FESHM 5031.4: Inspection and Testing of Relief Systems

Revision History

Author	Description of Change	Revision Date
Abhishek Deshpande	Added information about paying attention to accumulation of vacuum grease on tested/inspected relief devices in Section 4.2.	August 2018
Abhishek Deshpande	• Added information about inspection and testing of vacuum vessel relief devices. • Updated inspection details for trapped volume relief devices. • Changed D/S/C to D/S/P.	July 2017
Michael White	• Updated introduction section to reference all other FESHM chapters which require relief valves; • Revised definitions section; • Updated responsibilities section; • Reduced maximum testing frequency interval from six to five years for primary relief devices; • Added reference to Fermilab Relief Device Database • Deleted inspection form	October 2016
Thomas Page	Revised definition of “primary relief devices”; changed “external inspection” to “visual inspection”.	December, 2011
Thomas Page	Added chapters 5031.1 and 5031.6 to the scope of the chapter. Revised wording in Section 3.3.	January, 2011

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1.0 INTRODUCTION

Relief systems, at the Fermilab site in Batavia, Illinois and all Fermilab leased spaces, must be periodically inspected and maintained in order to assure proper operation. This chapter specifies an inspection and testing program for all pressure relief systems that are required under the provisions of the following Fermilab ES&H Manual Chapters:

- 5031: Pressure Vessels
- 5031.1: Piping Systems
- 5031.5: Low Pressure Vessels[A]
- 5031.6: Dressed Niobium SRF Cavity Safety
- 5031.7: Membrane Cryostats
- 5032.1: Liquid Nitrogen Dewar Installation & Operation Rules[B]
- 5033: Vacuum Vessels[A]
- 5033.1: Vacuum Window Safety[C]
- 5034.1: Retesting Procedures for D.O.T Gas Storage Cylinders Including Tube Trailers[D]
- 5035: Mechanical Refrigeration Systems[E]
- 6020.3: Storage & Use of Flammable Gases[F]

Notes:

A. Relief devices on low-pressure and vacuum vessels are not required to be retested per FESHM 5031.5. However, the relief devices shall be visually inspected every three years and opened (if appropriate) every 5 years per FESHM 5031.5.
B. Liquid nitrogen dewars may have additional components such as automatic fill line shutoff valves that require inspection and/or testing as outlined in FESHM 5032.1. Records of these tests shall be maintained in the Fermilab relief device database.
C. If the vacuum window is on a vacuum system, it may experience an excursion to positive pressure under any circumstance, then a relief device shall be installed to maintain the maximum pressure below 1/4th of the pressure which would cause failure of the thin vacuum window per FESHM 5033.1.
D. Relief devices on D.O.T Gas Storage Cylinders require D.O.T certification as outlined in FESHM 5034.1. Records of inspections and tests are required to be stored in the Fermilab relief device database.
E. Mechanical Refrigeration Systems are exempt from inspection and testing requirements per FESHM 5035 due to the safety and environmental hazards associated with release of the refrigerant. Details of the relief devices are still required to be stored in the Fermilab relief device database.
F. See FESHM 6020.3 for detailed requirements regarding relief devices discharging into a common vent header and requirements for venting relief devices outdoors

2.0 DEFINITIONS

Design Pressure - A relief device is always set to open at or below the design pressure of the protected system. The qualified person designing the protected system is responsible for verifying that all components have a maximum allowable working pressure (MAWP) greater than or equal to the design pressure across the entire range of expected operating temperatures.

Engineering Note - A formal analysis of the relief device required by one of the FESHM chapters listed in Section 1.0 for a protected system. The engineering note undergoes a formal peer review and approval. The relief device specifications for a protected system covered by an engineering note cannot be changed without revising the Engineering Note and undergoing another peer review and approval.

Engineering Document – In some cases a formal engineering note is not required by FESHM. An engineering document is then created by a qualified person to capture the relief device's required capacity calculations, specified relief device capacities, and other key relief device specifications. A single engineering document may cover a group of relief devices.

External pressure source - The qualified person designing the protected system is responsible for identifying all credible sources of pressure external to the volume which the relief device protects. Common examples of external pressure sources at Fermilab include compressors, pumps, gas storage tanks, dewars, gas cylinders, tube trailer fill connections, and cryogenic liquid fill lines.

Pressure Vessel Primary Relief Device - A relief device that protects a system that includes a pressure vessel from pressures exceeding the design pressure due to upset conditions including, but not limited to: equipment failure, control failure, operator error, sustained heat loads, self-limiting heat loads, and external sources of pressure which may exceed the vessel design pressure. The relief device shall be stamped or certified as required by the governing code.

