10 CFR 851 Pressure Systems Variance

Roza Doubnik and Lidija Kokoska

Engineering Week 2024

19 February 2024

On behalf of MSS and CSS

Mechanical Safety Subcommittee Chair - Roza Doubnik

Cryogenic Safety Subcommittee Chair – Mike Zuckerbrot

MSS Pressure and Vacuum Systems Panel Chair - Lidija Kokoska

Gratitude to Amber Kenney, Jim Niehoff and Mike Andrews for their outstanding leadership in spearheading the FRA variance submission, along with heartfelt appreciation to all team members who have supported this endeavor.

General Information

Title 10 Code of Federal Regulations (CFR) Part 851 - Worker Safety and Health Program **(10 CFR 851)**

10 CFR 851 is a law.

It is a regulation issued by the United States Department of Energy (DOE) under Title 10 of the Code of Federal Regulations (CFR).

This regulation specifically addresses worker safety and health requirements for DOE contractors and subcontractors involved in the operation of DOE-owned or -leased facilities.

It establishes the safety standards and procedures that must be followed to ensure the protection of workers at these facilities.

Violations of 10 CFR 851 can result in penalties and other enforcement actions by the DOE.

Bottom Line Up Front (BLUF)

- FRA is requesting a permanent pressure variance for a process to accept:
  - International Codes/Standards for pressure equipment,
- FRA has developed a process that will confirm a level of safety equivalent to or greater than that required by the ASME BPVC
- The Office of Science's mission includes International Partnerships that do not follow ASME
- 10 CFR Part 851 currently limits the lab's ability to utilize non-ASME pressure equipment with equivalent protection

Why

- The current **10 CFR Part 851** requires adherence to the set of codes under ASME BPVC and **does not recognize the use of international codes in the design and construction of pressure equipment**
- Fermilab is upgrading its accelerator complex to provide a minimum one-megawatt proton beam to develop and support a world-class neutrino program
- One-of-a-kind accelerator and experimental detectors are required
- Development of such equipment with international **partners necessitates the use of international design and safety codes**
- Several **international partners have already received funding to begin the process** of upgrading the Fermilab accelerator complex

How (Acceptance of Internationally Compliant Equipment)

- Utilizing FESHM Chapter 2110 titled *Ensuring "As Safe and Healthful As" Performance when Using International Codes or Standard for Equipment*
  - Development of an International code evaluation (White Paper)
    - Identify gaps which will require further engineering analysis
    - Shall incorporate the seven (7) equivalency attributes including the sub-attributes in the review process:
      - (A) material
      - (B) code design
      - (C) fabrication
      - (D) examination
      - (E) testing
      - (F) over-pressure protection
      - (G) inspections and certifications
- Development of an Engineering Note that will document International Compliance and reference the white paper which will be reviewed and accepted by qualified engineer
- This will allow FRA to accept/operate International pressure equipment

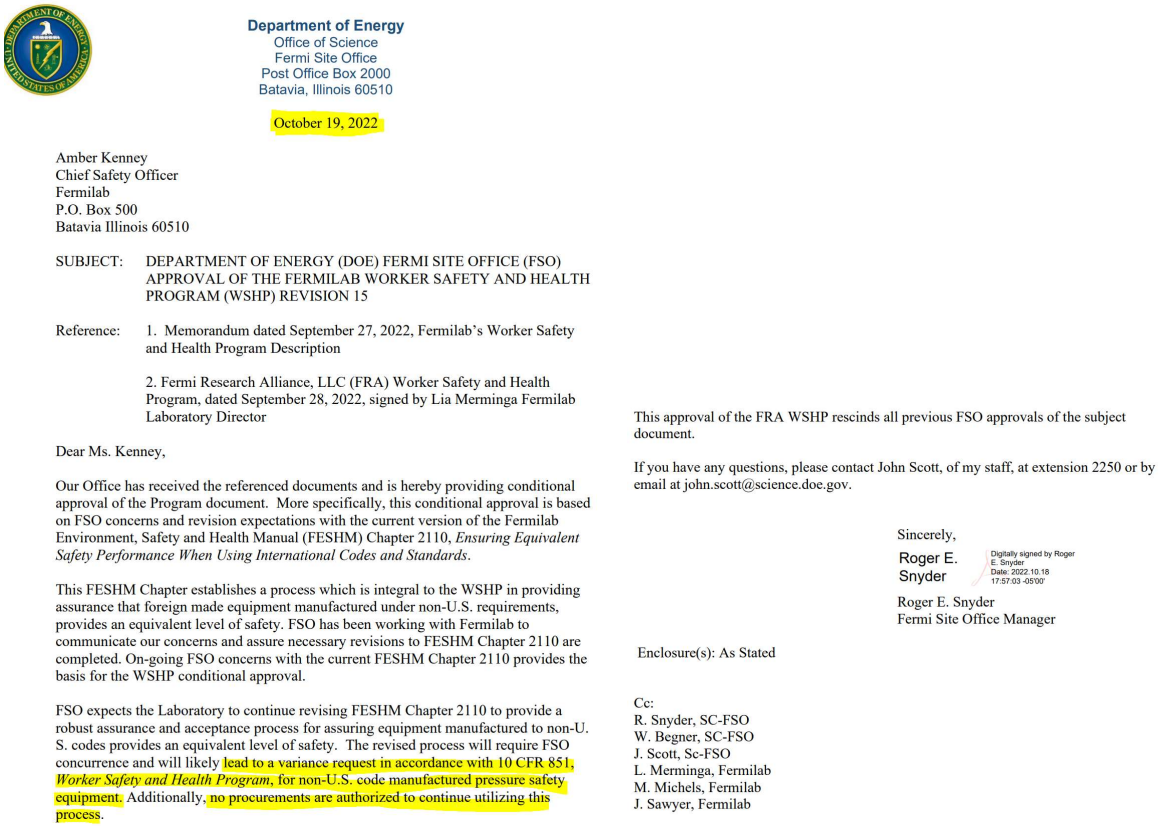
How (Acceptance of non-Code compliant, Fermilab & In-Kind-Contribution legacy pressure equipment)

