Agreement States and EPA or EPA's RCRA Authorized States. The fundamental and most comprehensive statutory definition is found in the Federal Facilities Compliance Act (FFCA) where Section 1004(41) was added to RCRA: "The term 'mixed waste' means waste that contains both hazardous waste and source, special nuclear, or byproduct material subject to the Atomic Energy Act of 1954."
ML	Management level, defined AP-341-502 and ESM Chapter 1 Section Z10.
POC	Point of contact. For the ESM discipline POCs see http://engstandards.lanl.gov/POCs.shtml
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.]
SSC	Structures, systems, and components.
TLV	Threshold Limit Value

3.0 DESIGN CRITERIA [2]

3.1 General Hazardous Material Protection

A. Moderate and high hazard category facilities shall comply with ESM Chapter 12 - Nuclear requirements/sections addressing early and iterative safety analysis development.

B. High hazard facilities shall also comply with these ESM Chapter 12 - Nuclear requirements/sections:

1. Establishing Technical Requirements and Design Criteria.
2. Maintaining Technical Requirements Documents and Design Criteria during Design.

Guidance: Moderate hazard facilities should also control design in this manner.

C. Comply with the requirements of the applicable laws for hazardous material protection where personnel could potentially be exposed to hazardous materials listed in 29 CFR 1910 at concentrations approaching the listed permissible exposure limits (8-hour, time weighted average, normal operations) and concentrations approaching the listed Threshold Limit Values in ACGIH TLVs and TLVs. [3]

D. Satisfy requirements for design of engineered controls for hazardous material protection contained in 29 CFR 1910, Subparts G, H, and Z. [4]

E. Provide decontamination facilities, safety showers, and eyewashes to mitigate external exposures to hazardous materials where mandated by 29 CFR 1910, Subparts H and Z. Design per ANSI Z358.1 and ANSI Z124.2. Also follow ESM Chapter 6 Section D20 (D2010). [5]

F. Comply with NFPA 704, Identification of the Hazards of Materials, and other pertinent NFPA codes and standards.

G. The facility design must provide reliable safe conditions and sufficient confinement of hazardous material during and after all DBAs. At both the facility and SSC level, the design must ensure that more probable modes of failure (e.g., fail to open versus fail to close) will increase the likelihood of a safe condition.

H. Airflow and other design requirements for specific types of ventilation systems shall comply with 29 CFR 1910, Subparts G and H. *Ventilation systems for hazardous material protection should use local exhaust ventilation (LEV) to control concentrations of hazardous materials from discrete sources, or should control the number of air changes per hour for an entire room or bay (but avoid concentration control by dilution ventilation). 29 CFR 1910, Subpart Z, provides requirements for monitoring and alarm systems for facilities that manage or use specific hazardous materials. Additional guidance on design of ventilation systems for hazardous material protection is provided in ANSI Z9.2 and ASHRAE 62.* [6]

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2 DOE G 420.1-1A.
3 Ibid4 DOE G 420.1-1A, Section 5.4.5
4 DOE G 420.1-1A, Section 5.4.5
5 Ibid
6 Ibid

I. *Ventilation systems are engineering controls commonly used to prevent worker exposure to hazardous materials and are used in combination with personal protective equipment and operational procedures. 29 CFR 1910, Subpart G, 1910.94, requires that where ventilation is used to control worker exposures, it must be adequate to reduce the hazardous material concentrations of air contaminants to the degree that the hazardous material no longer poses a health risk to the worker (i.e., concentrations at or below the permissible exposure limits). 29 CFR 1910, Subpart Z, 1910.1000, requires that wherever engineering controls are not sufficient to reduce exposures to such levels, they must be used to reduce exposures to the lowest practicable level and supplemented by work practice controls. The design should ensure that respirators are not required for normal operating conditions or routine maintenance activities except as a precautionary measure.* [7]

J. *Facilities with hazardous material exposure concerns should be designed to minimize personnel exposures, both external and internal, and to provide adequate monitoring and notification capabilities to inform workers of unsafe conditions.* [8]

