

SPECIFICATION FOR DFBX BOX MULTI-LAYER INSULATION

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1. PURPOSE:

This note identifies the requirement for the DFBX box 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 DFBX box. The multi-layer insulation is defined for four locations; insulation on the liquid helium tank assembly, insulation on the piping at temperatures less than 50 K, insulation of the piping at a temperature above 50 K and insulation on the outside of the shield and on parts above 80 K.

3. MLI COMPONENTS TO BE DESCRIBED IN THIS REPORT

- 3.1. **The Shield Top Plate MLI Blanket** This is the insulation blanket between the vacuum vessel top plate and the shield top plate. This blanket shall have at least 30 layers. The shield standoffs go through this insulation blanket.
- 3.2. **The MLI for around the Piping Assembly** This MLI is in two different blankets. The first blanket is installed on the top of the helium tank before the piping is installed. The first blanket shields the helium tank from the piping. The second blanket is installed after the piping is installed. This blanket shields the piping from the 75 K shield top plate. The two blankets are joined to surround the piping subassembly. These MLI blankets should have at least 10 layers. The piping is insulated separately according to 3.7 below.
- 3.3. **The MLI Blankets for the Helium Tank Assembly** There are four MLI blankets in this assembly in boxes C, D, G, and H. There are two MLI blankets in this assembly for boxes A, B, E, and F. The first blanket covers the bottom, the sides and the top of the helium can. This blanket has a minimum of ten layers. At the bottom of the tank around the places where the supports attaches to the tank, the number of MLI layers should be increased prevent shine through. The second blanket covers the bus duct piping at the quadrupole end of the box. The third blanket (found only in boxes C, D, G and H) covers the bus duct piping at the dipole end of the box. The fourth blanket (found only in boxes C, D, G, and H) covers the cross over pipe between the bus ducts.
- 3.4. **The MLI Blankets for the Shield Sides, ends, and Bottom** These are the multi-layer insulation blankets that cover the shield sides, end and bottom. There are five of these MLI blankets. These blankets should have at least 30 layers. The boxes have slit end MLI blankets for both

ends to allow the shield hat assembly to pass through the MLI. Additional short MLI blankets cover the hats. The hat at the quadrupole end has its own short MLI blanket. The side MLI blanket that will be over the side door must be slit to allow access to the shield side door. An additional blanket is put over the slit MLI over the access door.

- 3.5. **The MLI Blankets over the Piping inside the Shield Clam Shell** These blankets cover the piping that is inside the shield clam shells. These blankets should have at least 10 layers.
- 3.6. **The MLI Blanket over the Shield Clam Shells** These are the MLI blankets between the shield clam shell and the vacuum vessel clam shells. These MLI blankets should have at least 30 layers.
- 3.7. **Insulation for the Piping** This is the insulation that is applied to the pipes before they are installed in the DFBX box. The minimum insulation for the piping should be a layer of aluminum tape, to reduce the emissivity of the pipe surface. Pipes E1, E2, and EX, which are exposed to 300K surfaces, must have at least 30 layers of MLI.

4. REFERENCE DRAWINGS

There are no LBNL drawings of the MLI blankets. The LBNL assembly drawings will refer to this specification.

5. GENERAL REQUIREMENTS

- 5.1 Reflector material shall be 6 micron thick Mylar film, covered on both sides with a 250 Angstrom thick aluminum layer.
- 5.2 The reflector may be smooth or crinkled.
- 5.3 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 LBNL approval.
- 5.4 The thermal shields and current lead chimneys shall be covered with a minimum of 30 reflecting layers.
- 5.5 Piping exposed to 300 K thermal radiation shall be covered with a minimum of 30 reflecting layers.
- 5.6 The liquid helium vessel and piping located inside the thermal shield shall be covered with a minimum of 10 reflecting layers.
- 5.7 To prevent thermal shorts, no more than 5 reflectors can be overlapped as a group.
- 5.8 Care shall be taken to prevent "shine-through" from room temperature surfaces through cracks in the MLI.
- 5.9 Provision shall be made to prevent MLI layers from being sucked into evacuation and pressure relief ports.