- Utilize FESHM Chapters 5031 *Pressure Vessel* and 5031.1 *Pressure Piping* processes to validate compliance with “As Safe and Healthful As”
  - Complete an extended Engineering Note
    - Incorporate the seven (7) equivalency attributes, the sub-attributes
    - Supplemental engineering analysis shall be completed:
      - Reason for Exception
      - What-if Analysis
      - Hazard Analysis
      - Failure Mode Effects Analysis
      - Compensatory Measures
  - Mechanical Safety Subcommittee (MSS) Chair and Cryogenic Safety Subcommittee (CSS) Chair shall convene a panel of qualified engineers to review and approve the Engineering Note
  - The Associated Laboratory Director or Project Manager shall ensure that required corrective, preventive, and remedial actions are implemented and tracked.

Code Clarification

- 10 CFR Part 851 references ASME BPVC 2015 version
- Review of Fermi Research Alliance "*FRA Permanent Pressure Variance Request for 10 CFR 851" Rev. 23 May 2023 Report Number PRE-L-01 Rev.0* Report:
  - Paragraph 4.2.1, page 8, entitled "ASME Boiler & Pressure Vessel Code" and the Appendix A, page 24, entitled "Overview of ASME Boiler and Pressure Vessel Codes (BPVC)" includes a reference to ASME XIII titled "Overpressure Protection"
  - ASME XIII is currently not identified in 10 CFR Part 851
  - ASME XIII was first published in 2021
- What version of ASME should be utilized in reference to this variance?

Oct. 19, 2022 – No Procurements are Authorized for non-US Codes Manufactured Pressure Safety Equipment.



Department of Energy
Office of Science
Fermi Site Office
Post Office Box 2000
Batavia, Illinois 60510

October 19, 2022

Amber Kenney
Chief Safety Officer
Fermilab
P.O. Box 500
Batavia Illinois 60510

SUBJECT: DEPARTMENT OF ENERGY (DOE) FERMI SITE OFFICE (FSO) APPROVAL OF THE FERMILAB WORKER SAFETY AND HEALTH PROGRAM (WSHP) REVISION 15

Reference: 1. Memorandum dated September 27, 2022, Fermilab's Worker Safety and Health Program Description

2. Fermi Research Alliance, LLC (FRA) Worker Safety and Health Program, dated September 28, 2022, signed by Lia Merminga Fermilab Laboratory Director

Dear Ms. Kenney,

Our Office has received the referenced documents and is hereby providing conditional approval of the Program document. More specifically, this conditional approval is based on FSO concerns and revision expectations with the current version of the Fermilab Environment, Safety and Health Manual (FESHM) Chapter 2110, *Ensuring Equivalent Safety Performance When Using International Codes and Standards*.

This FESHM Chapter establishes a process which is integral to the WSHP in providing assurance that foreign made equipment manufactured under non-U.S. requirements, provides an equivalent level of safety. FSO has been working with Fermilab to communicate our concerns and assure necessary revisions to FESHM Chapter 2110 are completed. On-going FSO concerns with the current FESHM Chapter 2110 provides the basis for the WSHP conditional approval.

FSO expects the Laboratory to continue revising FESHM Chapter 2110 to provide a robust assurance and acceptance process for assuring equipment manufactured to non-U.S. codes provides an equivalent level of safety. The revised process will require FSO concurrence and will likely lead to a variance request in accordance with 10 CFR 851, *Worker Safety and Health Program*, for non-U.S. code manufactured pressure safety equipment. Additionally, no procurements are authorized to continue utilizing this process.

This approval of the FRA WSHP rescinds all previous FSO approvals of the subject document.

If you have any questions, please contact John Scott, of my staff, at extension 2250 or by email at john.scott@science.doe.gov.

Sincerely,

Roger E. Snyder

Digitally signed by Roger E. Snyder
Date: 2022.10.18 17:57:03 -05'00'

Roger E. Snyder
Fermi Site Office Manager

Enclosure(s): As Stated

Cc:
R. Snyder, SC-FSO
W. Begner, SC-FSO
J. Scott, Sc-FSO
L. Merminga, Fermilab
M. Michels, Fermilab
J. Sawyer, Fermilab

…lead to a variance request in accordance with 10 CFR 851, Worker Safety and Health Program, for non-U.S. code manufactured pressure safety equipment.

Fermilab

Memo to all engineers 11.14.2022.

Fermi National Accelerator Laboratory — Fermilab

Memorandum

Date: 11/14/2022

To: All Engineers

From: Amber Kenney, Mayling Wong-Squires

Re: Pressure systems variance to 10 CFR 851

Mayling Wong-Squires
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Amber M. Kenney
ES&H Director
ES&H Division
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Office: 630.840.2977
tamber@fnal.gov

Dear colleagues,

A lot has been changing at Fermilab in the last couple of years including many changes related to ES&H expectations. One area to clarify is around pressure systems designed and constructed to non-ASME codes.

10 CFR 851 incorporates many standards by reference which drive the Fermilab Worker Safety and Health Program (WSHP). This program document is high-level and is implemented via the Fermilab ES&H Manual (FESHM). FESHM Chapter 2110 established a mechanism for Fermilab to assess non-US codes for equivalent levels of safety as compared to the US counterpart. This process has been used for many years and approved by DOE at the time, through our WSHP, to enable the use of equipment constructed to non-US codes.

