A.6: Design, fabrication and installation of Horizontal Test Stand cyrostat

A major milestone was accomplished by fabricating and installing a Horizontal Test Stand (HTS) cryostat at RRCAT. This system will be used to test two superconducting radio frequency (SCRF) cavities at cryogenic temperature before installing them inside cryomodules of the linear accelerator. This is the third such facility in the world which can test two SCRF cavities in a single cycle. At RRCAT, two such HTS cryostats have been developed, one for the proposed Indian Spallation Neutron Source (ISNS) project and the other for FNAL, USA as a part of PIP II project.

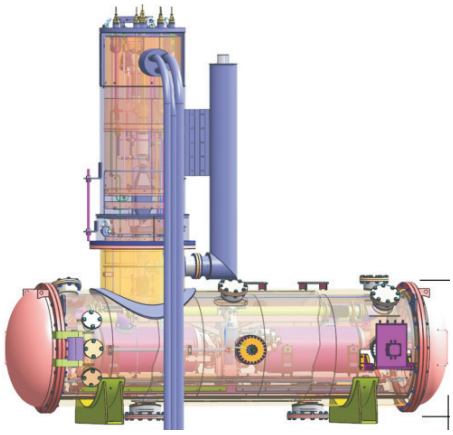

Fig. A.6.1: 3D model of HTS cryostat designed at RRCAT.

HTS cryostat is very similar to a two cavity cryomodule. Design and development of this system has given important learning experience for the six cavity cryomodule development. Design of cryostat for this HTS facility was carried out by Cryomodule Development & Cryo-engineering Application Section (CDCAS), RRCAT in collaboration with Fermilab, USA, under Indian Institute Fermilab Collaboration. Figure A.6.1 shows the 3D model of HTS cryostat. This HTS cryostat, designed to test two 650 MHz SCRF dressed cavities, can generate a refrigeration capacity of about 50 W at 1.8 K with supply of liquid helium at 4.5 K and liquid nitrogen at 80 K. Design and development of this complex cryostat was a challenging task. Getting it fabricated in Indian industry was still more difficult as such complex cryogenic engineering based devices have not been made by them. Vendor development in this technological field would also benefit cryomodule development exercise for the proposed ISNS project. Two such cryostats were fabricated and tested successfully in Indian industry (M/s INOX India Pvt. Ltd., Vadodara, Gujarat). Figure A.6.2 shows the fabricated HTS cryostat with feedcan.

Subsequent to the fabrication and testing at industry, one of the cryostats has been installed and successfully tested at RRCAT.

Fig. A.6.2: Fabricated HTS cryostat with feedcan.

HTS cryostat has many challenges in design and fabrication. A very strict quality assurance plan was worked out and implemented very meticulously. Cryostat houses superconducting cavities which have to be maintained at 2 K temperature, hence heat in-leak has to be kept at a minimum. A very strict alignment control among several ports in cryostat vessel, in conjunction with cavity support structure assembly was needed. It was required for critical assembly between cavity and coupler. The feedcan is the part of cryostat that supplies and controls the cryogen distribution to the cryostat. It houses 2K heat exchanger and all the control valves along with numerous meandering connecting tubings packed very compactly. It resulted in more than 150 numbers of weld joints and several dissimilar material brazing joints, to be carried out within a constrained space. All butt joints of cryogen piping within the cryostat were 100% radiographed. All butt joints of vessel shell were also 100% radiographed. The outer vacuum jacket of the cryostat and feedcan was certified with ASME U stamp. Due to strict quality control during fabrication, both the devices, despite all such exacting requirements, passed factory acceptance test successfully. The leak rate of the order of 10^{-9} mbar.l/s after cold shock with LN_2 was achieved. It was better than acceptable limit of 10^{-8} mbar.l/s defined by Fermilab. The cryostat and feedcan were shipped to RRCAT in specially designed transportation fixture while maintaining the road shock within prescribed limit. The cryostat and the feedcan were unloaded and reassembled at the location of HTS facility. The site acceptance test was carried out successfully with leak rate of the order of 10^{-9} mbar.l/s after cold shock with LN_2. The system has been installed inside the shielded cave for HTS facility and is ready for commissioning.

Reported by:
Rupul Ghosh (rupul@rrcat.gov.in) & colleagues