6. MULTI-LAYER INSULATION REQUIREMENTS

- 6.1 **Specification for the Shield Top Plate MLI** The MLI blanket that goes over the shield top plate shall be about 150 mm (6 inches) longer and about 150 mm (6 inches) wider than the shield top plate assembly. The MLI blanket shall consist of a minimum of 30 layers.
- 6.2 **Specification for the MLI for between the Helium Tank and the Piping** This Blanket shall be at least 400 mm longer than the tank so that it can be tucked around the piping. This blanket width should be a little over half the circumference of the helium tank. The helium tank to piping insulation shall consist of at least 10 layers.
- 6.3 **Specification for MLI for between the Piping and the Shield Top Plate** This Blanket shall be 400 mm longer than the shield top plate so that it can be tucked around the piping. This blanket width shall be about 400 mm wider than the shield top plate, in order to permit the blanket to be tucked around the piping. The shield top plate to piping insulation shall consist of 10 layers.
- 6.4 **Specification for MLI for the Helium Tank** The helium tank insulation blanket should be about 500 mm longer than the tank so that it can be tucked and taped over the ends of the tank and the insulated lambda plate pipes. The helium tank blanket should be wide enough to go around the helium tank plus an additional 150-mm of width. The blanket should be slit where it goes around the lead chimneys. The helium tank insulation shall consist of 10 layers. When the MLI blanket is applied, the layers must be interleaved and there must be no portion of the helium tank that is visible through the MLI blanket.
- 6.5 **Specification for MLI around the Support Structure** This MLI blanket goes around the support structures on the helium tank. The blanket shall be 100 to 150 mm longer than the support structure in all directions. The blanket between the support structure and the insulated helium tank shall have a minimum of 30 layers. Care must be taken to insure that no radiation passes from the vacuum vessel base plate to the liquid helium tank. Care must also be taken to see that the most of the bottom of the tank around the support structure is covered with an extension of the 80 K shield.
- 6.6 **Specification for MLI for Shield Bottom** The MLI blanket for the shield bottom shall be about 150 mm longer than the shield bottom and it shall be about 150 mm wider than the shield bottom. The extra length and width allows for the interleaving of MLI layers at the corners. The MLI blanket shall consist of at least 30 layers. It is recommended that the blankets be sewn together at four points. Velcro buttons can be attached to the MLI blankets to allow it to be attached to the shield bottom plate. Care must be taken when interleaving the bottom shield insulation layers with the insulation layers on the shield sides and ends. The thickness of the MLI on the shield bottom must be at least 25 mm.

- 6.7 **Specification for MLI for Shield Ends** The MLI blanket for the shield ends shall be about 150 mm higher than the shield end and it shall be about 150 mm wider than the shield end. The extra length and width allows for the interleaving of MLI layers at the corners. The MLI blanket shall consist of at least 30 layers. The MLI blanket shall be slotted to allow the shield end flanges to pass out through the MLI. The shield flanges will have MLI applied to them interweaving with the end plate MLI. It is recommended that the blankets be sewn together at four points. Velcro buttons can be attached to the MLI blankets to allow it to be attached to the shield end plates. Care must be taken when interleaving the end shield insulation layers with the insulation layers on the shield top, bottom and sides. The minimum thickness for the MLI on the shield ends is 30 mm.
- 6.8 **Specification for MLI for Shield Sides** The MLI blanket for the shield Side shall be about 150 mm longer than the shield side and it shall be about 150 mm higher than the shield side. The extra length and width allows for the interleaving of MLI layers at the corners. The MLI blanket shall consist of at least 30 layers. The center of the MLI blanket on the access door side plate shall be slit to allow the door to be removed. It is recommended that the blankets be sewn together at four points. Velcro buttons can be attached to the MLI blankets to allow it to be attached to the shield side plate. Extra layers of MLI and netting should be interleaved with the shield side MLI blanket that is over the side plate access door. Care must be taken when interleaving the side shield insulation layers with the insulation layers on the shield top, bottom and end. The minimum MLI thickness on the shield sides is 30 mm.
- 6.9 **Specification for MLI for Inside the Shield Clam Shells** This MLI blanket covers the piping that is surrounded by the shield clam shells. The insulation around the clam shell piping assembly is in addition to the insulation that is on the pipes. The MLI blanket shall consist of at least 10 layers.
- 6.10 **Specification for MLI for Outside the Shield Clam Shells** This MLI blanket insulates the shield clam shell from the vacuum vessel. The MLI blanket shall consist of at least 30 layers. None of the shield clam shells should be visible once the shield clam shell insulation has been applied. Layers of the shield clam shell insulation should be interleaved with layers of the shield top plate insulation. This inter leaving process must be carefully done. The minimum thickness for the clam shell insulation is 20 mm.
- 6.11 **Specification for MLI for the Bus Duct Piping** There shall be at least 10 layer of MLI applied to the lambda plate piping. This insulation can be applied in stripes that are 100 to 150 mm wide. These strips should be alternating layers of aluminized Mylar and spacer.
- 6.12 **Specification for MLI on the Rest of the Piping** The rest of the piping must have insulation to cut radiation heat transfer and heat transfer between the spider and the pipes. The minimum insulation required for the pipes is a coating of

aluminum tape to cut the thermal emissivity of the pipe surface. Pipes that operate at temperature below 50 K can have a surface covered with aluminum tape only. The area around the bellows and flex hoses should be insulated with strips of 10 alternating layers aluminized Mylar and Dacron bridal veil netting. Pipes that must be cold shocked after they have been installed may be insulated with aluminum tape alone. Pipes E1, E2, and EX that operate at above 50 K must be insulated using 30 layers.