However, earlier this year, DOE brought to our attention that this process is not compliant for pressure systems because the ASME code does not explicitly allow it. This puts us in a non-compliant situation and challenges the arrangements already in place with international partners planning to contribute pressure systems designed and constructed to their 'home' code.

In order to avoid significant disruption to our international projects, a variance to 10 CFR 851 is being sought. This will mitigate the non-compliant situation. Guidance from our DOE Fermi Site Office (FSO) is that we submit this variance no later than 12/31/2022, update FESHM 2110 to address a few shortcomings (summarized below) and implement the revised process in FY23. This allows for our partners to continue on their current paths for pressure equipment destined for Fermilab (near or far).

Nevertheless, the DOE FSO has also communicated to us that FRA specifically procuring non-US pressure systems is not compliant with 10 CFR 851.27. If FRA is purchasing pressure systems, those systems must conform to ASME. If you have non-ASME procurements in process with a scheduled delivery date before 1 October 2023, please notify us immediately. Our goal is that the approved variance will enable these procurements in the future. But until then, they are prohibited. Pressure systems (vessels and piping) designed to non-US code that are currently in the procurement process should be

Fermi National Accelerator Laboratory — Fermilab

modified to ensure ASME compliance. We can work with you to understand how to move forward with the procurement and how this modification will affect the procurement's technical issues, any change in cost and any change in schedule.

Please note, 10 CFR 851 allows design, construction, and/ or purchase of non-ASME equipment when there is no applicable code because of pressure range, vessel geometry, use of special materials, etc. This equipment would follow our typical exceptional vessel process defined in FESHM.

Jim Niehoff and Mike Andrews are leading a team of engineers to develop a variance and revise FESHM in order to meet the DOE's timeline.

Moving forward, Mayling and I are committed to our success and will be meeting on a regular basis to ensure communication. We appreciate your attention to this matter. If you have any questions, please feel free to contact one of us, Jim or Mike.

Thank you,
Amber & Mayling

FESHM 2110 issues and actions

Issue	Action
Chapter mentions cost savings as a driver to use non-US codes	Remove all mentions of cost/money from chapter
Chapter mentions cost savings as a driver to use non-US codes	Remove all mentions of cost/money from chapter
No seismic analyses for IL or SD	Consider blanket/site analyses for IL and SD
No criteria for "as safe and healthful"	Include criteria for "as safe and healthful"
Code analyses do not require periodic review	Establish a periodic review of white papers and codes, update as needed

Fermi Research Alliance, LLC (FRA) has requested a Title 10 Code of Federal Regulations (CFR) Part 851 - Worker Safety and Health Program - Pressure Systems Variance – 2.13.2024 FRA Notification.

Reason for variance:

The Department of Energy (DOE) *Worker Safety and Health Program* (10 CFR 851) requires contractors to comply with codes and standards incorporated by reference, including the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel and Piping Codes.

Unlike other national consensus codes, **ASME does not include an explicit process** for the Authority Having Jurisdiction (AHJ) and local engineering judgment **to determine an equivalent level of safety** when constructing pressure equipment to **non-ASME Codes**.

This combined with the narrow exception process in §851.27 Materials incorporated by reference, portion (d) and Appendix A Worker Safety and Health Functional Areas, portion 4 Pressure Safety to Part 851 resulted in Fermilab seeking a variance to accept pressure systems that do not fully comply with ASME codes.

These systems are increasingly important for working with international partners who contribute significantly to scientific experiments and vendors that provide specialized capabilities and equipment.

NOTICE OF REQUEST FOR VARIANCE FROM SAFETY

As a U.S. Department of Energy site, this job site is subject to the Worker Safety and Health Program established by 10 C.F.R. 851. Fermi Research Alliance, LLC ("FRA") is a management and operations contractor for the Department of Energy. FRA has requested a variance from certain requirements of 10 C.F.R. 851.

Variance requested:

10 CFR 851.23 (a)(3) incorporates 29 CFR 1910 Occupational Safety and Health Standards and 10 CFR 851.27 (d)(1) and (2) incorporates American Society of Mechanical Engineers (ASME) Boilers and Pressure Vessel Codes (BPVC) 2015 Edition and ASME B31 codes for pressure piping. The specific portions of 10 CFR 851 from which a variance is being sought are:

