NATIONAL ACCELERATOR LABORATORY

ENVIRONMENT, SAFETY & HEALTH DIVISION

Chapter 14: Pressure Systems

Alternate Pressure Systems Qualification Requirements

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1 Purpose

The SLAC pressure systems program requires all piping and pressure vessels to be designed, constructed, and installed in a safe and professional manner. (See Pressure Systems: Design and Construction Requirements.) It is expected that in most cases this will be achieved through the application of Cal/OSHA regulations (8 CCR), applicable codes and standards (including the ASME *Boiler and Pressure Vessel Code*, the ASME *Code for Pressure Piping* [B31 series], and NFPA codes), California building standards codes (mechanical, plumbing, fire) as applicable, and sound engineering principles.

The purpose of these requirements is to provide an option to evaluate and qualify pressure system components that were not manufactured under the required codes, require modifications not possible within the scope of the approved codes, or are to be used in a manner outside the applicability of the code under which they were designed or manufactured.

They apply to design engineers when they design a new *conventional* or *scientific* pressure system or modify or alter any existing system, including a legacy system; to persons responsible for determining design specifications; and to system owners, project managers, and the pressure systems program manager.

Equipment covered by these alternate requirements includes

- Custom vacuum chambers with thin windows designed to allow unimpeded transmission of electron or X-ray beams
- Research equipment that due to the required pressure range, vessel geometry, use of special materials, or temperature cannot be feasibly constructed under national consensus codes
- Specialized equipment manufactured under pressure code systems different than the codes identified in this chapter. This includes equipment that is either: a) not manufactured under national consensus codes, or b) the equipment that cannot be manufactured under national consensus codes and still meet the scientific performance requirements.
- Specialized equipment manufactured under other code systems (such as the European Pressure Equipment Directive (PED 2014/68/EU). Note such equipment meeting the national consensus codes should be used wherever possible or feasible.
- Equipment or components built under the national consensus codes that are used outside the scope of the code under which they were manufactured.
- Equipment or components that do not have documentation to show it was constructed to national consensus codes.

These alternate qualification requirements should not be used to qualify equipment that is otherwise available manufactured under national consensus codes and that meets the performance requirements in support of the laboratory's mission.

1.1 Examples of Systems

The following are examples of systems or components where use of the items was allowed through the application of these requirements or their predecessors.

- Cryo-EM microscopes. These precision instruments were constructed under European Pressure Equipment Directive (PED) codes. The instruments were certified to meet the European codes by a professional third-party organization. The application of PED codes was evaluated and accepted in this application. Instruments built under US codes meeting the performance requirements were not available.
- Xenon purification. The purification process uses aluminum DOT-rated gas cylinders in the purification processing. The cylinder is cryogenically cooled to freeze xenon gas and the use will extend beyond the DOT retest date. The choice of this component is driven by chemical purity requirements. An analysis showed that the use of these cylinders in this manner is safe at the process pressures and temperatures.
- Beamline scattering chambers with thin X-ray or electron windows. The windows do not meet the ASME BPVC requirements for material choice and thickness. The chambers cannot be pressure tested due to the window openings. The thin windows are required to allow undisturbed passage of the beam. The construction of the chamber was analyzed and engineering and administrative controls for protecting the window implemented.
- Superconducting accelerator cavities. Pure niobium metal is not a qualified material for an ASME-rated pressure vessel. Niobium is the superconducting material that has the properties required for the cavity performance. An analysis showed that the use of these cavities in the cryogenic modules is safe at the pressures and temperatures involved.

2 Requirements

2.1 Application

2.1.1 Preparation

In all cases the system owner or equipment project manager is encouraged to notify and consult with the pressure systems program manager, who may engage the Pressure Systems Working Group, chief safety officer and/or chief engineer before recommending to proceed with an alternate pressure system qualification.

2.1.2 Description of System

The engineering evaluation (see below) must include a description of the pressure system component. The description should include vendor data sheets, drawings, and/or pictures of the device, and why the use of the alternate qualification process is required for this application. If the component is part of a larger

system, a description of that system, including the associated process and instrumentation diagram, should be included.

2.1.3 Engineering Evaluation

An engineering evaluation of the suitability and safety of the equipment is required. Examples of engineering evaluation methods that may be utilized include the following:

1. If the equipment was constructed under a non-US code standard. Documentation that the system was designed and constructed under an applicable code standard, that the system meets this code standard, that the code standard used provides equivalent protection at a level of safety comparable to that achieved by complying with the requirements of these national consensus codes, and that the use of the equipment at SLAC is consistent with the standard. An evaluation of the applicable code standard may be required if SLAC has not already accepted its use in a similar application.
2. If the equipment is specialized research equipment designed for or by SLAC to meet the demands of the research program. An engineering note should be written describing the equipment. The note should analyze the design, material properties, stresses, manufacturing methods, and demonstrate that the device has sufficient engineering margin to provide a level of safety comparable to that achieved using the ASME codes. The basic minimum design margin[1] (safety factor) is 3.5 for any pressure system(s) unless a lower design margin can be justified by applicable codes, stress analysis, or engineering calculations. The note should be reviewed and concurred with by other engineers for the line organization before submission.
3. If some aspect of the equipment cannot be manufactured with an engineering margin providing equivalent protection at a level of safety comparable to that achieved by complying with the requirements of these national consensus codes. Similar to above for specialized equipment. The engineering note should additionally identify and analyze the engineering and administrative controls proposed to address the deficiencies.
4. Or some other engineering evaluation process that includes system analysis, hazard controls, and/or other mitigations.

