Jim Kerby
Headquarters
Technical Division

630.840.3595 (phone)
kerby@fnal.gov

10 July 2010

To: MICE Spectrometer Review Committee File

Subject: Recommendation on vacuum system for MICE magnet email

Findings

The MICE solenoid vacuum can is approximately 3 m long with an outer radius of approximately 1.5 m. The inner bore is 40 cm. The pump out was done via a 25 mm KF flange and pipe through a roughly 2 m flex hose to a mechanical pump. There was an auxiliary pump out for attachment to a leak detector. Vacuum instrumentation consisted only of thermocouple gauges and therefore the actual vacuum could not be determined during cool down and during magnet operations.

Comments

Best practices for a vacuum space of this size would indicate a pump out port of a minimum of 4" and up to 6" pumped out with a 150-200 L/s turbo. The large volume of MLI used in this magnet also points to the need for much greater pump capacity. Vacuum instrumentation should include a device that can monitor the vacuum at all times, i.e., below that which a thermocouple gauge is sensitive. A vacuum of 10^{-5} T assumes good performance. However, a vacuum better than 10^{-3} and greater than 10^{-5} does not guarantee the necessary performance as can be seen from the figure given below (from Boroski et al., FERMILAB Conf-92/96).

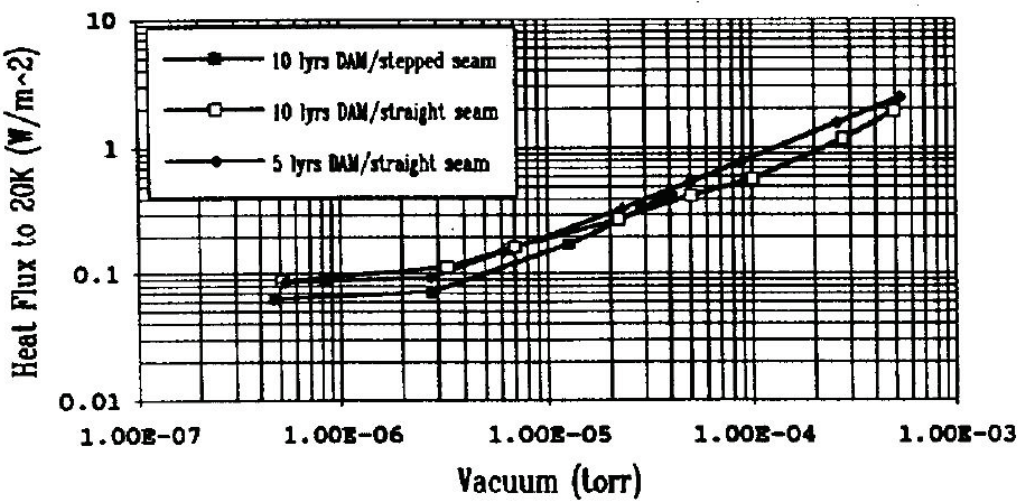

Figure 2. Heat flux through MLI systems near 20K

Recommendations

A large pump port should be added to the magnet. It should have a gate valve so that the pumping system can be isolated and a 150-200 L/sec turbo pump should be used. Any auxiliary pumping ports should have isolation valves between the pump and the tank. Vacuum instrumentation such as a cold-cathode gauge should be added so that the vacuum can be monitored during the entire cooldown procedure.

The following is taken from the text of an email sent 24 June 2010 from Cary Kendziora to Alan Bross regarding recommendations for the MICE vacuum system.

+++++

I suggest that the vacuum pressure required should be **10-5 torr**. Ultimately when the device is cold it will be at 10-7. In order to achieve this, care needs to put into the assembly to obtain a reasonable cleanliness, virtual leaks and materials that outgas should be avoided. There should be an isolation gate valve mounted directly on chamber and the turbo (preferably hybrid) directly mounted on the valve maximizing the throughput to the turbo. The foreline can be a KF 40. A design for a turbo that can be used as a baseline design is shown here: