

FESHM 1071: CODES & STANDARDS

Revision History

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1.0 INTRODUCTION AND SCOPE

The objective of US Department of Energy (DOE) is to provide a level of environmental, safety, and health protection consistent with 10 CFR 851 titled Worker Safety and Health Program along with DOE Orders and Directives. This requires facilities and processes to be designed to and protected by robust design codes and standards including safeguards & security, electrical, fire protection, cryogenics, mechanical, and pressure systems. When designing a new facility or experiment, strong consideration shall be given to all applicable design codes and standards when evaluating the features, processes, and the assembly of the facility and well as the experimental systems.

This chapter should be utilized to facilitate the development of design criteria for facilities or experiments to establish a basis of design and the code of record. This chapter applies to Fermilab site and Leased Spaces.

2.0 DEFINITIONS

- **Code of Record (COR)** - Code of Record (COR): The COR is a set of design and operational requirements, including Federal and state laws, in effect at the time a facility or item of equipment is designed and accepted by DOE. The COR is (i) initiated during the conceptual design phase, placed under configuration control to ensure it is updated to include more detailed design requirements as they are developed during preliminary design, (ii) controlled during final design and construction with a process for reviewing and evaluating new and revised requirements to determine their impact on project safety, cost, and schedule before a decision is taken to revise the COR, and (iii) maintained and controlled through facility decommissioning. The COR may be defined in contracts, Standards, or Requirements Identification Documents (or their equivalent), or project specific documents.
- **Cryogenics Safety Subcommittee (CSS)** – Subcommittee of the FESHCom consists of subject matter experts overseeing design, installation, and operation of the laboratory’s cryogenic systems including the development of oxygen deficiency hazards (ODH) analysis. CSS provides quarterly status reports to FESHCom.
- **Electrical Safety Subcommittee (ESS)** – Subcommittee of the FESHCom consisting of subject matter experts related to electrical safety. ESS is also the alternate Authority Having Jurisdiction (AHJ) in the absence of the primary AHJ Electrical Safety Officer. ESS provides quarterly status reports to FESHCom
- **Fermilab ES&H Committee (FESHCom)** - Has the responsibility for reviewing environmental, safety, health, and security policies for the general laboratory workforce and activities which may be of concern to the public. In carry out these responsibilities, FESHCom assigns coordinates the activities of its subcommittees, such as CSS, ESS, FHS,

MSS, and RSS. FESHCom reports its findings and recommendations to the laboratory directorate.

- **Fire Hazard Safety Subcommittee (FHS)** – Subcommittee of the FESHCom consisting of subject matter experts related to fire safety. FHS is also the alternate AHJ in absence of the primary AHJ Site Fire Protection Engineer approved by Fermi Site Office (FSO). The FHS is responsible for fire safety, life safety aspects of facilities, processes and experiments, and flammable and compressed gas systems. FHS provides quarterly status reports to FESHCom.
- **Mechanical Safety Subcommittee (MSS)** – Subcommittee of the FESHCom consisting of subject matter experts related to mechanical safety including pressure and vacuum systems, structures, lifting, and material handling. MSS provides quarterly status reports to FESHCom.
- **Radiological Safety Subcommittee (RSS)** – Subcommittee of the FESHCom consisting of subject matter experts related to radiation safety & health protection measures for the laboratory workforce and public. RSS provides quarterly status reports to FESHCom.
- **Structural AHJ – (S-AHJ)** - Subject Matter Expert with demonstrated expertise, including education, professional licensing, and/or meeting various state or federal requirements in Structural Engineering field.

3.0 RESPONSIBILITIES

The ESH Division Director or designee shall conduct periodic review and update of this chapter, gathering input from projects, CSS, ESS, FHS, MSS, and RSS subcommittees.

4.0 PROGRAM DESCRIPTION

Technical Appendix A is a list of the most commonly used at Fermi National Accelerator Laboratory property located in Batavia, IL and at Sanford Underground Research Facility (SURF) located in City of Lead SD. The appendix shall be utilized to establish code of record. The appendix also incorporates by reference the codes and standards into the FESHM Chapters. This chapter shall be reviewed on an annual basis by the AHJs and SMEs or designee from the projects and listed subcommittees along with the representative of ES&H Division.

