STATUS OF THE SPALLATION NEUTRON SOURCE SUPERCONDUCTING RF FACILITIES*

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Abstract

The Spallation Neutron Source (SNS) project was completed with only limited superconducting RF (SRF) facilities installed as part of the project. A concerted effort has been initiated to install the infrastructure and equipment necessary to maintain and repair the superconducting Linac, and to support power upgrade research and development (R&D). Installation of a Class10/100/10,000 cleanroom and outfitting of the test cave with RF, vacuum, controls, personnel protection and cryogenics systems is underway. A horizontal cryostat, which can house a helium vessel/cavity and fundamental power coupler for full power, pulsed testing, is being procured. Equipment for cryomodule assembly and disassembly is being procured. This effort, while derived from the experience of the SRF community, will provide a unique high power test capability as well as long term maintenance capabilities. This paper presents the current status and the future plans for the SNS SRF facilities.

INTRODUCTION

The SNS project was completed in June 2006 with only limited SRF facilities installed as part of the project, namely a 5 MW, 805 MHz RF test stand, a fundamental power coupler processing system, a concrete test cave shell, and temporary cleaning/assembly facilities. Approximately 800 of the nominal 1000 MeV of H^- acceleration is provided by 23 superconducting RF cryomodules, 11 of which are 3 cavity, β=0.61 structures, and 12 are 4 cavity, β=0.81 structures. Recent operational experience has resulted in the turning off of several cavities due to excessive fundamental power coupling through higher order mode (HOM) antennas, while other cavities performance is limited by field emission [1]. Thus a concerted effort has been initiated to install the infrastructure and equipment necessary to maintain and improve the superconducting Linac.

The overall layout of the SRF facilties is shown in Figure 1. They are housed in the SNS RF test facility.

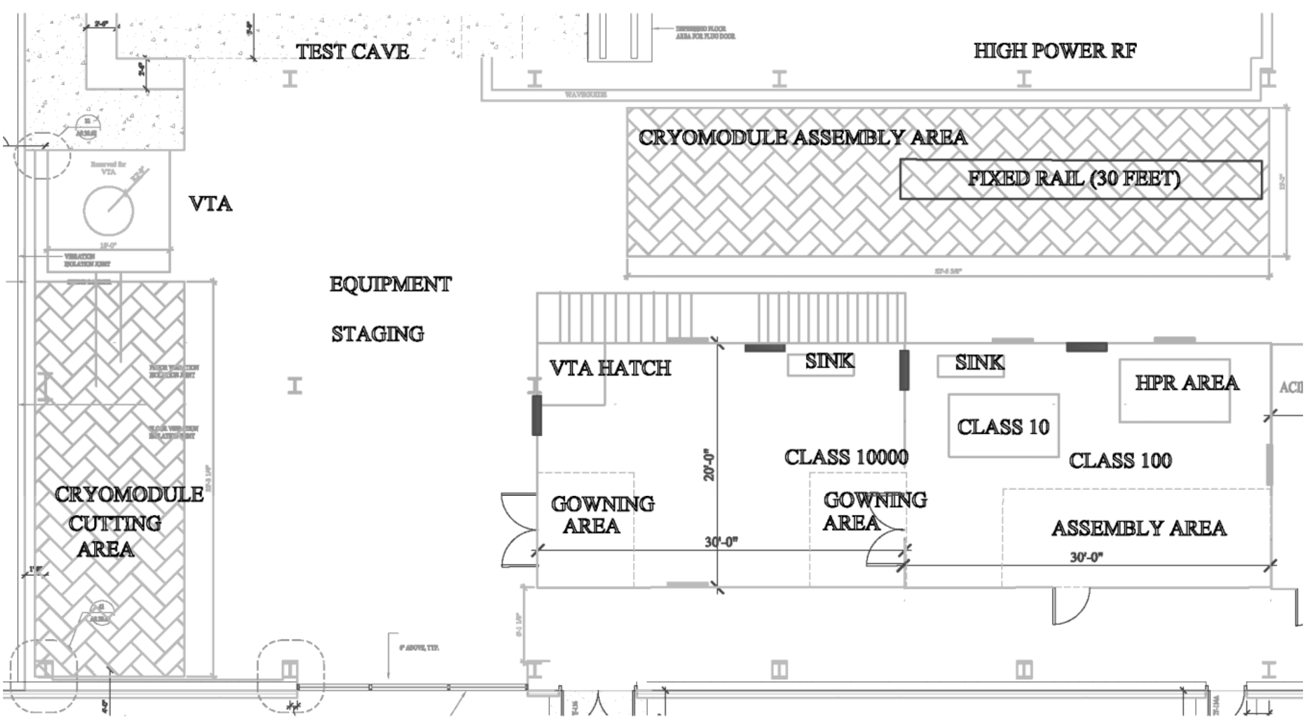

Figure 1: SRF Facility Layout

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Not all items identified for this facility have been installed. The items that have been installed include the cleanroom and the test cave. Installation of the cryomodule repair area and fabrication of the horizontal cryostat are underway. Future items include a high pressure rinse system and a vertical test assembly (VTA).

INSTALLED ITEMS

The 5 MW, 805 MHz RF test stand and fundamental power coupler processing system, installed as part of the SNS project, were discussed previously [2, 3].

Cleanroom

The cleanroom consists of two rooms: a Class 10,000 room and a Class 100 room, each measuring 20 by 30 feet. The Class 100 room also houses an 8 foot by 8 foot Class 10 assembly area. The overall cleanroom design is modelled after the Michigan State University SRF facilities [4]. The rooms employ banks of pipe ducts to facilitate utility routing from the outside and between cleanrooms. Figure 2 presents an external view of the cleanroom.