K. *Hazardous material protection should be provided through facility design (e.g., remote handling, area and equipment layout, spill-control features, confinement, ventilation, etc.).* [9]

L. *Occupied spaces should be designed to preclude locations where low oxygen content or air displacement may occur or where reactive, combustible, flammable, or explosive gas, vapor, or liquid accumulation might occur.* [10]

M. *Safety controls and features should be designed to consider contaminant chemical forms and minimize the potential for inhalation and contact under all conditions.* [11]

N. *Directed ventilation flow paths should be used to move contaminants away from worker breathing zones. The design should ensure that ventilation flow will cascade from clean areas to contaminated areas to preclude contamination spread. Uniform distribution of incoming air and/or air mixing equipment should be provided to ensure that no pockets of stagnant air exist in areas where workers are present.* [12]

O. *Provide double block valves with intermediate bleed valve (to assure shutoff prior to line maintenance).*

3.2 Accessibility and Maintainability

A. Surveillance equipment used to monitor and determine the operability of safety SSCs shall be located and sufficient space provided for relative ease of routine testing and maintenance activities. [13]

7 DOE G 420.1-1A, Section 5.4.5; may be included in ventilation system section of Ch 6 instead.
8 Ibid
9 Ibid
10 Ibid
11 Ibid
12 Ibid
13 DOE G 420.1-1A, Section 5.4.2.

B. *Accessible inspection covers to allow for visual inspection should be provided and located such that necessary routine inspections can be conducted with minimum disruption to the facility or equipment operation.* [14]

C. *The facility design should include features that provide for ease of routine maintenance without a subsequent mission reduction.* [15]

3.3 Architectural

A. Comply with the requirements in ESM Chapter 4, Architectural.

B. Access Control Requirements:

1. Implement specific requirements for access control as specified by 10 CFR 835 for radiological hazards and by 29 CFR 1910 and 1926 (OSHA) for hazardous material locations within operating facilities and construction sites.[16]

Access controls must not prevent operator actions required to achieve and maintain a facility in a safe condition.[17]

Nuclear Only: Where access control is provided for control rooms that contain safety-class SSC controls and monitoring, the same level of qualification shall be considered for the access control features.[18]

C. *Waste Management: The facility design/layout should include features that facilitate waste management activities (collection, storage, transport/transfer, etc).*

D. *The type and level of hazards should be determined for each functional area, the attendant degree of risk established, and the possibility of cross contamination considered. Wherever possible, work areas with compatible contaminants should be located together to simplify design criteria related to air supply and exhaust, waste disposal, decontamination, and cross contamination.*[19]

E. *Radioactive and hazardous material contamination control requirements should be considered in the design to minimize the potential for contamination spread and generation of mixed waste.*[20]

F. *Office areas should be located in common-use facilities (e.g., data computation and processing, word processing, etc.) and away from process areas to minimize risks to workers of exposure to radioactive and/or hazardous materials.*[21]

G. *The building layout should provide protection from the hazards associated with handling, processing, and storing of radioactive and/or hazardous materials.*[22]

H. *The arrangement and location of hazardous process equipment and its maintenance provisions should provide appropriate protective and safety measures as applicable.*[23]

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14 DOE G 420.1-1A, Section 5.4.2
15 Ibid
16 DOE G 420.1-1A, Section 5.4.4
1717 Ibid
18 Ibid. This requirement could extend nuclear criteria to control rooms located outside the nuclear facility.
19 DOE G 420.1-1A, Section 5.4.3
20 Ibid
21 Ibid
22 Ibid

I. *Facility layout should provide specific control and isolation, if possible, of quantities of flammable, toxic, and explosive gases, chemicals, and other hazardous materials admitted to the facility.*[24]

J. *The facility design should accommodate the requirements for safeguards and security, emergency egress, and area access control for worker protection. Where these requirements may appear to conflict, life safety takes precedence.*[25]