5.0 REFERENCES

- Title 10 CFR Part 851, Worker Safety & Health Program
- DOE Order 413.3B, Chg 6, Program and Project Management for the Acquisition of Capital Assets
- DOE Order 420.1C, Chg 3, Facility Safety
- DOE Order 440.1B, Chg 4, Worker Protection Program for DOE (including NNSA) Federal Employees
- DOE Order 473.1A, Physical Protection Program
- DOE Guide 420.1-1A, Nonreactor Nuclear Safety Design Guide for use with DOE Order 420.1C, Facility Safety
- DOE Standard 1066, Fire Protection
- DOE Standard 1090, Hoisting & Rigging
- DOE Standard 1189, Integration of Safety into the Design Process

6.0 TECHNICAL APPENDIX – APPLICABLE CODES & STANDARDS

This appendix defines the applicable codes and standards at Fermilab and at DOE Leased Space.

- American Disabilities Act of 1968
 - American Architectural Barriers Act (ABA)
- American National Standard Institute (ANSI) Health Physics Society (HPS)
 - ANSI/ISA 7.0.01, Quality Standard for Instrument Air, 1996
 - ANSI A17.1, Safety Code for Elevators and Escalators, 2019
 - ANSI A17.3, Safety Code for Existing Elevators & Escalators, 2020
 - ANSI/HPS N13.1, Sampling & Monitoring Releases of Airborne Radioactive Substance from Stack & ducts of Nuclear Facilities, 2021
 - ANSI/HPS N43.2, Radiation Safety for X-ray Diffraction & Fluorescence Analysis Equipment, 2021
 - ANSI/HPS N43.3, For General Radiation Safety Standard Installations Using Non-Medical X-Ray & Sealed Gamma-Ray Sources, 2008
 - ANSI N14.6, Radioactive Materials, Special Lifting Devices for Shipping Containers Weighing 10,000 pounds (4,500 kg) or more
 - ANSI N278.1, Self-Operated & Power-Operated Safety Related Valves Functional Specification Standard, 1992
 - ANSI N322D, Information Technology – Card Durability, 2015
 - ANSI N323D, Installed Radiation Protection Instrumentation, 2002
 - ANSI O1.1, Woodworking Machinery
 - ANSI Z49.1, Cutting, Welding, and Hot Work, 2021
 - ANSI Z358.1, American National Standard for Emergency Eyewash & Shower Equipment, 2014
 - ANSI Z136.1, Safe Use of Lasers, 2014
 - ANSI Z359.1, Safety Requirements for Personal Fall Arrest Systems, Subsystems and Components, 2020
 - ANSI/UL 723, Standard for Test for Surface Burning Characteristics at Building Materials, 2018
 - ANSI/UL 94, Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, 2022
- American Society of Mechanical Engineering (ASME) (Latest Edition)
 - ASME BTH-1, Design of Below-the-Hook Lifting Devices
 - ASME BPVC, Boiler & Pressure Vessel Code,
 - Section II - Materials
 - Section IV - Rules for Construction of Heating Boilers
 - Section V - Nondestructive Examination
 - Section VI - Recommended Rules for the Care and Operation of Heating Boilers

Section VII - Recommended Guidelines for the Care of Power Boilers

Section VIII - Rules for Construction of Pressure Vessels

Section IX - Welding and Brazing Qualifications

Section X - Fiber-Reinforced Plastic Pressure Vessels

Section XI - Rules for Inservice Inspection of Nuclear Power Plant Components

Section XII - Rules for the Construction and Continued Service of Transport
Tanks

Section XIII - Rules for Overprotection

ASME B20.1, Safety Standard for Conveyors & Related Equipment

ASME B30.5, Mobile and locomotive truck cranes

ASME B30.9, Slings

ASME B30.10, Hooks

ASME B30.11, Monorails and Underhung Cranes

ASME B30.16, Overhead Hoists (Underhung)

