

Corrections 8, 12, 4, 5

SUPERCONDUCTING
SUPER
COLLIDER

MATERIAL SPECIFICATION

NO. SSC-MAG-M-405

TITLE: ELECTRICAL INSULATION
FOR SSC MAGNETS

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REVISION RECORD

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1. Scope:

This specification establishes the requirements for the procurement of electrical insulation-film wrapping material for use in SSC magnet construction.

- 1.1 Film Types - This specification provides procurement requirements for the film types shown in Table 1-1.

TABLE 1-1. Insulating Film Types				
Specification Number Type	Name	Base Material Specification Section	Coating-Material Specification Section	Dimensions Specification Section
SSC-MAG-M-405-1	Uncoated Insulation	3.1.1	None	3.1.4
SSC-MAG-M-405-2	Adhesive-Coated Insulation	3.1.1	3.1.2	3.1.4
SSC-MAG-M-405-3	Teflon (FEP) Coated Insulation	3.1.1	3.1.3	3.1.4

2. Applicable Documents

The following documents of the issue in effect on the date of invitation to quote form a part of this specification to the extent specified herein.

2.1 Industry

- 2.1.1 Bulletin No. E-72087 - Kapton Polyimide Film - Summary of Properties, DuPont Co.

- 2.1.2 3M Product Specification for Scotch-Weld Structural Adhesive 2290.

- 2.2 Reference - National Bureau of Standards Monograph 132 - A Compilation and Evaluation of Mechanical, Thermal and Electrical Properties of Selected Polymers - Section 9 PPMI.

- 2.3 Conflicts - Where any of the above documents conflict with the requirements of the Purchase Order or this specification, such conflicts shall be brought to the attention of the Buyer.

3. Requirements

3.1 Material Properties - The insulation - film material shall consist of (1) a base material with or without (2) an adhesive coating applied on one side of the base material as specified by the applicable purchase order, or (3) a base material coated on one or two sides with a teflon coating as specified by the applicable purchase order. The material properties of each component shall be as specified below.

3.1.1 Base Material - The base material shall be polypyromellitimide (PPMI) with mechanical and thermal properties equal to or better than those listed for Kapton Type H film in DuPont Bulletin No. E-72087 [¶2.1.2 above].

3.1.2 Adhesive-Coating Material - The adhesive coating material shall be:
Resin - "B" Stage Epoxy
3M Brand
Scotch-Weld Structural Adhesive 2290 or equivalent

This material shall have properties equal to or better than those listed in 3 M Production Specification 2290 (¶ 2.1.2 above).

3.1.3 Teflon Coated Material - The teflon coated material shall have mechanical, thermal moisture and chemical resistance properties equal to or better than those listed for Kapton Type F film in DuPont Bulletin No. E-72087 (¶ 2.1.1 above).

3.1.4 Design Application - Design applications of SSC-MAG-M-405-1 and -3 films include considerations of the base material ^{and Teflon-coated material} properties defined in the ¶ 2.1.1 reference document. Significant properties from that document are included in Table 3-1 and Table 3-3, respectively, for ease of reference.

Design applications of SSC-MAG-M-405-2 include consideration of the adhesive-coating material properties defined in the ¶2.1.2 reference document. Significant properties from that document are included in Table 3-2 for ease of reference.

Table 3-1 Significant Properties of Base-Material	
Density (295 K)	1.43 gm cm ⁻³
Crystalline melting point	None
Crystallinity	Variable
Approximate transition regions	220-300 K, 400-430 K
Chemical resistance	Highly resistant
Flammability	Self extinguishing Flame resistant
Thermal expansion coefficient (295 K)	2 x 10 ⁻⁵ K ⁻¹
Dielectric constant (10 ⁵ Hz)(295 K)	3.4
Dielectric loss tangent (10 ⁵ Hz)(295 K)	0.005
Tensile Ultimate Strength	
at 296 K (23 C)	22 ksi
at 423 K (150 C) <u>a/</u>	19 ksi
Tensile Yield Strength (3 % elongation)	
at 296 K (23 C)	10 ksi
at 423 K (150 C)	7 ksi

a/ Cure temperature used for adhesive-coating material.

