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MERIT Pulsed Solenoid Status

Leaks of LN_2 and some gaseous N_2 were observed under certain conditions during a systems integration test at MIT prior to shipping the magnet to CERN. Attempts to mitigate the problem before shipping were not successful, and similar behavior was also observed at CERN during the reception testing.

The problem has been diagnosed as consisting of radial fractures in several of the silicone rubber washers which had been used as sealant barriers around the 6 cylindrical electrical feedthroughs for the 3 internal coil packages within the magnet.

Consulting with cryo experts at BNL lead us to consider an alternative sealant material know as GoreTex Joint Sealant which has particularly attractive compliance properties over a broad temperature range including room temperature and 80^0K.

Two test fixtures were prepared to allow an examination of the properties of GoreTex at both room temperature and 80^0K A compression fixture permitted an examination of compliance properties at room temperature. In addition, a second fixture was prepared which gave us the capability to mimic more precisely the environment of the electrical leads penetrations at both room temperature and 80^0K

A testing program was followed in which several packing solutions were tried. The favored solution showed acceptable sealant behavior at both room temperature and 80^0K. The tests consisted of measuring the leak rate of 10-bar gaseous He at both cryogenic and room temperatures. This exceeds the expected operating conditions of the solenoid which will experience brief periods of 5-bar gaseous N_2 in which the LN_2 will be purged from the magnet prior to it being energized.

Leak rates of $\sim 10^{-3}$ mbar-l/s were observed for the 10-bar He gas at cryogenic temperatures. This corresponds to a loss rate of 12 mg/day of He gas if it is held at this pressure continuously.

This packing solution was implemented on all 6 electrical leads of the solenoid coils. As part of this implementation, all three triports were removed and the 6 retaining rings used for the packing were reinforced to allow at least 14 N-m torque on each of the 6 bolts required for tightening the packing. Upon completion of the re-packing, a pressure/leak test of the cryostat was conducted with 5-bar N_2 gas at room temperature. No leaks were observed and the 5-bar pressure was held for 1 hour before release.

A full test of the magnet was conducted at cryogenic temperatures for the purpose of confirming the sealant characteristics prior to insertion of the magnet into the TT2A tunnel. The cooldown commenced on Monday, June 4.

The magnet was initially tested at 80^0K on Wednesday, June 6. Initial torques had been conservatively set to 8 N-m on all bolts. The magnet was filled (80 l of LN_2) and then the cryostat was pressurized to 5 bar with N_2 gas in preparation for purging the LN_2 from the magnet. No leaks were observed in 4 of the six leads. Some LN_2 was observed to issue from the other two leads.   All leads were further tightened to 10 N-m torque per bolt and the two remaining leads were further tightened to 12 N-m/bolt and 13 N-m/bolt, respectively.

During testing at 80^0K and 5-bar pressure on Thursday, June 7 no leaks, either of liquid or gas was observed.

The magnet was then further tested by implementing a full warmup to room temperature on June 8, immediately followed by a two-day cooldown to 80^0K. Further testing on June 10 of the magnet with a filled cryostat and 5-bar pressure revealed no obvious leaks of gas or liquid N_2.