A.8: Upgradation of vacuum system of Transport line-2

Upgradation of 23.5 m long vacuum system of Transport Line-2 (TL-2), connecting Booster to Indus-1 storage ring, was carried out during machine shutdown period from 18th to 26th Feb. 2023. Ageing of aluminium wire sealed demountable joints of ~ 25 year old vacuum system was affecting its reliable performance. New vacuum chambers and sputter ion pumps (SIP), having ConFlat (CF) demountable joints, were installed replacing old ones for reliable operation in years ahead. This activity was accomplished by the entire team working extended hours due to very tight shutdown schedule.

New vacuum components installed replacing old ones during the stated shutdown period are: 02 numbers of bending magnet (BM) chambers of 28º and 35º angles respectively, 11 numbers of straight section chambers, 04 numbers of bellow sub-assemblies, 10 numbers of sputter ion pumps and 02 numbers of Bayard Alpert gauges (along with new cables). Aged beam diagnostic devices namely wall current monitor (WCM) and 2-π monitor were also replaced with new ones. One manually operated ultra-high vacuum (UHV) gate valve of size DN-63-CF was installed in central portion for facilitating the maintenance on either side. New compatible supports were installed at several locations to obtain better alignment accuracies.

The new vacuum chambers along with diagnostic devices with upgraded features were designed, fabricated, tested for its vacuum performance in lab prior to their installation at TL-2 site. Flange design of all the new chambers and associated components are based on CF sealing technology replacing wire seal design in old components for enhanced reliable performance. New straight section chambers were designed with longer length thereby reducing number of demountable joints and incorporating pumping ports having larger diameter offering higher conductance for SIP's compared to old design. Salient features of BM chambers are listed in Table A.8.1 below.

Table A.8.1: Salient features of BM chamber.

Sr. No.	Parameter	Value
1.	Material of construction	SS316L
2.	Bending angles and radius	28° and 35°/ 2000 mm
3.	Internal aperture	30 mm (V) x 55 mm (H)
4.	Profile cutting method	Water jet cutting
5.	Welding method	GTAW

28° BM is at upstream end of TL-2, after extraction chamber of booster. 35° BM, also known as switching magnet, is located in central portion of TL-2. Switching magnet chamber (35º chamber) is having two ports: zero degree port connecting to TL-3 leading to Indus-2 storage ring and 35º port connecting to downstream part of TL-2 leading to Indus-1 storage ring. The switching magnet is energised for beam injection into Indus-1 ring, whereas during beam filing in Indus-2, through TL-3, it remains un-energised. Photograph of newly installed vacuum system of TL-2 is shown in Figure A.8.1.

Fig. A.8.1: Photograph of newly installed vacuum system of TL-2 (Indus-1 hall).

New vacuum components were fabricated and leak tested for helium leak tightness $<1x10^{-10}$ mbar.l/s using helium mass spectrometer leak detector (MSLD). All the components were tested for its UHV performance after chemical treatment as per UHV requirements in lab prior to their deployment in ring. The chambers were assembled in lab with their vacuum system evacuated, baked at 250 °C for 48 hours and ultimate vacuum of $<1x10^{-9}$ mbar was achieved after baking.

Old vacuum system was dismantled and removed from TL-2 after opening the upper halves of quadrupole magnets followed by placing new vacuum chambers at their respective locations and finally re-assembling the magnets upper halves. Subsequently all the newly installed vacuum system was integrated with Booster ring, Indus-1 ring and TL-3 successfully. Leak detection was carried out after assembly for leak tightness of $<1x10^{-10}$ mbar.l/s with MSLD. Complete vacuum system of TL-2 was baked for short duration at 150 °C for 8 hrs. and vacuum level of $3.3x10^{-8}$ at Booster end and $6.2x10^{-10}$ mbar at Indus-1 side was attained.

Installation of vacuum components, vacuum conditioning and recovery of required vacuum in TL-2 was accomplished well within the scheduled shutdown period and handed over for resumption of regular operation of the machine.

Reported by:
B. K. Sindal (bksindal@rrcat.gov.in)