K. *Nuclear Facilities Only:*

1. *The building design should accommodate prompt return to a safe condition in emergencies and allow ready access for and protection of workers in areas where manual corrective actions are required and in areas that contain radiation monitoring equipment readouts.*[26]

Additional space should be provided for temporary or additional shielding in the event radiation levels are higher than anticipated.[27]

3.4 Biological

A. Comply with applicable federal, state, and local laws and regulations.

1. Key regulations include:
   a. 42 CFR 73 and 42 CFR 1003, *Possession, Use and Transfer of Select Agents and Toxins*. https://oig.hhs.gov/authorities/docs/05/032905FRselectagents.pdf
   b. 7 CFR 331 and 9 CFR 121, *Agricultural Bioterrorism Protection Act of 2002: Possession, Use and Transfer of Select Agents and Toxins.* http://www.gpo.gov/fdsys/pkg/FR-2012-10-05/pdf/2012-24434.pdf
   c. OSHA 3404-11R, *Laboratory Safety Guidance*

3.5 Nanomaterials

A. Comply with DOE Policy 456.1, Secretarial Policy Statement on Nanoscale Safety

B. *Additional guidance is available in NSRC Revision 3a, DOE Nanoscale Science Research Centers – Approach to Nanomaterial ES&H*

3.6 Deactivation, Decontamination, and Decommissioning -- Design to Facilitate

A. Deactivation: Design to facilitate deactivation, incorporating facility features that aid in the removal of surplus radioactive and chemical materials; storage tank cleanout and maintenance; stabilization of contamination and process materials; and the removal of hazardous, mixed, and radioactive wastes. *In general, these features reduce the physical risks and hazards associated with facility decontamination and decommissioning and are also be called for when designing for ease of maintenance during operation.*[28]

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23 DOE G 420.1-1A, Section 5.4.3
24 Ibid
25 DOE G 420.1-1A, Section 5.4.4
26 DOE G 420.1-1A, Section 5.4.3
27 Ibid
28 DOE G 420.1-1A, Section 5.4.1.1

B. Decontamination: Design-in measures to simplify decontamination of areas that may become contaminated with radioactive or hazardous materials. *Items such as service piping, conduits, and ductwork should be kept to a minimum in potential contamination areas and should be arranged to facilitate decontamination. Walls, ceilings, and floors in areas vulnerable to contamination should be finished with washable or strippable coverings. Metal liners should be used in areas that have the potential to become highly contaminated. Cracks, crevices, and joints should be filled and finished smooth to prevent accumulation of contaminated material. The facility design should incorporate features that will facilitate decontamination to achieve facility decommissioning, to increase the potential for other uses, and to minimize the generation of mixed waste.* [29]

C. *Decommissioning: Design features consistent with the requirements of DOE O 435.1, Radioactive Waste Management, should be developed during the planning and design phases based on decommissioning requirements or a conversion method leading to other facility uses. DOE O 430.1B lists requirements for lifecycle facility management. The following design principles should be considered.* [30]

1. *Location of exhaust filtration components of the ventilation systems at or near individual enclosures to minimize long runs of internally contaminated ductwork.*

Equipment, including effluent decontamination equipment, which precludes, to the extent practicable, the accumulation of radioactive or other hazardous materials in relatively inaccessible areas, including curves and turns in piping and ductwork. Accessible, removable covers for inspection and cleanouts are encouraged.

Use of modular radiation shielding in lieu of or in addition to monolithic shielding walls.

Provisions for flushing and/or cleaning contaminated or potentially contaminated piping systems.

Use of lifting lugs on large tanks and equipment.

Piping systems that carry contaminated or potentially contaminated liquid should be free draining via gravity. Low points should have drain valves with barstock plugs to facilitate draining.

3.7 Effluent Monitoring and Control

This subsection applies to any facility that produces airborne or liquid radioactive and/or hazardous material effluents, including contaminated storm water, under normal operating conditions.

