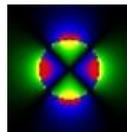


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Magnet Division Specification

Specification Number: SMD-APUL-2008

Revision: A



Superconducting
Magnet Division

Procurement Specification, APUL D1 Dipole Coil Insulators

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Revision History

- Rev A:

1. Scope:

This specification establishes the material requirements and quality assurance requirements for APUL D1 coil insulators. These insulators are composed of a thermoset plastic consisting of a phenolic two-step resin with glass fiber reinforcement.

2. Applicable Documents:

2.1 Specifications:

The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, the issue date or revision level shall be that in effect on the date of the invitation to quote:

ASTM D149	Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
ASTM D256A	Impact Resistance of Plastics and Electrical Insulating Materials
ASTM D257D-C	Resistance or Conductance of Insulating Materials
ASTM D495	High-Voltage, Low-Current, Dry Arc Resistance of Solid Electrical Insulation
ASTM D570	Water Absorption of Plastics
ASTM D638	Tensile Properties of Plastics
ASTM D695	Compressive Properties of Rigid Plastics
ASTM D696	Coefficient of Linear Thermal Expansion of Plastics
ASTM D790	Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
BNL-QA-101	Seller Quality Assurance Requirements

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3. Requirements:

3.1 Molding Material:

The molding material to be used for the insulators shall be Rogers ®RX630 which is obtainable from the supplier listed below:

Rogers Corporation
Molding Materials Division
P.O. Box 550
Manchester, CT 06040
(203) 646-5500

3.2 Testing, Analysis, and Certification of the Molding Material:

For each production lot (batch) of molding material ordered from Rogers Corp., the Buyer shall obtain a Certificate of Chemical and Physical Analysis. This report shall be based on a series of lab tests performed by Rogers Corp. on samples molded from each lot of material. The analysis must include all of the measurements listed in paragraph 3.2.3.

3.2.1 Properties for which a minimum value is stated: The measurements shall not fall below the minimum value in any lot nor shall they vary by more than 20% from lot to lot or within any given lot of material.

3.2.2 Properties for which a range is given: All measurements must fall within the specified range from lot to lot or within any given lot of material.

® Trademark - Rogers Corp.

3.2.3 Material Properties:

Property (as molded)	Test Method	Value
Izod Impact	ASTM D256A	0.81 ft.lb/in. minimum
Flexural Strength	ASTM D790	22,000 psi minimum
Flexural Modulus	ASTM D790	1.4 x 10 ⁶ psi minimum
Tensile Strength	ASTM D638	10,000 psi minimum
Compressive Strength	ASTM D695	30,000 psi minimum
Compressive Modulus	ASTM D695	1.1 x 10 ⁶ psi minimum
Water Absorption:		
24 hrs. @ 23°C	ASTM D570	0.01% - 0.10%
48 hrs. @ 50°C	ASTM D570	0.15% - 0.25%
Dielectric Strength 60 Hz ST/SS (wet)	ASTM D149	325/275 volts/mil minimum
Volume Resistivity	ASTM D257	2.0 x 10 ¹¹ ohm-cm minimum
Arc Resistance	ASTM D495	120 sec minimum
Coeff. of Thermal Expn.		
Parallel to flow dir:	ASTM D696	13 - 28 x 10 ⁻⁶ in/in/°C
Transverse to flow dir:	ASTM D696	29 - 41 x 10 ⁻⁶ in/in/°C

3.3 Material Approval:

The Certificate of Chemical and Physical Analysis for each production lot of molding material shall be approved by the Buyer prior to the use of that material by the Seller.

3.4 Process Uniformity:

Since uniformity of the mechanical and electrical characteristics of the insulators is fundamentally important to the successful operation of APUL magnets, there shall be no significant change in manufacturing methods during the entire production run without prior written approval from the Buyer.

4. Quality Assurance Provisions:

Unless otherwise specified, responsibility for the performance of the following inspections, test, and data requirements rests with the Seller. Insulators shall be subjected to the following inspections and tests.