- The following sections of § 851.23(a)(3) Title 29 CFR, Part 1910, "Occupational Safety and Health Standards":
  - 29 CFR § 1910.103(b)(1)(i) - Hydrogen, Gaseous Hydrogen Systems, Design, Containers; subparagraph 29 CFR § 1910.103(b)(1)(i)(a)(1).
  - 29 CFR § 1910.103(c)(1)(i) - Hydrogen, Liquefied Hydrogen Systems, Design, Containers; subparagraph 29 CFR § 1910.103(c)(1)(i)(a).
  - 29 CFR § 1910.104(b)(4)(ii) - Oxygen, Bulk Oxygen Systems, Storage Containers, Construction – Liquid; subparagraph 29 CFR § 1910.104(b)(4)(ii).
  - 29 CFR § 1910.104(b)(4)(iii) - Oxygen, Bulk Oxygen Systems, Storage Containers, Construction – Gaseous; subparagraph 29 CFR § 1910.104(b)(4)(iii)(a).
  - 29 CFR § 1910.106(b)(1)(iv) - Flammable Liquids, Tank Storage, Design and Construction of Tanks, Low Pressure Tanks; subparagraph 29 CFR §
  - 1910.106(b)(1)(iv)(b)(2)
  - 29 CFR § 1910.106(b)(1)(v) - Flammable Liquids, Tank Storage, Design and Construction of Tanks, Pressure Vessels; subparagraph 29 CFR § 1910.106(b)(1)(v)(b).
  - 29 CFR § 1910.169(a)(2) - Air Receivers, General Requirements, New and Existing Equipment; subparagraph 29 CFR § 1910.169(a)(2)(i)
- The following portions of § 851.27 Materials incorporated by reference and Appendix A (c) Pressure Safety
  - ASME Boilers and Pressure Vessel Codes (BPVC) as follows:
    - (ii) BPVC.II.A-2015, *Section II - Materials, Part A - Ferrous Material Specifications (Beginning to SA-450),* 2015 edition, issued July 1, 2015; IBR approved for appendix A, section 4, Pressure Safety;
    - (iii) BPVC.II.A-2015, *Section II - Materials, Part A - Ferrous Material Specifications (SA-451 to End),* 2015 edition, issued July 1, 2015; IBR approved for appendix A, section 4, Pressure Safety;
    - (iv) BPVC.II.B-2015, *Section II - Materials, Part B - Nonferrous Material Specifications,* 2015 edition, issued July 1, 2015; IBR approved for appendix A, section 4, Pressure Safety;
    - (v) BPVC.II.C-2015, *Section II - Materials, Part C - Specification for Welding Rods; Electrodes, and Filler Metals;* 2015 edition, issued July 1, 2015; IBR approved for appendix A, section 4, Pressure Safety;
    - (vi) BPVC.II.D.C-2015, *Section II - Materials, Part D - Properties (Customary);* 2015 edition, issued July 1, 2015; IBR approved for appendix A, section 4, Pressure Safety
    - (vii) BPVC.II.D.M-2015, *Section II - Materials, Part D - Properties (Metric);* 2015 edition, issued July 1, 2015; IBR approved for appendix A, section 4, Pressure Safety;
    - (xx) BPVC.IV-2015, *Section IV, Rules for Construction of Heating Boilers;* 2015 edition, issued July 1, 2015; IBR approved for appendix A, section 4, Pressure Safety;
    - (xxi) BPVC.V-2015, *Section V, Nondestructive Examination;* 2015 edition, issued July 1, 2015; IBR approved for appendix A, section 4, Pressure Safety;
    - (xxii) BPVC.VI-2015, *Section VI, Recommended Rules for the Care and Operation of Heating Boilers;* 2015 edition, issued July 1, 2015; IBR approved for appendix A, section 4, Pressure Safety;
    - (xxiv) BPVC.VIII.1-2015, *Section VIII - Rules for Construction of Pressure Vessels, Division 1;* 2015 edition, issued July 1, 2015; IBR approved for appendix A, section 4, Pressure Safety;
    - (xxv) BPVC.VIII.2-2015, *Section VIII - Rules for Construction of Pressure Vessels, Division 2, Alternative Rules;* 2015 edition, issued July 1, 2015; IBR approved for appendix A, section 4, Pressure Safety;
    - (xxvi) BPVC.VIII.3-2015, *Section VIII - Rules for Construction of Pressure Vessels, Division 3, Alternative Rules for Construction of High Pressure Vessels;* 2015 edition, issued July 1, 2015; IBR approved for appendix A, section 4, Pressure Safety;

Date: 2/05/2024

NOTICE OF REQUEST FOR VARIANCE FROM SAFETY (continue)

(xxvii) BPVC.IX-2015, *Section–n IX - Welding, Brazing and Fusing Qualifications, Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators;* 2015 edition, issued July 1, 2015; IBR approved for appendix A, section 4, Pressure Safety;
(xxviii) BPVC.X-2015, *Section X, Fiber - Reinforced Plastic Pressure Vessels;* 2015 edition, issued July 1, 2015; IBR approved for appendix A, section 4, Pressure Safety;
(xxx) BPVC.XII-2015, *Section XII, Rules for Construction and Continued Service of Transport Tanks;* issued July 1, 2015; IBR approved for appendix A, section 4, Pressure Safety;
(xxxi) BPVC.CC.BPV-2015, *Code Cases, Boilers and Pressure Vessels;* 2015 edition, issued July 1, 2015; IBR approved for appendix A, section 4, Pressure Safety; and

- ASME B31 codes for pressure piping as follows:

(i) B31.1-2016, *Power Piping, ASME Code for Pressure Piping, B31,* issued June 30, 2016; IBR approved for appendix A, Section 4, Pressure Safety;
(ii) B31.3-2014, *Process Piping, ASME Code for Pressure Piping, B31,* issued February 27, 2015; IBR approved for appendix A, Section 4, Pressure Safety;
(iv) B31.5-2016, *Refrigeration Piping and Heat Transfer Components, ASME Code for Pressure Piping, B31,* issued June 29, 2016; IBR approved for appendix A, Section 4, Pressure Safety;
(vii) B31.9-2014, *Building Services Piping, ASME Code for Pressure Piping, B31,* issued April 28, 2014; IBR approved for appendix A, Section 4, Pressure Safety; and
(viii) B31G-2012, *Manual for Determining the Remaining Strength of Corroded Pipelines, Supplement to ASME B31 Code for Pressure Piping,* issued October 24, 2012; IBR approved for appendix A, Section 4, Pressure Safety.

The variance has been formally submitted to the Fermi Site Office – 01.19.2024.

Fermilab

Fermi National Accelerator Laboratory

January 19, 2024

Lia Merminga
Director

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USA

Office: 630.840.3211
merminga@fnal.gov

Mr. Roger Snyder
Site Office Manager
Fermi Site Office
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P. O. Box 2000
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U. S. A.