ASME B30.17, Overhead and Gantry Cranes (Top Running Bridge, Single Girder,
Underhung Hoist)

ASME B30.2, Overhead and gantry cranes

ASME B30.7, Winches

ASME B30.20, Below the hook lifting devices

ASME B30.21, Manually Lever Operated Hoists

ASME B30.22, Articulating Boom Cranes

ASME B30.23, Personnel Lifting Systems

ASME B30.26, Rigging Hardware

ASME B30.30, Ropes

ASME B31.1, Power Piping

ASME B31.3, Process Piping

ASME B31.4, Pipeline Transportation Systems for Liquids & Slurries

ASME B31.5, Refrigeration Piping & Heat Transfer Components

ASME B31.8, Gas Transmission & Distribution Piping Systems

ASME B31.8S, Managing Systems Integrity of Gas Pipelines

ASME B31G, Manual for Determining the Remaining Strength of Corroded Pipelines

ASME B30.2, Overhead & Gantry Cranes

ASME B73.1, Specification for Horizontal End Suction

ASME B73.2, Specifications for Vertical In-Line Centrifugal Pumps for Chemical
Process

ASME D 2859, Standard Test Method for Ignition Characteristics of Finished Textile
Floor Covering Materials

ASME NOG-1, Rules for Construction of Overhead & Gantry Cranes

ASME NUM-1, Rules for Construction of Cranes, Monorails, & Hoists

ASME Y14.1, Drawing Sheet Size and Format

ASME Y14.2, Line Conventions and Lettering

ASME Y14.3, Orthographic and Pictorial Views

ASME Y14.5, Dimensioning and Tolerancing

ASME Y14.6, Screw Thread Representation

- ASME Y14.8, Castings, Forgings, and Molded Part
- ASME Y14.24, Types and Applications of Engineering Drawings
- ASME Y14.31, Unidimensional Drawings
- ASME Y14.34, Associated Lists
- ASME Y14.35, Revision of Engineering Drawings and Associated Documents
- ASME Y14.36, Surface Texture Symbols
- ASME Y14.37, Product Definition for Composite Parts
- ASME Y14.38, Abbreviations and Acronyms for Use in Product Definition and Related Documents
- ASME Y14.41, Digital Product Definition Data Practices
- ASME Y14.43 Dimensioning and Tolerancing Principles for Gages and Fixtures
- ASME Y14.44, Reference Designations for Electrical and Electronics Parts and Equipment
- ASME Y14.46, Product Definition for Additive Manufacturing
- ASME Y14.47, Model Organization Practices
- ASME Y14.5 Geometric Dimensioning & Tolerances
- ASME Y14.100 Engineering Drawing Practices
- American Petroleum Institute (API)
 - API 520, Sizing, Selection, and Installation of Pressure-Relieving Systems
 - API 521, Guide for Pressure-Relieving and Depressuring Systems
 - API 620, Design & Construction of Large, Welded, Low-Pressure Storage Tanks, 2018
 - API 650, Welded Tanks for Oil Storage, 2020
- American Society of Heating, Refrigerating, & Air Conditioning Engineers (ASHRAE)
 - ASHRAE, Handbook, Fundamental, 2021
 - ASHRAE Handbook - HVAC Systems & Equipment, 2020
 - ASHRAE Handbook - HVAC Applications, 2019
 - ASHRAE Handbook - Refrigeration, 2018
 - ASHRAE, Standard 15, Safety Standard for Refrigeration Systems, 2019
 - ASHRAE, Standard 62, Ventilation for Acceptable Indoor Air Quality, 2022
 - ANSI/ASHRAE/IES Standard 90.2-2018 Energy Efficient Design of Low-Rise Residential Buildings
 - ASHRAE/ANSI 111-2008 Testing, Adjusting, and Balancing of Building HVAC Systems
 - ASHRAE/ANSI/IES 100-2018 Energy Efficiency in Existing Buildings
 - ASHRAE/ANSI 209-2018 Energy Simulation Aided Design for Buildings except Low-Rise Residential Buildings

