

DRESSED NIOBIUM SRF CAVITY PRESSURE SAFETY

INTRODUCTION

This chapter defines the policy for the design, fabrication, testing, and quality control of dressed Superconducting Radio Frequency (SRF) Cavities, also referred to in this chapter as Dressed SRF cavities. Dressed SRF cavities containing cryogenics pose a potential pressure hazard. Pressure vessels such as SRF cavities fall within the scope of the ASME Boiler and Pressure Vessel Code and/or ASME Code for Pressure Piping. The use of niobium as a material for the SRF cavities and other design features fall outside the scope of the ASME Codes and require additional provisions to ensure safe design and operation.

This chapter specifies the engineering policy that governs the design, fabrication, testing, and control of SRF cavities. The purpose is to minimize hazards associated with design and operation, as well as to ensure consistent design review and approval. Although it is impossible to meet the code explicitly, the intent of the policy is to assure a level of safety equivalent to that afforded by the ASME codes.

SCOPE

The chapter applies to any dressed SRF Cavity designed or used at Fermilab regardless of size, shape, site of installation, duration of use, origin of manufacture, operational location, or previous use at Fermilab or other facilities.

Bare SRF Cavities are explicitly excluded from the scope of this chapter.

DEFINITIONS

Dressed SRF Cavity –An integrated assembly wherein a niobium cavity has been permanently joined to a cryogenic containment vessel, such that niobium is part of the pressure boundary and the cavity is surrounded by cryogenic liquid during operation.

Bare SRF Cavity - A niobium cavity which has not been permanently integrated into a cryogenic containment vessel.

Engineering Note: A written analysis demonstrating that a given dressed SRF Cavity satisfies the requirements of this chapter.

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.

SRF Review Panel: A panel specifically assigned to SRF cavity engineering note reviews to ensure uniformity in preparation and review.

Exceptional Vessel: A vessel within the scope of this chapter which does not fully meet the requirements of the Technical Division technical note TD-09-005 "*Guidelines for the Design, Fabrication, Testing and Installation of SRF Nb Cavities.*", referenced in the policy statement. The Engineering Note originator, in consultation with the SRF Review Panel, will make the determination whether the vessel needs to be considered exceptional. Engineering analysis and justification for all exceptions are required additions to the engineering note.

SPECIAL RESPONSIBILITIES

The Division/Section Head who controls the area of design and fabrication of the dressed SRF cavity is responsible for carrying out the requirements of this chapter. The Division/Section Head, or designee, shall certify compliance of the dressed SRF cavity with this chapter by signing the Engineering Note following review and approval by the SRF Review Panel. The original Engineering Note shall be placed into the Laboratory Pressure Vessel master file maintained by the ES&H Section.

The Mechanical Safety Subcommittee and Cryogenic Safety Subcommittee shall establish and maintain the SRF Review Panel. The Mechanical Safety Subcommittee and/or Cryogenic Safety Subcommittee may propose appropriate modifications to this chapter as necessary. Changes in policy shall be recommended by the Fermilab ES&H Committee after consulting with the Division/Section Heads.

The SRF Review Panel shall arrange for the review of required Engineering Notes by a qualified person and verify that the dressed SRF Cavity meets the requirements specified in this chapter.

POLICY AND REQUIREMENTS

1. *Policy*: The design, fabrication, testing, and quality control for all dressed SRF cavities built and/or operated at Fermilab shall be in accordance with this chapter and Technical Division technical note TD-09-005 "*Guidelines for the Design, Fabrication, Testing and installation of SRF Nb Cavities.*"
2. *Documentation*: An Engineering Note shall be prepared by a qualified person for all dressed SRF Cavities. The format of the Engineering Note is shown in the TA 5031.6 Dressed SRF Cavity Engineering Note Form. Its purpose is to allow a reviewer to document the completion of the requirements of this chapter and Technical Division technical note TD-09-005 "*Guidelines for the Design, Fabrication, Testing and installation of SRF Nb Cavities.*" The document shall include design calculations for the relief system. The document shall also include precautions, diagrams, documents and operational procedures necessary for the safe use of the cavity.

3. *Review*: All required Engineering Notes shall be reviewed by an independent, qualified reviewer, other than the person who prepared it, for concurrence to this chapter.

The associated cryogenic system review will be conducted in accordance with FESHM 5032, "Cryogenic System Review" by the appropriate area Cryogenic Review Panel.

4. *Modifications to a compliant system*: Any subsequent changes in usage or operation of an SRF cavity (already in compliance with this chapter) shall meet the requirements of this chapter. Significant modifications impacting system safety shall be documented in a reviewed Amendment to the original Engineering Note.
5. *Director's Exception*: Exception to the provisions of this chapter shall be allowed only with the signature of the Laboratory Director or designee and documented in the Engineering Note. The need for such exceptions is to be minimized by adherence to the provisions of this chapter. Exceptions are to be identified and submitted to the Director for review as early in the design process as possible. These exceptions shall only be allowed after the Director is assured that sound engineering practice will be followed during design, fabrication, testing, and operation of the cavity. The ES&H Section shall maintain copies of exceptions for the Director.

ENGINEERING NOTE

An Engineering Note (see Technical Appendix for note format) shall be prepared by a Qualified Person for all Dressed SRF cavities that fall within the scope of this chapter. Its purpose is to allow a reviewer to check the design and to inform a future user of the appropriate vessel parameters. At a minimum, the following topics shall be addressed as required in Technical Division technical note TD-09-005 "*Guidelines for the Design, Fabrication, Testing and installation of SRF Nb Cavities.*"

1. Cavity description
2. Material data
 - a. Materials and properties used in construction
 - b. Material certifications
 - c. Serial numbers of cells (traceability)
3. Design calculations
4. Fabrication information
 - a. Welding / brazing details and specifications
 - b. Welder's qualification
 - c. Processing history
5. Cavity wall thickness
 - a. Internal pressure
 - b. External pressure
6. Examination reports
7. Pressure test reports

8. Relief system verification
9. Operating procedures