Dear Mr. Snyder,

Fermi National Accelerator Laboratory (Fermilab) is upgrading its accelerator complex to provide a minimum one-megawatt proton beam to develop and support a world-class neutrino program. The program's flagship project is the Long-Baseline Neutrino Facility and Deep Underground Neutrino Experiment (LBNF/DUNE), which, to reach its ambitious physics goals, requires completion of the Proton Improvement Plan II (PIP-II). Fermi Research Alliance (FRA), with the DOE, continues to foster the international collaboration and partnerships required to support the design and construction of LBNF/DUNE and PIP-II.

For this type of world-class global science, specialized/custom pressure equipment for superconducting accelerators and one-of-a-kind experimental detectors is required. Development of such equipment with international partners necessitates the use of international design and safety codes. Title 10 Code Federal Regulation (CFR) Part 851 requires adherence to the set of codes under American Society of Mechanical Engineers (ASME) which includes the Boiler and Pressure Vessel Code (BPVC) and ASME B31 codes for pressure piping and does not recognize the use of international codes in the design and construction of pressure equipment. FRA therefore requests a permanent variance from portions of 10 CFR Part 851, as outlined in the attached and in accordance with 10 CFR 851, Subpart D. This variance application seeks approval for FRA's process to ensure pressure equipment constructed to international codes is As Safe and Healthful As (ASAHA) equipment constructed to the ASME codes.

The attached variance is submitted for your approval. Please reach out to Marc Clay (mclay@fnal.gov) to address any questions or concerns.

Sincerely,

Lia Merminga

Digitally signed by Lia Merminga
Date: 2024.01.19 07:57:20 -06'00'

Lia Merminga
Director
Office of the Director

cc: M. Andrews, W. Begner, A. Bihary, E. Chapelle, M. Clay, B. Fleming, M. Kaducak, J. Macier, C. Mossey, J. Niehoff, R. Ray, J. Sawyer, M. Wong-Squires, J. Scott, K. Vetter

Several versions were submitted by FRA:

a. December 2022
b. May 2023
c. July 2023
d. August 2023
e. November 2023
f. January 2024

This Time it was the common effort from FRA, FSO, and EHSS-11.

The extended timeframe was partly a result of the Department of Energy (DOE) seeking a comprehensive legal solution for the entire facility complex, rather than requiring individual sites to potentially apply for variances separately.

The Pressure Variance is limited to Five Countries

This variance request is based on FRA demonstrating that the following international codes are As Safe and Healthful As (ASAHA) equipment constructed to the ASME Codes.

Country / Member Countries	Description
European Union	Pressure Equipment Directive (PED) compliant codes
Canada	Boiler, Pressure Vessel, & Pressure Piping (CSA B51:19)
United Kingdom	National Pressure Code, PD 5500
Japan	Construction Code for Pressure Vessels (CCfPV)
India	Indian Boiler Regulations (IBR)

Qualified persons[1] (Subject Matter Experts) will review the international code the equipment is constructed[2] to and determine if the codes are ASAHA to the ASME codes.

Their conclusion could be the codes are ASAHA (no further action is needed) or a recommendation for compensatory measures to achieve ASAHA.

If compensatory measures cannot be used to achieve ASAHA, either because there is no compensatory measure or it is infeasible, then the code and equipment constructed to that code, will not be utilized.

This review will be documented by a White Paper.

Once the White Paper is approved by FRA's subject matter experts (SMEs) they will submit the White Paper to the Chief Safety Officer for approval and subsequent submittal to the DOE Fermi Site Office (FSO) for notification.

FRA Permanent Pressure Variance Request for 10 CFR 851 (cont)

Background

Safety and hazard evaluations of pressure systems need to consider the consequences of a failure. Complete pressure vessel ruptures can be categorized as:

(1) blast effect due to the sudden expansion of the pressurized fluid

(2) consequential damage and injury caused by fragments if a fragmentation-type rupture occurs.

A leak failure can include a wide range of consequences, from no effect to very serious depending on the medium contained in the vessel or system (National Institute of Standards & Technology, 1990).

10 CFR 851.27(d)(1) and (2) incorporates by reference sections of the ASME BPVC and ASME B31 codes for pressure piping and does not allow conformance to an international code.

FRA has developed a process to evaluate and verify the international construction code ASAHA the requirements in 10 CFR Part 851 and provides pressure equipment in the workplace that is ASAHA workplaces with pressure equipment that is designed, fabricated, tested, and inspected by applicable ASME standards.

This variance request is based on FRA demonstrating that the following international codes are ASAHA to the ASME codes.

FRA Permanent Pressure Variance Request for 10 CFR 851 (cont)

Process

FRA will ensure ASAHA through the utilization of the steps outlined below.

The Fermilab Cryogenics and Mechanical Safety Subcommittees are comprised of SMEs in pressure safety. This ASAHA process utilizes the Cryogenics and Mechanical Safety Subcommittees to create and review a White Paper, see Figure 1 for additional details of the process.

The White Paper is a technical analysis of the ASME codes and international codes evaluating the seven attributes and sub-attributes listed below. The White Paper will include a conclusion by SMEs for each attribute and sub-attribute. When there are differences between attributes the SME will provide technical reasoning behind their conclusions and provide recommendations if needed. Their conclusion could be no further action is needed because the codes are ASAHA or a recommendation for compensatory measures.

A compensatory measure is used to correct a deficiency in the international code to ensure the equipment is ASAHA.

If compensatory measures cannot be used to achieve ASAHA, either because there is no compensatory measure or it is infeasible, then the code and equipment constructed to that code, will not be utilized.