4.1 Physical characteristics:

All insulators delivered to the Buyer shall conform to their applicable engineering drawing. Approval of new mold(s) shall be based on a complete inspection of no less than twenty insulators to determine conformance with the applicable drawing. In addition, any subsequent tooling and/or set-up alterations shall first be officially approved of by the Buyer before production resumes. The Buyer reserves the right to perform an inspection of no less than twenty insulators to determine conformance with the applicable drawing after any tooling and/or set-up change as well as a material lot or batch change.

4.2 Mechanical Characteristics:

One insulator in each production lot or one in 300, whichever yields the greater number of test samples, shall be sacrificed for compressive modulus testing in accordance with ASTM D695. Test specimens shall be machined from the pole region of the insulator.

4.2.1 Criteria for Acceptance (Mechanical Performance)

The compressive modulus measured from these specimens shall not be less than 1.1×10^6 psi. Failure to meet this requirement for minimum compressive modulus shall result in a rejection of the entire lot of insulators from which the sample originated.

4.3 Electrical Characteristics:

4.3.1 Dielectric Integrity: The Buyer shall perform the following test for volume resistivity on three insulators from each production lot or one insulator in 50, whichever yields the greater number of test samples. While a sample insulator is constrained in the fixture, voltage shall be applied from the press mandrel across the part, to the press cavity and the leakage current through the insulator shall be measured.

4.3.1.1 Procedure for Measuring Leakage Current:

4.3.1.1.1 Place the RX630 insulator into the electrical test fixture as shown in Figure 1

4.3.1.1.2 Load the insulator as shown in the figure. The desired load (P) to be maintained during testing shall be enough to hold the I.D. and O.D. of the insulator in complete and uniform contact with the fixture. The load (estimated to be between 1000 and 2000 lbs) may be applied hydraulically, or by bolting the load bar to the press cavity,

or any equivalent method.

- 4.3.1.1.3 Apply a potential of 1 KV to the press mandrel while grounding the press cavity.
- 4.3.1.2 Criteria for Acceptance (Dielectric Integrity). The maximum leakage current measured through the sample part to electrical ground (press cavity) while a voltage of 1 KV has been applied for a minimum of 10 seconds shall be $3 \mu\text{a}$ (3×10^{-6} ampere) for 8cm dipole insulators and $6 \mu\text{a}$ for 8cm quadrupole insulators. Failure to meet the dielectric integrity requirement shall result in rejection of the entire lot.
- 4.3.2 Dielectric Strength: One insulator in each production lot or one insulator in 1000, whichever yields the greater number of test samples, shall be sacrificed to confirm the dielectric strength of the production material. This insulator shall be machined to create a thin sliver and tested in accordance with ASTM D149 (dielectric punch-through) and the punch-through value recorded.
- 4.3.2.1 Criteria for Acceptance (Dielectric Strength): The dielectric strength measured in Sect. 4.3.2 shall not be less than 275 V/mil. Failure to meet the dielectric strength requirement shall result in rejection of the entire lot.
- 4.4 Criteria for Maintaining Acceptable Performance:
- Failure of any of the samples to meet the requirements for maximum leakage current and dielectric strength may result in a rejection of the entire lot from which they belong. Furthermore, once the Buyer has concluded that the insulators satisfy all requirements, the Seller shall not alter the curing process or alter the properties of the molding material without first alerting the Buyer as to his intentions. In the event that the Seller must make the aforementioned changes while in the midst of production, he must send ten sample insulators to the Buyer for a recheck of the physical, mechanical, and electrical properties. Only after the Buyer has affirmed that the insulators continue to satisfy these requirements, shall the Seller resume production of insulators.
- 4.5 Applicable BNL-QA-101 Paragraphs:
- Per contractual agreement with BNL.

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5. Preparation for Delivery:

