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Large Hadron Collider
Magnet Division Specification

Spec. No.: LHC-MAG-M-1000

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Class: Ancillary Specification
Title: High Strength Non-Magnetic High Manganese Steel For Superconducting Magnets

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- ES&H Review: Signature on File

REVISION RECORD

Rev. No.	Date	Page	Subject	Approval
A	8/25/98		Initial Release.	

1. Scope:

This specification covers the requirements for high strength non-magnetic high manganese steel used for superconducting magnet collars. The material will be used at 300K during construction and near 4.35K during magnet operation.

2. Applicable Documents:

ASTM A370 - Test Methods and Definitions for Mechanical Testing of Steel Products.

ASTM A480 - Specification for General Requirements for Flat-Rolled Stainless.

3. Requirements:

High strength non-magnetic high manganese steel sheet offered by the Seller under this specification number shall meet the physical properties and inspection and test requirements.

3.1 Chemical Properties:

3.1.1

Chemistry	Composition, % (range or max.)
Carbon	0.4
Manganese	26-32
Phosphorus	0.04
Sulfur	0.06
Silicon	1.0
Chromium	10.0
Nickel	1.8
Nitrogen	0.12
Vanadium	0.06

3.2 Mechanical and Physical Properties:

NOTE: Properties are representative of the material in the final, cold worked condition.

3.2.1 Hardness: Vickers 300 max. at 300K.

3.2.2 Yield Strength: 0.2% yield strength at 300K
= 90,000 psi min. to 105,000 psi max.

3.3 Magnetic Properties:

NOTE: Properties are representative of the material in the final, cold worked condition.

3.3.1 Permeability:

Measured magnetic permeability at a field strength of 1000 Oersteds = 1.002 ± .002 at 300K and 4.2K.

3.4 Dimensions, Surface Quality, and Material Characteristics

3.4.1 Thickness: Finished thickness of the material
= .060 in. ± .003 in.

3.4.2 Width: Finished width after slitting
= 6.10 in. ± .03 in.

3.4.3 Flatness: Out of flatness in transverse direction (crossbow over 6.10 in. width) shall be .010 in. max. after slitting

3.4.4 Surface Finish: 63 micro-inches max.

3.4.5 Surface Quality (General): The surface shall be free from pits, seams, scale marks, laminations, and other injurious defects which due to their nature, degree, or extent, will interfere with the use of the material.

3.4.6 Edge Condition: Slit, minimal burr.

4. Quality Assurance Provisions:

By making a shipment of magnet steel, the Seller automatically certifies that the steel shipped and all processes applied to the steel comply with this specification and the requirements of the purchase order. The Seller agrees to retain objective evidence, including records, of the inspections and tests performed in the course of manufacturing, testing, inspecting, preserving, packaging, and preparation for shipment of the steel. These records shall be made available to the Buyer's representative for review upon request.

Responsibility for the performance of the following inspections, test and data requirements rests with the material manufacturer. Unless otherwise specified, each heat and master coil of finished material shall be subjected to the following inspections and tests.

4.1 Chemical Composition: A determination of the material conformity with the requirements of 3.1, Chemical Composition.

4.2 Mechanical Properties: A determination of the material conformity to:

Vickers Hardness: Paragraph 3.2.1
Yield Strength: Paragraph 3.2.2

4.3 Magnetic Properties: A determination of material conformity to:

Permeability: Paragraph 3.3.1

4.4 Dimensions, Surface Quality and Material Characteristics:
A determination of material conformity to:

Thickness: Paragraph 3.4.1
Width: Paragraph 3.4.2
Flatness: Paragraph 3.4.3

4.5 BNL material performance verification: The seller shall furnish Brookhaven National Laboratory (BNL) via air freight with four 1 inch x 10 inch samples from each master coil. These specimens shall be analyzed by BNL in order to verify conformance with this specification. The seller shall clearly label each specimen so that BNL can determine its origins as well as compare test data acquired from it to the seller's measurements if necessary.

4.6 Non-conforming Material: Material not meeting the requirements of this specification shall not be offered to the Buyer.

4.7 Certificate of Conformance: With each shipment of magnet steel, the Seller shall submit a certificate of conformance. In case of drop shipment, a copy of the certificate shall be submitted to the Buyer at the time of shipment. The certificate shall be signed by an officer of the company, and shall constitute a representation by the Seller that:

A. Materials used are those which have been specified by the Buyer, and that the items delivered were produced from materials for which the Seller has on file reports of chemical or physical analysis, or any other equivalent evidence of conformance of such items to applicable specifications;

B. Processes used in the fabrication of items delivered were in compliance with applicable specifications forming a part of the purchase order, of Buyer approved procedures of specifications;

C. The items as delivered comply with all specifications and other requirements of the purchase order.

4.8 Material certification required. One copy of actual chemical and physical test report(s) for each heat, batch or lot shall accompany each shipment. Test reports shall list the actual parameters tested, and shall contain the actual readings taken during test.

5. Preparation for Delivery:

5.1 Marking Identification Requirements: Each coil of steel shall be identified with the following data, in the order given:

LHC-MAG-M-1000- High Strength Non-Magnetic High Manganese Steel For Superconducting Magnets **B**uyer's P.O. No. _____ Manufacturer's Name Heat No.(s) _____ Master Coil No. _____ Batch Serial No. _____ Net Weight of Material _____

5.2 Treatment and Packaging After Slitting:

5.2.1 The material shall be free of all foreign matter, grease, oil, metal particles, etc.

5.2.2 20 inch coil I.D. min, 24 inch coil I.D. max.

5.2.3 3500 lb. max skid weight. (gross wt.)

5.2.4 Coils shall be shipped in "eye up" condition (20 in. I.D. "eye"), securely banded to pallets.

5.2.5 Paper shall be used between layers of steel in coils, to minimize out of flatness caused by final coiling process.

5.2.6 Each individual coil is to be suitably bound and wrapped to protect it against shipping and environmental damage.