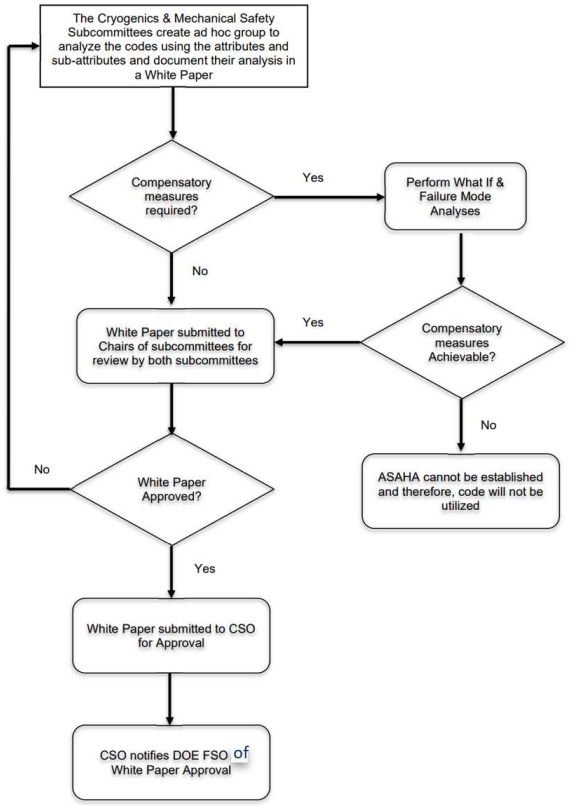

Figure 1 Process flow for accepting "as safe and healthful as" in safety performance.

FRA Permanent Pressure Variance Request for 10 CFR 851 (cont)

A White Paper will include:

(1) Abstract including the international code or standard being evaluated

(2) Placeholder for concurrence and approval signatures

(3) List of Cryogenics and Mechanical Safety subcommittee members and consultants (SMEs) and their roles

(4) Goals

(5) Technical Analysis

(6) Findings & Recommendations

(7) Conclusions

(8) References and supporting documents

(9) Period of Review

The White Paper will provide recommendations to the Chief Safety Officer and will be signed by all SMEs.

The White Paper will identify the next period of review. The review will evaluate changes to the ASME codes and the international codes.

A technical analysis will be reperformed by the SMEs commensurate with the identified impact and rerouted for approval.

The White Paper will be retained in the ES&H internal document management system.

FRA Permanent Pressure Variance Request for 10 CFR 851 (cont)

ASME Seven Attributes for Construction of Pressure Equipment

The following seven attributes will be included in the technical analysis of the White Paper.

A. Materials

B. Code Design

C. Fabrication

D. Examination

E. Testing

F. Over-Pressure Protection

G. Inspection and Certifications

The White Paper is a technical analysis of the codes utilizing the seven attributes and sub-attributes.

The following scenarios could result from the White Paper:

1) ASAHA is established between codes on all seven attributes and sub-attributes without any meaningful differences.

2) ASAHA is established between codes on all seven attributes and sub-attributes with differences addressed with a written conclusion based on technical reasoning.

3) Compensatory measures are established and implemented to address the differences between attributes and sub-attributes to achieve ASAHA.

4) ASAHA cannot be established between the codes, equipment will not be accepted or constructed, and codes will not be utilized.

FRA Permanent Pressure Variance Request for 10 CFR 851 (cont)

Compensatory measures, related to item 3, will be determined by completing additional risk analysis, such as What-if-Analysis or Failure Mode Effects Analysis.

The following is a list of potential compensatory measures:

- Proof test per ASME BPVC VIII Div. 1 UG-101.
- Borescope examination.
- Helium leak testing.
- Certified Mill Test Reports and Certificates of Conformance per published industry consensus standards.
- Material verification (e.g., X-ray fluorescence).
- Material thickness verification (e.g., ultrasonic measurement).
- Finite Element Analysis per ASME BPVC VIII Div. 2 Part 5.
- Reduced basic allowable stress or increased load factor.
  - Note: Design margin ≥ 10 against ultimate tensile strength to be applied to brittle or potentially brittle materials.
  - Note: Brittle materials exhibit elongation before rupture at less than 14% over the design temperature range.
- Reduced component pressure-temperature ratings.
- Reduced weld joint efficiency.
- Increased weld joint inspection and examination.
- Liquid Nitrogen (LN2) thermal shocking.
- Destructive testing of base material, heat-affected zones, and weld joints (e.g., Charpy impact testing).
- Non-destructive testing of material properties (e.g., measuring ferrite to ensure toughness at low temperatures in austenitic stainless steels).
- Increased failure probability included in Oxygen Deficient Hazard (ODH) analysis.
- Oxygen deficiency monitoring, activated ventilation, activated alarms, and Fermilab fire department response.
- Smoke and/or flammable gas detection monitoring and activated alarms, and Fermilab fire department response.
- Secondary barrier and/or containment (e.g., insulating vacuum jacket).
- Following American Petroleum Institute (API) Standard 510 procedure for existing vessels with minimal documentation.
- Strain gauge monitoring during testing.
- Safety Instrumented System as an additional layer of protection to pressure relief device(s).
- Locating equipment in unmanned controlled access areas.

White Paper Status and the Next Steps

The Department of Energy (DOE) enlisted the support of an ASME expert to assist with the EN White Papers.

EHSS is furnishing the initial code comparisons for the EN piping and EN vessel codes, which will serve as a benchmark for our acceptance procedures.

FRA has received draft copies of the White Paper for code comparison.

One has been evaluated and returned regarding Pressure Piping, while another is under review until February 28 for Pressure Vessels.

The following actions should entail crafting an implementation plan, detailing the required updates to FESHM Chapters.

The Variance Once Approved is Law.

