A.10: Development of 2 K Cryostat for Characterization of SCRF Cavities

RRCAT has developed a 2 K Cryostat for characterization of SCRF cavities, under Indian Institution Fermilab Collaboration (IIFC). A vertical Test Stand (VTS) Cryostat is a facility for characterizing bare SCRF cavities by measuring quality factor (Q_o) and cavity gradient (E_{acc}) at 2 K. The VTS cryostat has been designed for a large testing aperture of 86.36 cm for testing variety of SCRF cavities including 325 MHz Spoke resonators, 650 MHz and 1.3 GHz multi-cell SCRF cavities. VTS cryostat assembly comprises of stainless steel liquid helium (LHe) vessel, process piping, vacuum vessel manufactured from stainless steel, multilayer super-insulation (MLI), liquid nitrogen (LN_2) cooled thermal shield assembly, internal and external magnetic shields, shipping restraint, control valves, top plate assembly and instrumentation. The Cryostat has been designed using ASME Boiler and Pressure Vessel (BPV) Code and Finite Element Analysis. Liquid helium vessel is designed for MAWP of 4.5 bar surrounded by vacuum. Design of internal and external magnetic shields was performed to limit the magnetic field inside LHe vessel at the cavity surface <1 μT at 2 K. External magnetic shield will be made of Mu metal whereas internal magnetic shield will be of Amuneal 4K (A4K). Thermal analysis for liquid nitrogen shield was performed to check the effectiveness of LN_2 cooling and for compliance with ASME piping code allowable stresses. The top plate assembly has provisions for RF cable connections to the cavities, active cavity vacuum pumping and cavity diagnostic instrumentation connections for multiple cavities. A 3-D model of VTS assembly is shown in Fig. A.10.1. *(Ref.: PAC-11, New York, Engineering Design of Vertical Test Stand Cryostat, S.C.Joshi et al.)*

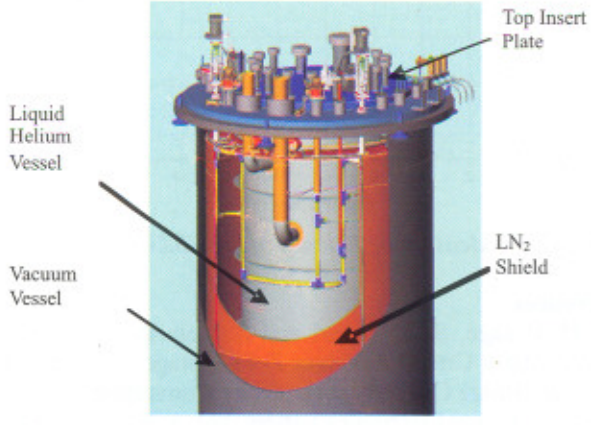


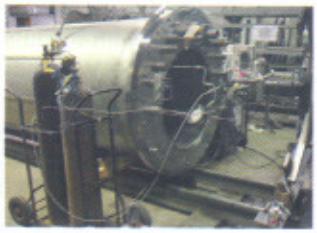
Fig. A.10.1: VTS Assembly

Fabrication of Cryostat was carried out at M/s. Ability Engineering in strict accordance with ASME BPV code under joint supervision of engineers from RRCAT and Fermilab. The Cryostat was U stamped by the ASME authorised inspector. Photographs of fabrication stages of Cryostat are shown in Fig. A.10.2.

(a) LHe Vessel

(b) MLI laying on LN2 shield

(c) Assembly of LHe vessel, LN_2 shield and vacuum vessel



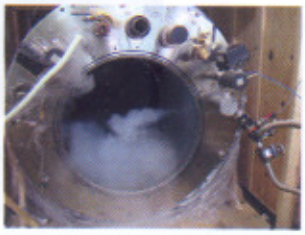
(d) Testing of cryostat

Fig. A.10.2: Cryostat under fabrication and assembly

For Acceptance testing of the cryostat following tests were performed: Electrical continuity tests on the Cernox RTDs located in the helium piping circuits, vacuum leak checking by pressurizing the LHe vessel with helium gas and vacuum leak test of Cryostat using helium leak detector for a leak rate less than 1 $x10^{-9}$ torr.l/sec. Cold shock testing of helium circuit, temperature sensing lines and thermal shield was performed by flowing LN_2 through the respective circuits and observing leak rate and vacuum level. The test results were meeting technical requirement specifications of the Cryostat.

After receiving the Cryostat at RRCAT, all the tests mentioned above were repeated to ensure that no damage has occurred to the Cryostat during shipment from USA to RRCAT, India. All the test results were acceptable. Figure A.10.3 shows pictures during testing at RRCAT.

Vacuum leak testing of Cryostat



Vacuum testing of Cryostat during Cold Shock

Fig. A.10.3: Testing of Cryostat

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