The intent of these requirements is to provide equivalent protection at a level of safety comparable to that achieved by complying with the requirements of these national consensus codes.

The engineering evaluation is the responsibility of the system owner or project manager for the equipment. The evaluation should be in the form of a formal document or engineering note.

2.1.4 Alternate Pressure Systems Qualification Application

The complete package must include the following:

1. A description of the system, including a description of its use

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1 Equivalent to ASME *Boiler and Pressure Vessel Code* requirements. See ASME BPVC, Section II, Part D, Mandatory Appendix 1-100. “At temperatures below the range where creep and stress rupture strength govern the selection of stresses, the maximum allowable stress is the lowest of: (1) the minimum tensile strength divided by 3.5, or (2) two-thirds the minimum yield strength” (simplified by author).

2. An engineering evaluation of the system
3. A completed Pressure Systems: New Pressure System Registration Form
4. A note from the project's associate laboratory director indicating approval of the application

2.2 Submission and Review

The engineering evaluation is submitted to the pressure systems program manager. Depending on the complexity of the system, risks, and consequence of a failure, the pressure systems program manager may refer the analysis to members of the Pressure Safety Working Group, chief safety officer and/or chief engineer for a review of the engineering evaluation.

Pressure vessels and pressure systems for which pressure testing is a proposed mitigation may not be pressurized until the engineering evaluation has determined that the vessel or system can withstand the proposed testing protocol. Approval for pressure testing may be given to the system owner by the pressure systems program manager as an interim step to final qualification.

Pressure vessels or pressure systems submitted for qualification under these requirements may not be used until the pressure systems program manager has confirmed to the system owner that the system is considered acceptable and has been qualified.

3 Forms

The following forms and systems are required by these requirements:

- For non-ASME pressure vessels, a fabricator's certificate of compliance confirming that the pressure system has been designed and constructed according to SLAC's specifications and stamping is required.
- Pressure Systems: New Pressure System Registration Form (SLAC-I-730-0A21J-040). Form for registering and approving new pressure systems; documents compliance with program requirements
- Pressure Systems Database. Database of pressure systems

4 Recordkeeping

The following recordkeeping requirements apply for these requirements:

- The pressure systems program manager maintains the registration record and all submitted attachments in the Pressure Systems Database, which serves as the repository for all pressure system records throughout the pressure system's service life.

5 References

SLAC Environment, Safety, and Health Manual (SLAC-I-720-0A29Z-001)

- Chapter 14, "Pressure Systems"

  - Pressure Systems: Design and Construction Requirements (SLAC-I-730-0A21S-047)
  - Pressure Systems: Registration Procedure (SLAC-I-730-0A21C-031)
  - Pressure Systems: Installation, Inspection, Maintenance, and Repair Requirements (SLAC-I-730-0A21S-053)
  - Pressure Systems Safety Program (SharePoint)
- Chapter 1, "General Policy and Responsibilities"
  - General Policy and Responsibilities: ESH Project Review Procedure
- Chapter 40, "Chemical Lifecycle Management"

Other Documents

- Title 10, *Code of Federal Regulations*, "Energy", Chapter 3, "Department of Energy", Part 851, "Worker Safety and Health Program" (10 CFR 851) (as described in SLAC Injury and Illness Prevention Program [SLAC-I-720-0A21B-001])
- Title 49, *Code of Federal Regulations*, "Transportation", Subtitle B, "Other Regulations Relating to Transportation", Chapter 1, "Pipeline and Hazardous Materials Safety Administration, Department of Transportation", Subchapter C, "Hazardous Materials Regulations", Part 180, "Continuing Qualification and Maintenance of Packagings" (49 CFR 180)
- Title 8, *California Code of Regulations*, "Industrial Relations", Division 1, "Department of Industrial Relations", Chapter 4, "Division of Industrial Safety"
  - Subchapter 1, "Unfired Pressure Vessel Safety Orders" (8 CCR 450–560)
  - Subchapter 2, "Boiler and Fired Pressure Vessel Safety Orders" (8 CCR 750–797)
- Title 24, *California Code of Regulations,* "California Building Standards Code"
  - Part 4, "California Mechanical Code" Part 4 (24 CCR Part 4)
  - Part 5, "California Plumbing Code" Part 5 (24 CCR Part 5)
- American Society of Mechanical Engineers (ASME) *Boiler and Pressure Vessel Code (BPVC)* (ASME BPVC), including applicable addenda and code cases
- ASME. *Code for Pressure Piping* (ASME B31) (including applicable addenda and code cases)
- Directive 2014/68/EU of the European Parliament and of the Council of 15 May 2014 on the Harmonisation of the Laws of the Member States Relating to the Making Available on the Market of Pressure Equipment (Pressure Equipment Directive) (PED 2014/68/EU)

Note *See Chapter 14, "Pressure Systems" for a complete list of applicable codes and standards.*