A. Comply with the requirements and guidance in DOE G 420.1-1A, Section 5.4.6.

3.8 Explosives

A. Design and construct new explosives facilities and modifications to existing explosives facilities to DOE-STD-1212, Explosives Safety.

B. Facility structural design and construction shall comply with the requirements of Unified Facilities Criteria (UFC) 3-340-02 (DoD), *Structures to Resist the Effects of Accidental Explosions;* and DOE/TIC-11268, *A Manual for the Prediction of Blast and Fragment Loading of Structures*.

29 DOE G 420.1-1A, Section 5.4.1.2
30 DOE G 420.1-1A, Section 5.4.1.3

C. Base blast-resistant design for personnel and facility protection on the TNT equivalency of the maximum quantity of explosives and propellants permitted. Per UFC 3-340-02, the TNT equivalency shall be increased by 20 percent for design purposes.

D. The technical basis for establishing explosives quantity–distance separation for facility location, design, and operation (under normal and potential DBA conditions) shall follow the stricter of the criteria provided in DoD 6055.9-STD, *Department of Defense Ammunition and Explosives Safety Standards*. Follow DoD 6055.9 for the minimum distance for protection from hazardous fragments to facility boundaries, critical facility, and inhabited structures unless it can be shown that there will be no hazardous fragments or debris at lesser distances. The method of calculation presented in the DoD Explosive Safety Board (DoDESB) Technical Paper No. 13 may be used to establish a smaller fragment exclusion zone.

2. It is not intended that these minimum fragment distances be applied to operating facilities or dedicated support functions within an operating line. The criteria presented in DOE-STD-1212 shall apply for these exposures.

E. For an unproven facility design, either a validated model or a full-scale test is required to ensure structural adequacy unless a high degree of confidence can be provided by calculations or other means. Concurrence of the DOE Contract Administrator (head of field organization, e.g., NNSA LA) with the advice of competent engineering review shall be obtained in any determination regarding test requirements.

F. Comply with NFPA 495, Explosive Materials Code, and other pertinent NFPA codes and standards. In addition to this standard, the following are resource documents for the siting and design of explosives facilities:

1. DOE O 420.1C, Facility Safety
2. DOE O 430.1B, Real Property Asset Management
3. 10 CFR 830, Nuclear Safety Management
4. UFC 3-340-02, Structures to Resist the Effects of Accidental Explosions
5. DOE/TIC-11268, A Manual for the Prediction of Blast and Fragment Loading of Structures
6. DoD 6055.09-M, Department of Defense Ammunition and Explosives Safety Standards
7. DDESB TP-13, Prediction of Building Debris for Quantity Distance Siting
8. AMC-R-385-100, AMC Safety Manual
9. TR-828, Blast Environment from Fully and Partially Vented Explosions in Cubicles
10. AD 411445, Industrial Engineering Study to Establish Safety Design Criteria for Use in Engineering of Explosives Facilities and Operations
11. AFWL-TR-74-102, The Air Force Manual for Design and Analysis of Hardened Structures
12. HNDM-1110-01-2, Suppressive Shields, Structural Design and Analysis Handbook

G. Nuclear explosive work shall be performed per the requirements of DOE O 452.2D, Nuclear Explosive Safety.

3.9 Gaseous Hazardous Material Protection

A. Comply with the requirements in Attachment A, Hazardous Gas Design.

3.10 Human Factors Engineering (Guidance)

A. *Appropriate human factors engineering principles and criteria should be integrated into the design, operation, and maintenance.* [31]

B. *The human factor elements that should be considered include, but are not limited to, the following:* [32]

1. *equipment identification and labeling (also see ESM Chapter 1 Section 230)*
2. *workplace environment (temperature and humidity, lighting, noise, vibration, and aesthetics),*
3. *human dimensions,*
4. *operating panels and controls,*
5. *component arrangement,*
6. *warning and annunciator systems, and*
7. *communication systems.*