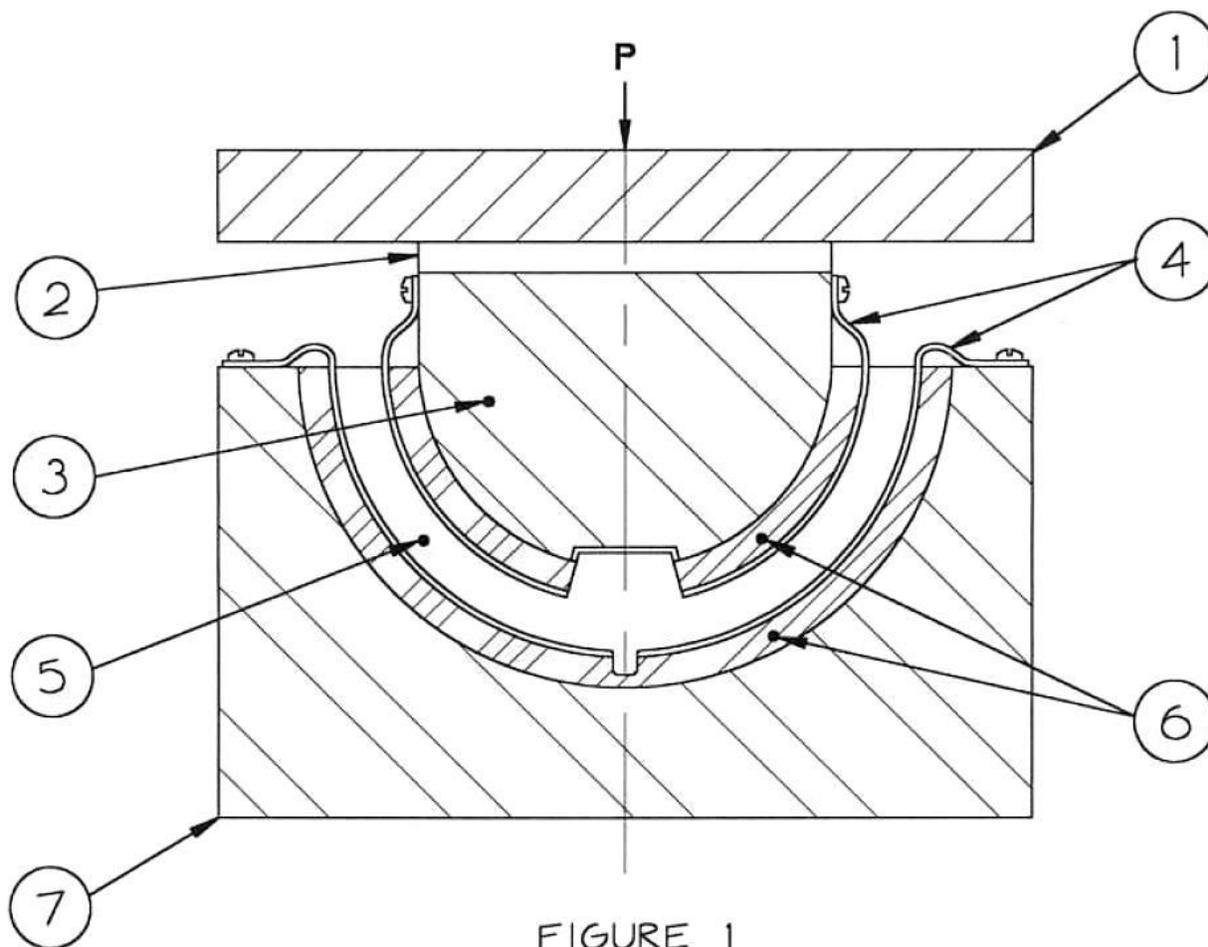
5.1 Packaging:

Insulators shall be clean (free of dirt, oil, etc.) and shall be individually wrapped in blank newsprint (or equivalent packaging medium but not ordinary newspaper) to protect them against scratching, cracking, chipping, etc., which may result from direct contact with each other during handling. Each carton shall contain insulators which all have the same lot number.

5.2 Release for Shipment:

In no event shall the Seller ship production articles without prior authorization from the Buyer in writing. In the event that articles are shipped prior to such authorization, the Seller shall bear all additional shipping costs this action may incur.

ELECTRICAL TEST FIXTURE ASSEMBLY



ITEM	DESCRIPTION
1	STEEL LOAD BAR
2	.250 THICK NEMA G-10 OR EQUIV.
3	STEEL (HIGH VOLTAGE) PRESS MANDREL
4	.005 THICK BRASS SHIM STOCK
5	SAMPLE RX630 PART
6	.250 THICK FLEXIBLE GASKET
7	STEEL (ELECT. GND) PRESS CAVITY