NCSX

Specification

Modular Coil Conductor Specification

NCSX-CSPEC-142-03-01

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Record of Revisions

Revision	Date	Description of Changes
Rev. 0	7/29/2004	Initial issue
Rev. 1		Changed copper grade to 101 in Section 3.3.2.4.2.
		Changed measurement distances to 3" apart (from 6") in Sections 4.2.2.1, 4.2.7, and 4.2.8.

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1 SCOPE

The National Compact Stellarator Experiment (NCSX) is an experimental research facility that is to be constructed at the Department of Energy's Princeton Plasma Physics Laboratory (PPPL). Its mission is to acquire the physics knowledge needed to evaluate compact stellarators as a fusion concept, and to advance the understanding of three-dimensional plasma physics for fusion and basic science.

One of the primary components of the NCSX Core is the modular coil. There are three different coil shapes with a quantity of total of (18) modular coils divided into three different types identified as Types A, B and C. There are quantities of six coils for each type of casting.

Each modular coil is wound using compacted copper rope conductor. This specification establishes the manufacturing and acceptance requirements for the insulated, compacted copper rope conductor that will be used in the fabrication of the modular coils.

2 APPLICABLE DOCUMENTS

NONE

3 REQUIREMENTS

3.1 Item Definition

The item is a continuous length of insulated, compacted copper rope conductor wound onto a spool. A layer of filamentary nylon "serve" is applied to the cable prior to compaction to assist in holding the compacted cable shape. PPPL-supplied glass tape insulation is applied to the outside surface prior to spooling.

3.2 Characteristics

3.2.1 Performance Characteristics

3.2.1.1 Conductor Resistance

The resistance of the conductor shall be less than 0.089 ohms per 1000 feet, measured at room temperature.

3.3 Design and Construction

3.3.1 Production Drawings

NONE

3.3.2 Physical Characteristics

3.3.2.1 Conductor Width

The width of the conductor shall be 0.391 +/- 0.008 inches with serve, after compaction, prior to insulation being applied.

3.3.2.2 Conductor Height

The height of the conductor shall be 0.350 +/- 0.008 inches with serve, after compaction, prior to insulation being applied.

3.3.2.3 Conductor Length

The spool shall be wound with a continuous length of conductor at least 300 feet long.

3.3.2.4 Cable Characteristics

3.3.2.4.1 Wire Size

The cable shall be constructed with 34 AWG wire (nominally 0.0063 inches in diameter).

3.3.2.4.2 Copper Grade

The wire shall be CDA 101 copper.

3.3.2.4.3 Cable Construction

The cable shall be constructed using a series of sub cables with the correct number of strands, lay length and direction as developed during the R&D program.

12x5/54/34 bare copper with single Nylon serve formed to dimensions per Sections 3.3.2.1 and 3.3.2.2.

Cable construction details are provided below.

a. Nine Sub-Cables

54/34 Bare OFHC copper at 2-1/2" Right Hand Lay (RHL) to 0.053" +/-0.002"

5/54/34 Bare OFHC copper at 3-1/2" RHL to 0.103" +/-0.003"

b. Three Sub-Cables for Core

54/34 Bare OF copper at 2-1/2" Left Hand Lay (LHL) to 0.053" +/-0.002"

5/54/34 Bare OF copper at 3-1/2" LHL to 0.103" +/-0.003"

c. Cable

9X5/54/34 Bare OF copper at 5-1/2" LHL around 3X5/54/34 at 5-1/2" RHL to 0.440" +/-0.009" diameter

d. Serve

Single Nylon serve 0.004 inch thick applied to outside bare cable surface and formed to dimensions specified in Sections 3.3.2.1 and 3.3.2.2.

3.3.2.4.4 Cable Weight

The weight of the cable (before the serve is applied) shall be 409.2 +/- 10 pounds per 1000 feet.

3.3.2.5 Turn Insulation

The PPPL shall supply the glass turn-insulation. One half-lapped layer of fiberglass insulation shall be applied to the outside surface of the compacted conductor prior to final spooling. Half- lapped is defined as the overlapping of insulation layers by ½ the width of the tape (+0 /- 1/8 inch). Overlapping more than two thicknesses of fiberglass insulation at any cross section is not permitted.

3.3.2.5.1 Size

1 inch wide x 0.004-inch thick S-2 glass tape heat-treated with S920 Silane finish.

3.3.2.5.2 Weight

3.6 oz. per square yard

3.3.2.5.3 Thread Count

Approximate thread count per inch: 50 (warp)/ 20 (fill)

3.3.2.5.4 Weave

Plain

3.3.2.6 Insulated Conductor Dimensions

The outside dimensions of the insulated conductor shall be 0.415 inch +/-0.010 inch by 0.374 inch +/-0.010 inch

3.3.3 Standards of Manufacture

3.3.3.1 Lubricants

The Subcontractor shall ensure that the finished conductor has been thoroughly cleaned and that no lubricants are used during the cable forming operations.