Figure 2: Exterior view of Cleanroom

The Class 10,000 room houses ultrasonic cleaning equipment and general assembly benches. The Class 100 will be used for high pressure rinsing, string assembly, and particulate-free assembly within the Class 10 region of the room.

A 2000 square foot mezzanine was constructed as part of the cleanroom project. The mezzanine will provide additional support facilities and laboratory space.

Cryomodule Test Cave

The cryomodule test cave has an interior dimension of 36 feet long, by 13 feet wide, and an interior height of 10 feet. The entire cave is encased in five foot thick concrete shielding.

With the exception of the rolling shield door and cryogenic transfer lines, all systems have been installed to test cryomodules. These systems include the high power RF (using a 5 MW klystron), low-level RF, communication, cryogenic controls, vacuum, personnel protection, and oxygen deficiency. Figure 3 shows the interior of the test cave following installation of these systems.

Figure 3: Interior View of Cryomodule Test Cave

Initially, the RF power will be interlocked with a radiation detector to limit the radiation inside the test cave to 10 R per hour. Simultaneous operation of up to four cavities is planned.

A readiness review has been conducted for the test cave, and the shield door and cryogenic transfer lines are scheduled to be completed in August 2007. Following the completion of some readiness review action items, the cave will be ready to support the scheduled testing of a repaired cryomodule in November 2007.

CURRENT ACTIVITIES

Initial efforts focused on those significant infrastructure items (i.e. cleanroom and mezzanine) whose installation was disruptive to overall facility use. Current activities are oriented towards establishing a cryomodule repair facility, able to perform repairs at the cryomodule and spaceframe level, and towards fabricating a horizontal cryostat to support testing improvements and power upgrade project research and development.

Cryomodule Repair Facilities

The cryomodule repair facilities will be used to separate the end cans from the vacuum vessel, remove the interior spaceframe from the vessel, and re-assemble these items following cryomodule repairs. The facilities can also be used for spare cryomodule assembly.

The facilities require a substantial amount of tooling to support and align components during assembly or removal. A thirty foot long assembly bench that uses two sets of rails is currently being fabricated. Other tooling items include end can benches with rails for use in end can removal and assembly, and a mobile 20 foot transfer bench for transferring items to the assembly bench (i.e. the vacuum vessel assembly less end cans) or for assembling/removing items to the assembly bench (i.e.

withdrawing the space frame assembly from the vacuum vessel). All of these items will be fabricated by the end of June 2007. Other tooling to support the major components on these rail systems was furnished by Jefferson Lab during SNS construction.

Horizontal Cryostat

The primary purpose of the horizontal cryostat is to support research and development testing for the SNS Power Upgrade Project. The cryostat will house a cavity, helium vessel and fundamental power coupler. After cooling to 2 K or 4 K, the cavity and coupler can be tested with high power RF.

The design is based on one recently developed at Fermilab, although the SNS version is supported at the top. Figure 4 shows the overall cryostat assembly drawing, and Figure 5 shows various fabricated components.

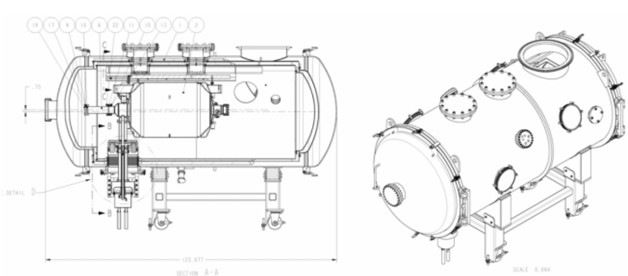

Figure 4: Horizontal Cryostat Assembly

Figure 5: Fabricated Cryostat Components

The vacuum vessel and shields of the cryostat are being fabricated and assembled. Design of the feedbox is underway. Testing of the cryostat is planned in 2008.

FUTURE ACTIVITIES

Facilities will soon exist to work on cryomodules; for example, replacing components on a space frame assembly within the Class 10,000 cleanroom. Future SRF facility activities will emphasize cavity improvement and assembly, with the goal of removing high field-emitting cryomodules from the tunnel, re-processing the cavities, and re-assembling the cryomodules. Re-processing will consist of cavity high pressure rinsing followed by testing either in the horizontal cryostat or a vertical test dewar. The items discussed below are part of a proposed FY2008 accelerator improvement project.

High Pressure Rinse System

The planned high pressure rinse system will be similar to those used at other laboratories. The existing ultra-pure water system, used for warm beam pipe cleaning and assembly, will be upgraded to provide additional filtration and storage capacity. A diaphragm pump will be used for the rinse fixture. The cleanroom area for the system has a higher ceiling than the rest of the cleanroom to accommodate the high beta SNS cavities. We plan on incorporating a nitrogen drying system in order to minimize particulate collection on the exposed cavity.

Vertical Test Assembly

The cleanroom and SRF facility have been designed to allow the addition of a vertical test assembly (VTA). The VTA would house a cavity-sized dewar and a research dewar within a stacked-block radiation shield. Although the horizontal cryostat will be used for cavity/coupler qualification, cryomodule testing may prevent access to the test cave, necessitating an independent means for testing cavity processing and of processing quality control samples. In addition to the dewars, the VTA project will include the dewar top plate and inserts, cryogenic transfer lines, instrumentation and controls, RF system, and radiation monitoring.

CONCLUSION

SRF facilities have been installed to support SNS cryomodule repair and testing. Efforts underway will expand cavity processing and research and development capabilities.

ACKNOWLEDGEMENT

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