Table 3-2 - Significant Properties of Adhesive-Coating Material	
Cure Temperature	30-60 minutes at 335-350°F (168-177°C)
Shelf-Life	1 year - at 40°F (4°C)
Shear Strength	5500 psi at 75°F (24°C)

Table 3-3 - Significant Properties of Teflon-Coated Material			
Property	Film Type*		
	120F616	150F019	250F029
Density (295°K) gm cm ⁻³	1.53	1.67	1.57
Tensile Ultimate Strength(ksi) @ 296°K (23°C)	24	17	25
@ 473°K (200°C)	16	11	16
Tensile Yield Strength(ksi) (3% elongation) @ 296°K (23°C)	9	7.3	10
@ 473°K (200°C)	5.5	4	8

*Since a number of combinations of polyimide film and fluorocarbon coating add up to the same total gauge, it is necessary to distinguish among them. A three digit system is used in which the middle digit represents the nominal thickness of the base film in mils. The first and third digits represent the nominal thickness of the coating of fluorocarbon resin in mils. The symbol 9 is used to represent 13 μm (1/2 mil), and 6 to represent 2.5 μm (1/10 mil). Example: 120F616 is a 120-gauge structure consisting of a 25 μm (1-mil) base film with a 2.5 μm (1-10 mil) coating of teflon on each side.

3.1.5 Physical Properties

3.1.5.1 Size - Nominal dimensions of the finished product will be specified on the purchase order.

3.1.5.2 Tolerances - The dimensional tolerances on the finished product shall be as listed in Table 3-4.

Table 3-4 Nominal Dimensions and Tolerances		
Nominal Dimension, Inch	Permissible Variations From Nominal Dimension	
	Plus	Minus
<u>Base-Material Thickness</u>		
.001	10%	10%
.002	10%	10%
.003	10%	10%
.005	10%	10%
<u>Adhesive-Coating Material Thickness</u>		
.0005	10%	10%
.0010	10%	10%
<u>Teflon-Coating Material Thickness</u> One or two sides		
.0001	10%	10%
.0005	10%	10%
Base Material width (with or without coating) <u>Width</u> Various widths (1/8" ^{to} 36 in.) <u>or</u> as specified on drawing <u>Purchase Order</u>		
	.010 in.	.010 in.

- 3.1.5 Cleanliness - Uncoated or coated film shall be processed, i.e., cut, coated, cured, spooled, and packaged in an environment controlled to prevent any surface contamination by dirt, grease or other foreign matter.
- 3.1.6 Film Surface Condition - The deliverable film surface finish shall be clean, free of dirt, grease, slivers, cracks, wrinkles, etc.
- 3.1.7 Porosity - The deliverable film shall be free of pinholes or porosity visible under 10X magnification.
- 3.1.8 Storage Conditions - Coated material in process of sizing, storage, or shipment, shall be controlled at temperatures to prevent degradation of its 1 year shelf life.

4. Quality Assurance Provisions

- 4.1 Incoming Film Material - Each manufacturer's lot of film base material and adhesive shall be verified upon receipt for compliance with the applicable requirements of Tables 3-1, 3-2 and 3-3, using the manufacturer's Certificate of Conformance. In addition, a sample of uncoated or teflon-coated film specimen from each manufacturer's lot of raw material shall be tested for tensile strength per ASTM Test Method D-882 at 23°C. A copy of the test results shall accompany shipments of the finished product. Film material not meeting or exceeding the tensile strength requirements for 23°C of Table 3-1 or Table 3-3 shall not be offered to the buyer for acceptance.

5. Preparation for Delivery

- 5.1 Packaging - Each roll of film shall be enclosed in a suitable plastic bag, identified as specified below, with a minimum of 10 rolls packaged in a cardboard container suitable to prevent slipping or storage damage.
- 5.2 Storage Conditions - Coated material awaiting shipment shall be stored at temperatures of 40°F (4°C) or lower.
- 5.3 Identification - Each roll-plastic bag shall be identified with the supplier shipment lot number. Each outer package will be identified as follows:

SSC Electrical Insulation Film

SSC-MAG-M-405-1, SSC-MAG-M-405-2, or SSC-MAG-M-405-3

Film Processor's Name _____

Film Mfg. Lot No. _____

Date of Manufacture _____

Material to be stored at 40°F (4°C) or lower.