ASHRAE/ANSI/IES 202-2018 Commissioning Process for Buildings and Systems

ASHRAE/ANSI 90.4-2019 Energy Standard for Data Centers

ASHRAE/ANSI/IES 90.1-2019 Energy Standard for Buildings Except Low-Rise Residential Buildings

ASHRAE/ANSI 135-2020 BACnet Data Communication Protocol for Building Automation and Control Networks

ASHRAE/ANSI 183-2007 Peak Cooling and Heating Load Calculations in Buildings Except Low-Rise Residential Buildings

ASHRAE/ANSI 55-2020 Thermal Environmental Conditions for Human Occupancy

ASHRAE/ANSI 188-2021 Legionellosis: Risk Management for Building Water Systems

- American Society for Testing and Material (ASTM)
ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials, 2021
- American Welding Society
AWS D1.1, Welding Steel
AWS D1.2, Structural Welding Code - Aluminum
AWS D1.3, Structural Welding Code - Sheet Steel
AWS D1.6, Structural Welding Code – Stainless Steel
AWS D1.9, Titanium Structural Welding
AWS D9.1, Sheet Metal Welding Code
AWS QC-1, Specification for Qualification & Certificate of Welding Inspectors
- American Water Works Association
AWWA D100-11, Welded Carbon Steel Tanks for Water Storage, 2011
AWWA M31, Distribution System Requirements for Fire Protection
- Code of Federal Regulations (CFR)
Title 10 CFR Part 110, Export & Import of Nuclear Equipment & Material
Title 10 CFR Part 435, Energy Efficiency Standards for the Design & construction of New Federal Low-rise Residential Buildings
Title 10 CFR Part 436, Federal Energy Management & planning Programs
Title 10 CFR Part 708, DOE Contractor Employee Protection Program
Title 10 CFR Part 709, Counterintelligence Evaluation Program
Title 10 CFR Part 719, Contractor Legal Management Requirements
Title 10 CFR Part 733, Allegations of Research Misconduct
Title 10 CFR Part 781, DOE Patent Licensing Regulations
Title 10 CFR Part 784, Patent Waiver Regulation
Title 10 CFR Part 810, Assistance to Foreign Atomic Energy Activities
Title 10 CFR Part 840, Extraordinary Nuclear Occurrences

Title 10 CFR Part 850, Chronic Beryllium Disease Prevention Program
Title 10 CFR Part 851, Worker Safety & Health Program
Title 10 CFR Part 1008, Records Maintained on Individuals (Privacy Act)
*Title 29 CFR Part 1910, Safety & Health Regulations for General Industry
*Title 29 CFR Part 1926, Safety & Health Regulations for Construction
 * *With the exception for exposure limits will use American Conference of Governmental Industrial Hygienists (ACGIH) 2016 Version Threshold Limit Values (TLV) for chemical substance, physical agents, and biological exposure indices*
48 CFR Part 970, Section 9710.5223-1, Integration of Environment, Safety & Health into Working Planning & Execution
49 CFR 173.34, DOT Cylinder Maintenance, Retest and Certification Requirements

