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Technical Specification

Multi-layer Insulation for the MICE Magnets and Absorbers

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1. Purpose

This note identifies the requirements for the MICE magnet and MICE absorber multi-layer insulation (MLI).

2. Scope

This note tells the vendor the minimum acceptable number of layers of multi-layer insulation used in various places in the MICE magnets and absorbers. The multi-layer insulation is defined for three locations; insulation on the 4 K cold mass assembly, insulation on the piping, and insulation on the outside of the shield and on parts above 50 K.

3. Reference Drawings

There are no MICE drawings of the MLI blankets. The MICE assembly drawings will refer to this specification. The magnets and absorbers are cooled using two stage 4 K coolers. The magnet or absorber includes anything that is attached to the second stage of the cooler. The shield is defined as anything that is attached to the first stage of the cooler.

4. General Multi-layer Insulation Requirements

4.1. Reflector material shall be 6 micron thick Mylar film, covered on both sides with a 250 Angstrom thick aluminum layer.

4.2. The reflector may be smooth or crinkled.

4.3. Blankets using smooth reflectors shall have a spacer between each reflector. Acceptable spacer materials include Dacron bridal veil netting, a light-weight, open-weave glass cloth, or 0.006 inch thick Reemay 2006 cloth. Mechanically fragile separators shall not be used. The use of alternate spacers is subject to MICE approval.

4.4. The thermal shields and current lead chimneys shall be covered with a minimum of 30 reflecting layers unless otherwise specified.

4.5. Piping exposed to 300 K thermal radiation shall be covered with a minimum of 30 reflecting layers. Because the space between the cold mass and the magnet warm bore tube is tight, the number of layers on the warm bore tube may be reduced to 10.

4.6. The 4 K cold mass and piping located inside the thermal shield shall be covered with a minimum of 10 reflecting layers unless otherwise specified.

4.7. To prevent thermal shorts, no more than 5 reflectors can be overlapped as a group.

4.8. Care shall be taken to prevent "shine-through" from room temperature surfaces through cracks in the MLI.

4.9. Provision shall be made to prevent MLI layers from being sucked into evacuation and pressure relief ports.

5. Specific Multi-layer Insulation Requirements for the Magnets

5.1. Specification for MLI for the Magnet Cold Mass

The cold mass insulation blanket should be about 500 mm longer than the cold mass so that it can be tucked and taped over the ends of the cold mass. It is recommended that the cold mass insulation be spooled onto the cold mass as it is being turned about the axis of the solenoid. The cold mass insulation shall consist of 10 layers, except on the inner bore where there may be 5 layers. The ends MLI blanket must be interleaved and there must be no portion of the cold mass that is visible through the MLI blanket.

5.2. Specification for MLI for the Helium Piping

Pipes that are within the cryostat shall be wrapped with 5 layers of MLI. It is recommended that the MLI consist of alternating layers of aluminized Mylar and bridal veil netting. The pipe shall not be visible when wrapped with MLI.

5.3. Specification for MLI between the Cold Mass and the Helium Shield Piping

This blanket shall be at least 400 mm longer that the cold mass so that it can be tucked around the piping. This blanket width should be a little over half the circumference of the cold mass. The cold mass to piping insulation shall consist of at least 10 layers.

5.4. Specification for MLI around the Bore Tubes

5.4.1. Coupling Magnet Bore Tube

The warm bore tube of the coupling coil shall be wrapped with 30 layers of MLI. The spooled MLI sheet shall be 650 mm wide so that the insulation can be tucked around the ends of the shield and interleaved with the shield insulation. An alternative to spooling insulation on the coupling coil bore tube is to extend the MLI on the outside of the coupling coil shield around the ends of the coil to the inside of the magnet. In this case the width of the outer shield insulation sheet shall be about 800 mm wide.

5.4.2. Focusing Magnet Bore Tube

The space between the magnet cold bore and the warm bore tube that goes around the hydrogen absorber is limited. A minimum of ten layers of insulation shall be between the warm bore tube and the aluminum shield. There shall be a minimum of five layers of insulation between the cold bore and the shield. It is recommended that the insulation shall consist of alternating layers of aluminized Mylar and bridal veil netting. This MLI blanket goes around the support structures on the helium tank. Care must also be taken to see that none of the inner bore of the magnet is exposed direct thermal radiation from the warm magnet bore.

5.4.3. Detector Magnet Bore Tube

The warm bore tube of the detector magnet coil shall be wrapped with 30 layers of MLI. The spooled MLI sheet shall extend over the full length of the detector module more plus 200 mm so that the insulation can be tucked around the ends of the shield and interleaved with the shield insulation.

5.5. Specification for MLI around the outside of the Magnet Shield

The MLI blanket width for the shield shall be the shield length plus the shield depth (in the radial direction) plus 100 mm. The extra length and width allows for the interleaving of MLI layers at the corners and with the MLI on the inner bore. The MLI blanket shall consist of at least 30 layers. It is recommended that the insulation be spooled as the solenoid is turned about its axis. The thickness of the MLI on the outside of the shield must be at least 25 mm.

6. Specific Insulation Requirements for the Absorber

6.1. Insulation between the Absorber Body and the Absorber Vacuum Vessel

There should be 5 layers multi-layer insulation between the absorber body or surge tank and condenser and the absorber shield, which is connected to the first stage of the cooler. The absorber and the surge tank are connected to the second stage of the 4 K cooler.

6.2. Insulation around the Absorber Vacuum Vessel

There shall be a minimum of 10 layers of multi-layer insulation around the absorber body or the shield that is between the absorber body and the warm bore of the focusing magnet. The multi-layer insulation shall be installed in such as way so as to prevent it from plugging the absorber vacuum vessel vents. There is no MLI between a around a solid absorber, because this absorber operates at room temperature. A solid absorber should be painted black so that it can transmit heat the outside world by thermal radiation.

6.3. Insulation on the Liquid Absorber Thin Windows

There shall be a minimum of 4 layers of multilayer insulation on the outside of the thin absorber windows. This MLI shall be interleaved with the MLI on the absorber body. There shall be a layer of thin bridal veil on the outside of the window MLI. This layer shall prevent the migration of the MLI into the absorber vacuum space in the event of an absorber window burst.

6.4. Insulation around Absorber Piping

The hydrogen pipe, vent pipes and the helium fill pipe between 300 K and the first stage intercept should be insulated with a minimum of 5 layers of MLI. The pipes that connect the first stage intercept to either the absorber or the condenser surge tank should be insulated with a minimum of 10 layers of MLI. The pipes that connect from surge tank to the absorber should have at least 10 layers of MLI. Copper straps that connect the first stage of the cooler to the absorber and surge tank shields shall be insulated with 10 layers of MLI. The copper strap that connects the second stage of the cooler to the absorber shall be insulated with a minimum of 10 layers of MLI. It is recommended that the MLI consist of alternating layers of aluminized Mylar and fine open mesh Dacron bridal veil netting. None of the pipe surfaces shall be visible when wrapped with MLI.