Backup Slides

One – Pager Side 1

Establishing 10 CFR 851 Compliance for Non-ASME Pressure Systems

Background

Some DOE Office of Science contractors are increasingly working with international partners who make major contributions to scientific experiments (e.g., Long Baseline Neutrino Facility (LBNF) at Fermilab) and vendors that provide specialized capabilities and equipment. This equipment may be designed and constructed in accordance with non-US engineering codes (e.g., the European Pressure Equipment Directive (PED)) in the pursuit of the science mission. International pressure equipment contributions in many cases, are not able to be manufactured to ASME requirements.

10 CFR 851 DOE Worker Safety and Health requires contractors to comply with codes and standards incorporated by reference, including the American Society of Mechanical Engineers (ASME) boiler and pressure vessel and piping codes. Unlike other national consensus codes, ASME does not include an explicit process for Authority Having Jurisdiction (AHJ) and local engineering judgement to determine an equivalent level of safety. This combined with the narrow exception process in Appendix A to Part 851 (see below) will result in Fermilab seeking a variance in order to accept pressure systems designed to non-ASME codes.

Some DOE sites would benefit from a variance for pressure systems.

NREL, Pacific Northwest National Laboratory, Argonne National Laboratory, Fermilab

Existing Equipment

Short Baseline Neutrino Far Detector (ICARUS) Liquid Nitrogen phase separator, provided to Fermilab by CERN

Many sites have accepted, and operated pressure equipment designed to non-ASME codes, including some due to contributions from international partners. Fermilab, for example, has 128 items (106 provided as in-kind contributions) accepted for use on the site due to the process established in 2016 that ensured equivalent levels of safety (and approved via the Worker Safety and Health Program). This process is the basis for the request of a variance to 10 CFR 851 that will be vetted through the DOE Site Office.

This equipment has operated successfully at Fermilab and other DOE sites. Sites will consider submitting a Non-compliance Tracking System (NTS) report to notify DOE of existing equipment accepted under past practices.

ProtoDUNE – prototype detector at CERN

Path Ahead – Variance Request to 10 CFR 851 Appendix A, 4 – Pressure Safety (b)(1) and (2)

The sites listed intend to submit a variance request to the appropriate parts of 10 CFR 851 following the variance process described in Subpart D – Variances.

Each site has established a process to review and accept equipment that does not strictly satisfy ASME code requirements per 10CFR 851. Qualified engineers verify equipment that has exceptions to ASME code requirements or that is constructed to alternative standards to ASME code to ensure it is as safe and healthful as equipment constructed to ASME code.

Process criteria include:

- Structured design review by qualified personnel
- Qualified personnel and qualified procedures used to perform applicable examinations and inspections of materials, in-process fabrications, non-destructive tests, destructive tests, and acceptance tests
- Documentation including traceability and accountability
- International code evaluation, if applicable, to establish "as safe and healthful" by evaluating construction requirements to ensure equipment constructed to the non-ASME codes can be operated safely
- Additional evaluation to analyze risks and determine appropriate compensatory measures to ensure pressure systems which have exceptions to ASME requirements are as safe and healthful as equipment constructed that strictly satisfies ASME code requirements

Fermilab

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Establishing 10 CFR 851 Compliance for Non-ASME Pressure Systems

SUPPORTING INFORMATION

Appendix A to 851, 4 - Pressure Safety (c)

Exception to ASME:

When national consensus codes are not applicable (because of pressure range, vessel geometry, use of special materials, etc.), contractors must implement measures to provide equivalent protection and ensure a level of safety greater than or equal to the level of protection afforded by the ASME or applicable state or local code. Measures must include the following:

(1) Design drawings, sketches, and calculations must be reviewed and approved by a qualified independent design professional (i.e., professional engineer). Documented organizational peer review is acceptable.

(2) Qualified personnel must be used to perform examinations and inspections of materials, in-process fabrications, non-destructive tests, and acceptance test.

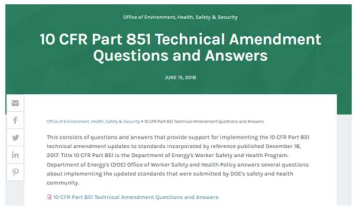
(3) Documentation, traceability, and accountability must be maintained for each unique pressure vessel or system, including descriptions of design, pressure conditions, testing, inspection, operation, repair, and maintenance.

10 CFR 851 Technical Amendment Q&A, 22(d)

Q: Research projects are increasingly becoming international in nature. May contractors use pressure equipment that conforms to the applicable harmonized EN standards of the European Pressure Equipment Directive 2014/68/EU in place of the ASME standards listed in 4(b)?

A: Contractors may apply for a variance to provide an equivalent level of safety and protection provided by the ASME standards listed in 4(b) by using the process provided in 10 CFR § 851.31, Variance process. Per 10 § 851.31(d)(2)(ii), the contactor is required to provide:

"A statement showing how the conditions, practices, means, methods, operations, or processes used or proposed to be used would provide workers a place of employment, which is as safe and healthful as would result from compliance with the standard from which a variance is sought."