Process Piping Primary Relief Device - A process piping primary relief device protects a volume of piping from pressures exceeding the design pressure due to upset conditions including, but not limited to: equipment failure, control failure, operator error, sustained heat loads, self-limiting heat loads, and external sources of pressure which may exceed the piping design pressure.

Protected System - the piping, vessel, or system of piping and vessel(s) for which the relief system is required.

Qualified Person - A qualified person is "a person who, by possession of a recognized degree or certificate of professional standing, or who, by extensive knowledge, training and experience, has successfully demonstrated the ability to solve or resolve problems relating to the subject matter and work."

Relief Device: A pressure relief device is actuated by static inlet pressure which opens the device at a pressure at or below the system design pressure to allow fluid to exit the system and reduce system pressure. A relief device may be a pressure relief valve, a non-reclosing pressure relief device, a safety valve, a relief valve, a rupture disk, or a pilot operated pressure relief valve. Refer to ASME Section VIII, Division 1, UG-125 for definitions of these device names.

Relief Device Owner - The qualified person responsible for inspecting and testing the relief device.

Relief Systems - Relief devices and their inlet and outlet piping.

Self-limiting Heat Loads: A heat load applied to a protected system that can be blocked-in by valves, flanges, or other closures to create a trapped volume. There is a limited volume of fluid in

the trapped volume, so entire volume of fluid is quickly expelled through the relief device. After the fluid inventory is expelled there is no further risk of over pressurization. Self-limiting sources of heat on a trapped volume include but are not limited to: heat transfer from ambient air, fire, and sudden loss of insulating vacuum.

Stable Fluid Systems - Protected system that utilizes a clean inert internal working fluid and is located in an external environment that is also not corrosive to the materials of construction used. Examples of inert working fluids commonly encountered at Fermilab include nitrogen, argon, and helium. No deterioration of the performance of the relief system is expected over time.

Potentially Degrading Fluid System - Protected system that may be susceptible to corrosion, fouling, scaling or other processes that potentially lead to a degradation in the performance of the relief system over time. Examples of potentially degrading working fluids include steam, hot water, and industrial cooling water pumped from ponds. The required inspection and testing intervals shall be determined by a qualified person, shall be recorded in an engineering note or engineering document, and shall not exceed those for Stable Fluid Systems.

Sustained Heat Loads - A heat load applied to a protected system which may require a relief device to operate for an extended period of time to prevent over pressurization. Sustained sources of heat on a protected system include but are not limited to: heaters and heat exchangers.

Testing of a Re-Closing Relief Device - verifying that the set pressure satisfies the requirements of ASME Code Section VIII Division 1 paragraphs UG-126 and UG-134 or Division 2 Article R-1 for code stamped relief valves or other Codes/Standards as required by the affected Engineering Note. For non-code stamped relief valves used on low pressure or vacuum vessels, use engineering judgment in determining if the set pressure and valve opening are appropriate for the service conditions.

The relief device may be tested in place provided the test pressure does not exceed the maximum allowable working pressure of the protected system; otherwise, the relief device must be removed for testing.

Three-way Selector Valve - A valve commonly used on pressurized equipment that allows pressure relief devices to be removed for testing without shutting down the equipment. One port of the valve always remains connected to the process stream. The valve handle can be turned to select either of the other two ports. This allows one of the two relief valves to be removed for testing without impacting system safety. Three-way selector valves used for relief valves shall be configuration lock controlled. Any problems identified with the three-way selector valve shall be noted in the relief device inspection or testing report.

Trapped Volume Relief Device - A relief device required solely to protect a potentially blocked-in portion of a piping system from being pressurized above the design pressure by expansion of a fluid due to heat absorption from self-limiting heat loads.

Visual Inspection - consists of verifying, to the extent possible without disassembling the relief system or removing relief devices, that:

a. The relief devices are the same as those described in Engineering Notes. If an engineering note is not required for the protected system, then the relief device shall be described in an Engineering Document

b. The outlet or discharge piping of relief devices has remained unrestricted

c. The inlet and outlet piping of the relief system have not been changed in a way that would reduce the relief capacity given in the Engineering Note or Engineering Document

d. The relief devices have not undergone severe corrosion or tampering.

3.0 RESPONSIBLILITIES

3.1 Division Head/Section Head/Project Manager (D/S/P)

The D/S/P who controls the area of operation of the protected system is responsible for the appointment of Relief Device Owners who will carry out the requirements of this chapter.

3.2 The Relief Device Owner

The Relief Device Owner is responsible for ensuring that the Fermilab Relief Device Database is updated whenever a relief device is changed, added, inspected, tested, or removed from service D/S/P shall assist ESH&Q if necessary to develop and execute a plan to bring relief devices in their areas of operation into compliance with this chapter.

3.3 The Mechanical or Cryogenic Safety Subcommittee(s)

The Mechanical or Cryogenic Safety Subcommittee(s) will serve in a consulting capacity to ESH&Q and D/S/P in all matters concerning the inspection and testing of relief systems.