3.3.3.2 Cleanliness

The Subcontractor shall take the necessary precautions to ensure that the conductor remains clean, free of any oils, or dirt related to processing or handling.

4 QUALITY ASSURANCE PROVISIONS

4.1 General

4.1.1 Responsibility for Inspection

The responsibility for performing all tests and verifications rests with the supplier. PPPL reserves the right to witness or separately perform all tests specified or otherwise inspect any or all tests and inspections.

4.2 Quality Conformance Inspections

This section provides the conformance and testing requirements for the requirements specified in Sections 3 and 5.

4.2.1 Verification of Conductor Resistance

A resistance measurement shall be made for the entire length of conductor (end to end) after spooling to verify compliance with Section 3.2.1.1.

4.2.2 Verification of Conductor Dimensions

4.2.2.1 Conductor Width and Height

The conductor width and height shall be measured to verify compliance with Sections 3.3.2.1 and 3.3.2.2. Six measurements shall be taken at the start of the conductor length, in the middle of the conductor length, and at the end of the conductor length. The six measurements at these locations shall be three inches apart. Measurements at the start and end of the conductor shall be at least 12 inches from terminus of the conductor. Measurements shall be taken after compaction, before applying the turn insulation.

4.2.2.2 Conductor Length

The Subcontractor shall provide an in-process measurement of the conductor length after compaction to verify compliance with Section 3.3.2.3.

4.2.3 Verification of Copper Grade

Material certifications shall be provided to verify compliance with Section 3.3.2.4.2.

4.2.4 Verification of Wire Size

Material certifications for the wire shall be provided to verify compliance with Section 3.3.2.4.1.

4.2.5 Verification of Cable Construction

a. Verification of strand count, lay length and direction is required at start and end of run to verify compliance with Section 3.3.2.4.3, parts a, b, and c.

b. Material certifications for the serve shall be provided to verify compliance with Section 3.3.2.4.3 part d.

4.2.6 Verification of Cable Weight

The length and weight of the cable shall be measured to verify compliance with Section 3.3.2.4.4.

4.2.7 Verification of Insulation

a. The Subcontractor shall certify that the PPPL-supplied insulation as described in Section 3.3.2.5 was applied.

b. The overlap shall be measured to verify compliance with Section 3.3.2.5. Six measurements shall be taken at the start of the conductor length, in the middle of the conductor length, and at the end of the conductor length. The six measurements at these locations shall be three inches apart. Measurements at the start and end of the conductor shall be at least 12 inches from terminus of the conductor.

4.2.8 Verification of Insulated Conductor Dimension

The outside dimensions of the insulated conductor shall be measured to verify compliance with Section 3.3.2.6. Six measurements shall be taken at the start of the conductor length, in the middle of the conductor length, and at the end of the conductor length. The six measurements at these locations shall be three inches apart. Measurements at the start and end of the conductor shall be at least 12 inches from terminus of the conductor.

4.2.9 Verification of Preparation for Shipping

The Subcontractor shall verify compliance with the requirements for conductor spooling (Section 5.1), conductor protection (Section 5.2), and crating (Section 5.3

5 PREPARATION FOR DELIVERY

5.1 Conductor Spooling

The conductor will be wound onto the wooden spools with the narrow side (0.366 inch nominal) of the conductor lying flat on the spool. The wider side (0.407 inch nominal) will be up and down. See below - Note: reference dimensions are without insulation. The spool surface upon which the conductor is placed shall have a minimum diameter of 11.5 inches. There will be only one continuous length of conductor per spool.

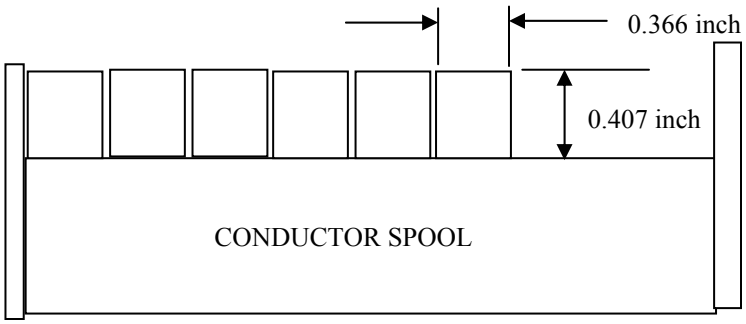

Figure 1 - Conductor and spool layout

5.2 Conductor Protection

Each spool of insulated conductor will be plastic wrapped to protect the conductor from dirt and foreign materials.

5.3 Crating

The spools shall be crated to protect the insulated conductor from shock and weather conditions, including precipitation. The crate shall be built for handling with slings from overhead cranes, and transport by forklifts.

5.4 Shipping

Subcontractor is responsible arranging shipment, and for the safe arrival of the item at PPPL in Princeton, New Jersey, USA. Subcontractor's name, shipper, purchase order number, contents and gross weight shall be marked on the shipping container.