10 CFR Part 851 Technical Amendment Questions and Answers

Previously approved variances that incorporate approaches to accept non-US pressure systems

LBNL - Permanent variance regarding using California OSHA in lieu of specific provisions of Title 10 CFR Part 851 for Lawrence Berkeley National Laboratory

SLAC - Permanent variance regarding using California OSHA in lieu of specific provisions of Title 10 CFR Part 851 for SLAC National Accelerator Laboratory

Fermilab

Fermilab

FESHCom Subcommittee – 8 Working Panels

Fermilab Mechanical Safety Subcomittee								
Representatives	Roza Doubnik (Chair, ND), Dave Pushka (Deputy, ND), Mark Adamowski (Secretary, LBNF)							
	APS-TD	Tony Vouris, Mike White, William Soyars, Dino Karas		Inf Serv Div (FESS)	Marcel Borcean, Brian Rubik, Noah Vollmer			
	ND	Michael Geynsiman, Roza Doubnik, Dave Pushka, Sai Manohari Kancharla		ES&H	Idris Habeeb, Tomas Fogarty			
	PPD	Erik Voirin, Parth Gandhi		DOE-FSO Observer	Matt Green, Josh Lewis			
	AD	Christine Ader, Abishek Deshpande, Nandhini Dhanaraj		LBNF	Mark Adamowski, Matt Maciazka, Markus Graf			
	OQA	Ashlee Banks		Other	Michael Zuckerbrot			
	PIP-II	Jeremiah Holzbauer, Lidija Kokoska, Christopher S. Becker, Ram Dhuley						
	Vacuum Windows	Relief Devices	Lifting and Material Handling	Pressure and Vacuum Systems	Welding and Brazing	Structures	Transportation	Prevention Through Design
Panel Chair	Christine Ader	Bill Soyars	Tomas Fogarty	Lidija Kokoska	Tony Vouris	Brian Rubik	Jeremiah Holzbauer	Roza Doubnik
Panel Members	Erik Voirin (deputy)	Noah Vollmer (deputy)	Marcel Borcean (deputy)	Noah Vollmer (deputy)	Matt Slabaugh (deputy)	Bart Lipinski (deputy)	Brian Hartsell (deputy)	TBD (deputy)
	Dave Pushka	Erik Voirin	Charlie Orozco	Dave Pushka	Dave Pushka	Chris Ader	Ladia Jakubec	Mike Zuckerbrot (CSS)
	Curtis Baffes	Greg Tatkowski	Giuseppe Gallo	Jerry Makara	Mike Jeeninga	Kathrine Laureto	Josh Kaluzny	Dave Merts (ESS)
	Nandhini Dhanaraj	Dave Hixon	Georgi Lolov	Michael Geynisman	Jamie Blowers	Arvydas Vasonis	Min Jeong Kim	Matt Slabaugh
		Aiham Al-Sabbagh	Shishir Shetty	Mark Adamowski	Luke Martin	Kevin Duel	Don Mitchel	Tom Digrazia
		Markus Graf	Idris Habeeb	Jennifer Chikelu	Ryan Mahoney	Parth Gandhi	Tom Nicol	Ashlee Banks
		Abishek Deshpande	Christopher S. Becker	Sai Manohari Kancharla	Vlad Nikolic	Sai Manohari Kancharla	Brian Niesman	Idris Habeeb
			Dino Karas	Kathrine Laureto	Aiham Al-Sabbagh	Dino Karas	Charles Orozco	
				Matt Maciazka			Vrushank Patel	
				Markus Graf			Jerel Brown	
				Ram Dhuley (PIP II rep)				
				Ashlee Banks				
				Erik Voirin				
Eng Notes Reviewed by Panel	Required	Not required	Not required	Not required	Not required	Not required	Required for Critical Transports	N/A
Participate on ORC Panel	Required	Not required	Not required	Not required	Not required	Not required	Required for Critical Transports	N/A

1. Vacuum Windows
2. Relief Devices
3. Lifting and Material Handling Equipment
4. Pressure and Vacuum Systems
5. Welding and Brazing
6. Structures
7. Transportation
8. Prevention through design

FRA Permanent Pressure Variance Request for 10 CFR 851

The United States (US) Department of Energy's (DOE) Fermi National Accelerator Laboratory (Fermilab) is upgrading its accelerator complex to provide a minimum one-megawatt proton beam to develop and support a world-class neutrino program. The program's flagship project is the Long-Baseline Neutrino Facility and Deep Underground Neutrino Experiment (LBNF/DUNE), which, to reach its ambitious physics goals, requires completion of the Proton Improvement Plan II (PIP-II). Fermi Research Alliance (FRA), with the DOE, continues to foster the international collaboration and partnerships required to support the design and construction of LBNF/DUNE and PIP-II.

The DOE's Office of High Energy Physics (HEP) and the Particle Physics Project Prioritization Panel (P5), a subcommittee of the DOE Office of Science's HEP Advisory Panel (HEPAP), have endorsed a global particle physics program. The DOE Office of International Science & Technology Cooperation and Trusted Research guides the overall Office of Science international cooperation and facilitates collaboration with international partners. Several international partners have already received funding to begin the process of upgrading the Fermilab accelerator complex.

For this type of world-class global science, specialized/custom pressure equipment for superconducting accelerators and one-of-a-kind experimental detectors is required. Development of such equipment with international partners necessitates the use of international design and safety codes. Title 10 Code Federal Regulation (CFR) Part 851 requires adherence to the set of codes under the American Society of Mechanical Engineers (ASME) which includes the Boiler and Pressure Vessel Code (BPVC) and ASME B31 codes for pressure piping and does not recognize the use of international codes in the design and construction of pressure equipment. FRA therefore requests a permanent variance from portions of 10 CFR Part 851, as outlined in this application, by 10 CFR Part 851 Subpart D. This variance application seeks approval for FRA's process to ensure pressure equipment constructed to international codes is As Safe and Healthful As (ASAHA) equipment constructed to the ASME codes.

FRA has begun constructing the portion of the LBNF/DUNE project at Sanford Underground Research Facility (SURF) in Lead, South Dakota to house the future DUNE detector modules. FRA has also begun constructing the PIP-II project, starting with the Cryogenics Plant, and soon will begin construction of a new LINAC facility and enclosure. These facilities propose to use non-ASME pressure equipment, that is constructed and provided as in-kind contributions by international partners.

FRA has developed a review and approval process to accept non-ASME pressure equipment.