C. *The applicable criteria found in the following should be considered in the design of these elements:*

1. *NRC Nuclear Regulatory Guide (NUREG) 0700, and Institute of Electrical and Electronic Engineers (IEEE) 1023.*
2. *Table G-1, Human Factors Standards and Guidance Documents in DOE-STD-1195.*

3.11 Liquid Hazardous Material Protection

A. Comply with NFPA 30, Flammable and Combustible Liquids Code. *This addresses flammable and combustible liquids, as well as corrosive and oxidizing liquids. It also covers design of storage and distribution systems.*

1. *Also available for reference: NFPA 30H, Flammable and Combustible Liquids Code Handbook*

3.12 Waste Management

This section applies to any DOE facility that under normal operating conditions produces containers of wastes having constituents that are regulated as radioactive, hazardous, or mixed waste. [33]

A. Design waste management systems to the federal, state, and local requirements referenced therein. [34]

31 DOE G 420.1-1A, Section 5.4.9
32 Ibid
33 DOE G 420.1-1A, Section 5.4.7

B. Design for waste avoidance/minimization, including but not limited to evaluation of non-hazardous material substitution alternatives, recycling/reuse options, and minimization of mixed waste generation.

C. Include features that facilitate waste management activities (e.g., collection, storage, transport/transfer, etc).

D. *Related requirements and guidance documents include:*

- *P 401, Implementing Environmental Requirements*
- *DOE GPG-FM-025A, Good Practice Guide Waste Minimization/Pollution Prevention*
- *P-101-14 Chemical Management*
- *ChemLog – How it Works*
- *Chemical Storage Schemes*
- *P409, Waste Management*
- *ENV-RCRA-TOOL-306.0, Potentially Radioactive or Mixed Investigation Derived Waste*
- *MAN-5004, R2, Environmental Protection – Environmental Data & Analysis*
- *PCB Site Revitalization Guidance under TSCA and ENV-RCRA-TOOL-712.0 , Polychlorinated Biphenyl (PCB) Waste*
- *New Mexico Administrative Code, 20.4.1 NMAC.*
- *New Mexico Hazardous Waste Act (NM HWA)*
- *LANL Waste Permit, which complies with:*
  - *Resource Conservation and Recovery Act, as amended, 42 U.S.C. Sec. 6901 et seq.*
  - *Title 40 CFR 261, "Identification and Listing of Hazardous Waste."*
  - *Title 40 CFR 262, "Standards Applicable to Generators of Hazardous Waste."*
  - *Title 40 CFR 262.34, "Accumulation Time."*
  - *Title 40 CFR 264, "Standards for Owners and Operators of Hazardous Waste*
  - *Treatment, Storage and Disposal Facilities."*
  - *Title 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous*
  - *Waste Treatment, Storage and Disposal Facilities."*
  - *Title 49 CFR 173,"Shippers—General Requirements for Shipments and Packaging."*

E. Nuclear Only:

1. Design waste management systems to DOE O 435.1, Radioactive Waste Management.
2. *Related requirements and guidance documents include:*
   - *ENV-RCRA-TOOL-300.1 General Radioactive Waste Management*
   - *DOE M 435.1-1, Chg 1 Radioactive Waste Management Manual, except for Chapter III, paragraph N. (1) and Chapter IV, paragraphs N. (1). (see LIR 404-00-05.2, para. 7.3.2)*
3. *Unless it can be demonstrated that the risk is acceptable in the DSA, waste management and storage systems and associated support systems should be*

34 Ibid

designed to remain functional following a DBA and should facilitate the maintenance of a safe shutdown condition. [35]

For high-level waste containment systems, at least one confinement barrier should be designed to withstand the effects of DBAs. [36]

3.13 Accelerator Safety

A. Comply with DOE O 420.2C, Safety of Accelerator Facilities.

4.0 ATTACHMENTS

ATT A HAZARDOUS GAS DESIGN

35 DOE G 420.1-1A, Section 5.4.7
36 Ibid