- Compressed Gas Association (CGA)
 - S-1.1, Pressure Relief Device Standards Part 1 Cylinders for Compressed Gases
 - S-1.2, Pressure Relief Device Standards Part 2 Cargo and Portable Tanks
 - S-1.3, Pressure Relief Device Standards Part 3 Compressed Gas Storage Containers
- Federal Emergency Management Agency (FEMA)
 - FEMA 453, Safe Rooms and Shelters Protecting People Against Terrorist Attacks
 - Publication P-431, Tornado Protection: Selecting Refuge Area in Buildings
- Fermilab ES&H Manual (FESHM) Specific Chapter on accepting exceptional equipment
 - FESHM Chapter 2110, Ensuring Equivalent Safety Performance when Using International Codes & Standards
 - FESHM Chapter 5031, Pressure Vessels
 - FESHM Chapter 5031.1, Piping Systems
 - FESHM Chapter 5031.5, Low Pressure Vessels
 - FESHM Chapter 5031.6, Niobium SRF Cavity
 - FESHM Chapter 5031.7 Cryostat Membrane Vessels
 - FESHM Chapter 5031.8, Boilers
 - FESHM Chapter 5032, Cryogenic System Review
 - FESHM Chapter 5032.1, Liquid Nitrogen Dewar Installation Rules
 - FESHM Chapter 5032.2, Guidelines for the Design, Fabrication, Testing, Installation, and Operation of LH₂ Targets
 - FESHM Chapter 5033, Vacuum Vessel Safety
 - FESHM Chapter 5033.1, Vacuum Window Safety
 - FESHM Chapter 5035, Mechanical Refrigeration Systems
 - FESHM Chapter 5100, Structural Safety
 - FESHM Chapter 6020.3, Storage & Use of Flammable Gases
 - FESHM Chapter 10100, Overhead Cranes and Hoists
 - FESHM Chapter 10110, Below-the-Hook Lifting Device
 - FESHM Chapter 10120, Powered Industrial Trucks
 - FESHM Chapter 10130, Slings and Rigging Hardware
 - FESHM Chapter 10200, Lift Plans
 - FESHM Chapter 10210, Equipment Transportation
- Illinois Administrative Code & Illinois Complied Statues

Title 17 Conservation

Part 525 Nuisance Wildlife Control Permits

Part 3700 Construction in Floodways of Rivers, Lakes, and Streams

Part 3702 Construction and Maintenance of Dams

Part 3704 Regulation of Public Waters

Part 3708 Floodway Construction in Northeastern Illinois

Title 29 Emergency Services, Disasters, & Civil Defense

Subchapter F titled Chemical Safety

Title 41 Fire Protection

Part 100 Fire Prevention & Safety

Title 77 Public Health

Part 830 Structural Pest Control Code

Part 855 Asbestos Abatement for Public & Private Schools, & Commercial & Public Buildings in Illinois

Part 890 Illinois Plumbing Code

Part 900 Drinking Water

Part 905 Private Sewage Disposal Code

Part 920 Water Well Construction Code

Part 925 Well Pump Installation

Chapter 210 ILCS 125 Swimming Facility Act

Chapter 225 ILCS 207 Commercial and Public Building Asbestos Abatement Act

• International Code Council

International Building Code, 2021

International Existing Building Code, 2021

International Fire Code, 2021 (*Except for quantities and limitations for Hazardous Materials including control/protection levels found in NFPA 1, Chapter 60 and NFPA 400; Flammable/Combustible liquids found in NFPA 30; and LP-gas storage or utilization system found NFPA 58 or NFPA 59*)

International Fuel Gas Code, 2021 (*Also reference NFPA 54, National Fuel Code*)International Mechanical Code, 2021 (*Except for the placement of in-duct smoke detectors, reference NFPA 90A*)International Plumbing Code, 2021 (*Also reference Illinois Part 890 Plumbing Code*)

• International Electrotechnical Commission (IEC)

IEC 61010-1 Safety Requirements for Electrical Equipment for Measurement Control & Laboratory Use – Part 1: General Requirements

IEC 61508, Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems

IEC 61511, Functional safety – Safety instrumented systems for the process industry Sector

• Institute of Electrical & Electronics Engineers (IEEE)

IEEE 315, Graphics Symbols for Electrical Diagrams

• International Organization for Standardization (ISO)

ISO 14644-1, Cleanrooms & Associated Controlled Environments – Part 1:
Classification of Air Cleanliness by Particle Concentration