3.4 The ESH&Q Section

The ESH&Q Section is responsible for administration, training, and enforcement of the Fermilab Relief Device Database described in Section 5.0.

- Administration includes organizing any efforts to troubleshoot or upgrade the database.
- Training includes teaching relief valve owners to use the database and answering questions regarding the database.
- Enforcement includes monitoring the number of relief devices due for inspection or testing.

Procedures for relief devices that are out of compliance are outlined in Section 4.0. ESH&Q will work with groups responsible for maintaining relief devices to develop a plan to reach compliance with this chapter and monitor progress.

4.0 PROCEDURE

4.1 Visual Inspection

A visual inspection of each relief system must be made prior to initial operation of the protected system. The inspection must be repeated at regular intervals. The maximum interval between inspections may not exceed three years for stable fluid systems. Potentially degrading fluid systems shall have an inspection interval determined by a qualified person.

4.2 Testing and Inspection of Primary Relief Devices

a. Re-closing primary relief devices must be tested prior to their installation. The testing must be repeated at regular intervals. The maximum interval between tests may not exceed five years for stable fluid systems. Potentially degrading fluid systems shall have a testing interval determined by a qualified person. Prior to re-installing tested/inspected relief valves, all surfaces shall be checked for accumulation of greases, oils, and other debris. These unwanted substances shall be removed appropriately, and this shall be noted in the testing/inspection notes for the relief device in the Fermilab Relief Device Database. In the case of new and not previously used relief devices, certification of the set pressure by the manufacturer will be considered to constitute a test. In this case, the test date will be the date on which the relief device was delivered at Fermilab and the requirement for further testing prior to installation will be waived. The manufacturer's test certificate shall be uploaded to the Fermilab Relief Device Database described in Section 5.0.

b. Non-re-closing (burst disk), trapped volume, and parallel plate primary relief devices (used on vacuum vessels and insulating vacuum spaces) need not be tested, but must be inspected every three years.

c. If a protected system is provided with n sets of primary relief devices, each of the sets individually satisfies all Fermilab ES&H Manual requirements, and each of the sets is always connected to the protected system, then the interval between tests specified in 2.a. may be extended to n times every five years. This rule can only be used for stable fluid systems where the performance of the relief system is not expected to deteriorate over time.

4.3 Corrective Actions

Immediate corrective actions must be taken if any inspection indicates that a relief device may not operate per design. The actions must ensure that the failure of the relief device to operate per design will not result in a safety hazard.

4.4 Records

A record of the inspections and tests of each primary relief system and each primary relief device shall be maintained by the person responsible for the protected system. These records shall contain vessel / system identification numbers, relief device specifications, and such documents as are necessary to record the results of inspections, repairs, alterations, or re-ratings of the relief system and devices. All records shall be entered into the Fermilab Relief Device Database, Section 5.0.

4.5 Existing Systems

If an existing primary relief system is not in compliance this chapter, immediate corrective actions must be taken to ensure safety. This may include taking the system out of service or incorporating administrative controls to assure safety until the system can be brought into compliance. Thereafter, the inspection and testing intervals specified in 1 and 2 apply.

5.0 FERMILAB RELIEF DEVICE DATABASE

Information regarding all relief devices used on protected systems is stored in the Fermilab Relief Device Database that is administered by the ESH&Q Section. The database shall be updated by the

relief device owner whenever a relief device is added, changed, inspected, tested, or removed from service. A link to the Fermilab Relief Device Database is located on the ESH&Q Section website also shown below:

https://www-bd.fnal.gov/cgi-msd/pvIndex.pl

The functions of the database include:

- All key specifications of the relief device are stored in the database such as the manufacturer, model number, device type, set pressure, flow rate capacity and inlet/outlet pipe size. Supervisors and/or ESH&Q personnel are notified if any relief device specification is changed.
- The database assigns responsibility of every single relief device to a relief device owner. The owner receives email notifications when inspections or tests are due. In the event that the owner fails to do the required inspection or test and enter the result in the database, escalating notifications are sent to supervisors and/or ESH&Q personnel.
- The location of the relief device is specified. The building location, device tag name, and photograph are included as necessary so that the relief device can be readily located.
- The inspection and test intervals can be adjusted based on the type of fluid service. For example, relief devices on corrosive fluid systems should be tested more frequently than those on inert fluid systems. The maximum inspection and testing intervals are specified in Section 4.0. Supervisors and/or ESH&Q personnel are notified if an inspection or test interval is changed.
- The database provides the Teamcenter ID to the engineering note or engineering document which describes the protected system. The engineering note or the engineering document provides the relief device specifications and analyzes the required versus actual capacity of the relief device.