- International Society of Automation (ISA)
 - ISA 5.1, Instrumentation Symbols & Identification
 - ISA 5.4, Instrument Loop Diagrams
 - ISA S20, Specifications Forms for Process Measurement & Control Instruments, Primary & control Valves
- International Window Cleaning Association
 - I-14 IWCA Window Cleaning Safety Standard (Replaced ANSI 39.1)
- National Board of Boiler & Pressure Vessel Inspectors
 - NBIC Inspection Code, 2021
- National Fire Protection Association (NFPA)
 - NFPA 1, Fire Code, 2021
 - NFPA 2, Hydrogen Technologies Code, 2020
 - NFPA 3, Standard for Commissioning of Fire Protection and Life Systems, 2021
 - NFPA 4, Standard Integrated Fire Protection & Life Safety Systems Testing, 2021
 - NFPA 10, Standard for Portable Fire Extinguishers, 2022
 - NFPA 13, Automatic Sprinkler Systems, 2022
 - NFPA 14, Standard for the Installation of Standpipe & Hose Systems, 2019
 - NFPA 15, Fixed Water Spray Systems, 2022
 - NFPA 17A, Wet Chemical Extinguishing Systems, 2021
 - NFPA 24, Standard for the Installation of Private Fire Service Mains & Their Appurtenance, 2022
 - NFPA 25, Inspection and Testing of Fire Suppression Systems, 2020
 - NFPA 30, Flammable and Combustible Liquids Code, 2021
 - NFPA 54, National Fuel Code, 2021
 - NFPA 58, Liquefied Petroleum Gas Code, 2020
 - NFPA 70, National Electrical Code, 2020
 - NFPA 70E, Standard for Electrical Safety in the Workplace, 2015
 - NFPA 72, National Fire Alarm and Signaling Code, 2022
 - NFPA 75, Standard for the Fire Protection of Information Technology Equipment, 2020
 - NFPA 80, Standard for Fire Doors & Other Opening Protectives, 2022
 - NFPA 86, Standard for Ovens & Furnaces, 2023
 - NFPA 90A, Standard for the Installation of Air-Conditioning & Ventilating Systems, 2021 (*NFPA should take precedence over IMC on induct smoke placement*)
 - NFPA 90B, Standard for the Installation of Warm Air Heating & Air-Conditioning
 - NFPA 92, Standard for Smoke Control Systems, 2021
 - NFPA 96, Standard for Ventilation Control of Commercial Cooking Operations

- NFPA 101, Life Safety Code, 2021
- NFPA 221, Standard for High Challenge Fire Walls, Fire Walls & Fire Barrier Walls, 2021
- NFPA 253, Standard Method of Test for Critical Radiant Flux of Floor Covering System Using Radiant Heat Energy Source, 2023
- NFPA 265, Standard Methods of Tests for Evaluating Room Fire Growth Contribution of Textile Expanded Vinyl Wall Covering on Full Height Panels and Walls, 2019
- NFPA 286, Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth, 2019
- NFPA 318, Standard for the Protection of Semiconductor Fabrication Facilities, 2022
- NFPA 400, Hazardous Materials Code, 2022
- NFPA 520, Standard on Subterranean Spaces, 2021
- NFPA 720, Standard for the Installation of Carbon Monoxide (CO) Detection & Warning Systems, 2015
- NFPA 730, Guide for Premises Security, 2020
- NFPA 750, Water Mist Fire Protection Systems, 2023
- NFPA 780, Standard for the Installation of Lightning Protection Systems, 2023
- NFPA 855, Standard for the Installation of Stationary Energy Storage Systems, 2020
- NFPA 2001, Clean Agent Fire Extinguishing Systems, 2022
- National Institute of Building Sciences for construction
 - National BIM Standard
 - National CAD Standard
 - South Dakota Office of Risk Management
 - Intergovernmental Agreement with South Dakota Science & Technology Authority (SDSTA) the entity that operates and manages SURF.
 - Underwriters Laboratories, Inc.
 - UL 61010, Safety requirements for electrical equipment for measurement, control, and laboratory use
 - UL 2050, National Industrial Security Systems
 - UL 634, Standard for Connectors and Switches for Use with Burglar-Alarm Systems
 - UL 471, Commercial Refrigerators and Freezers