

**NSTX UPGRADE- Spec for INNER TF COPPER EXTRUSION
D-NSTX-SPEC-13-128 Rev.01**

**NSTX UPGRADE
SPECIFICATION**

FOR

Inner TF Copper Extrusion

D-NSTX-Spec-13-128 Rev.01

WP#1672

Date: December 21, 2010

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1.0 SCOPE

- 1.1** This specification defines the alloy, form, quantity and integrity of the inner TF coil extruded copper conductors for the National Spherical Torus Experiment (NSTX) Upgrades. To minimize the risk of coil failure, for any reason, strict adherence to these specifications and the associated drawings is essential.
- 1.2** Seller shall furnish all material, labor and facilities necessary to complete the work as defined in the contract documents subject to the qualifications, conditions, or exceptions noted.

2.0 APPLICABLE DOCUMENTS

2.1 C-DC1402, Drawing of Inner TF Bundle copper extrusion for NSTX Upgrade

2.1.1 Dimensions in drawings and specifications shall refer to conditions at room temperature (20° Centigrade).

2.2 Standards and Codes

2.2.1 All materials shall comply with the latest revision of the following documents in effect at the date of the approved purchase order. These documents form a part of this specification to the extent referenced herein.

2.2.1.1 ASTM Standards

B193 Test for the Resistivity of Electrical Conductor Materials

B577 Test of Hydrogen Embrittlement of Copper

E8 Tension Testing of Metallic Materials

E18 Test for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials

B170 Oxygen-Free Electrolytic Copper Wire Bars

B187 Copper Bus Bar, Rod and Shapes

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- 2.2.2** The above Standards and Codes set forth the minimum requirements. They may be exceeded by the Seller with written permission from PPPL, if in the Subcontractor's judgment, superior or more economical designs or materials area available for successful and continuous operations as required by the specification.
- 2.2.3** Seller agrees, represents and warrants that all services, designs and material sold or otherwise provided to PPPL by the Seller comply with applicable Federal, State and Local laws, regulation and codes, and all applicable specifications and standards, including those specified above, in each case is in effect at the date of the order placement. Seller shall advise PPPL of the codes, standards and requirements complied with in the design and fabrication of the deliverable items.

3.0 REQUIREMENTS

3.1 Extrusion Material

The material required is UNS C10700 oxygen-free copper with silver content of 25 troy oz/ton (.085% Ag). The material shall be of such quality and purity that the finished product shall have the properties and characteristics prescribed in this specification and shall be cold drawn to produce the required temper, edge and surface finish. The conductors shall be furnished in the cold drawn condition.

3.2 Strength

- 3.2.1** Yield Strength shall be 20,000 psi min. to 30,000 psi max. (0.5% elongation)
- 3.2.2** Ultimate Tensile Strength shall be 32,000 psi minimum @ 15% elongation
- 3.2.3** Hardness checks shall be used to verify the uniformity of the properties along the conductor lengths. (80 to 84 Rockwell F scale)

3.3 Electrical Conductivity

- 3.3.1** Electrical resistivity shall be 100% minimum IACS.

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3.4 Shapes

3.4.1 One shape, cross-section, is required for the inner TF conductors.

3.4.2 Dimensional tolerances are given on the drawings.

3.5 Quantities and Lengths

3.5.1 Required quantity: 80 conductor lengths

3.5.2 Required conductor lengths: 236 inches +/- 1 inch

4.0 TEST AND INSPECTION REQUIREMENTS

4.1 COPPER BILLETS

4.1.1 General Inspection:

Extrusion billets shall be free of shrink holes, porosity, cracks, cold sets, inclusions, pits, laminations and similar defects. The metal furnished shall be of uniform purity and grade.

4.1.2 Microscopic Examination

The test specimens of the material designated as UNS C10700 shall be free of cuprous oxide as determined by Procedure-A of Methods B577. In the case of a dispute, a referee method, in accordance with Procedure C, shall be employed.

4.1.3 Embrittlement

It is required that the material designated as UNS C10700 pass the embrittlement test as indicated in ASTM B170 Paragraph 7.5 and Procedure B of Methods B577. In the case of a dispute, a referee method, in accordance with Procedure C, shall be employed.

4.2 EXTRUDED COPPER CONDUCTORS

4.2.1 General Inspection

The finished material's surface shall be free from internal and external blisters, slivers, laps, seams, cracks, piping and scale, as well as from all other imperfections, such as damaged corners or edges, not consistent with best commercial practice, and shall be bright and clean. Inspection procedures shall be proposed by Subcontractor and approved by PPPL. The vendor shall propose an

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acceptance test and criteria for internal flaws and defects. This should be included in their test plan in Section 5.4.

4.2.2 Dimensional Measurements

4.2.2.1 Conductors shall be checked to verify that the cross-sectional dimensions are within the required tolerance. Method and number of measurement locations shall be proposed by Subcontractor and approved by PPPL.

4.2.2.2 Conductors shall be checked to verify straightness of surfaces following extrusion prior shipping. Straightness check of conductors must be performed in the “free” unconstrained state. Method shall be proposed by Subcontractor and approved by PPPL. The straightness acceptance criteria are identified on conductor drawing.

4.2.2.3 Conductors shall be checked to verify that the length of each extrusion is within the required tolerance (3.5.2). Method shall be proposed by Subcontractor and approved by PPPL.

4.2.3 Measurement of Properties

4.2.3.1 Each extruded conductor shall be subjected to the Rockwell hardness test as prescribed in ASTM E18. Measurements shall be taken along the entire length of each extruded conductor at intervals of not less than three feet along the length. The values for numbers shall confirm hardness is within the range indicated in Section 3.2.

4.2.3.2 One sample piece shall be cut from each bar of the inner TF conductor for test specimens as described below. If any test specimen shows defective machining or develops flaws, it may be discarded and another specimen substituted.

4.2.3.3 Specimens taken from each sample piece shall be subjected to the electrical resistivity test as prescribed in ASTM B193.

4.2.3.4 A 10% random set of specimens shall be taken from the sample lot and tested for yield and ultimate tensile strength using the methodology in ASTM E8.

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4.2.3.5 If any test specimen shows defective machining or develops flaws, it shall be discarded and another specimen substituted.

4.2.3.6 If the percentage elongation of any tension test specimen is less than that specified and any part of the fracture is outside the middle two-thirds of the gage length or in a punched or scribed mark within the reduced section, a retest of an additional specimen, either from the same sample piece or a new sample piece is allowed.

5.0 QUALITY ASSURANCE REQUIREMENTS

5.1 Inspection/ Surveillance/Audit By Princeton

Authorized representatives of PPPL and the U. S. Government shall have the right at all reasonable times to visit the Subcontractor's premises and those of Subcontractor's suppliers during the performance of the Subcontract for the purposes of inspection, surveillance, audit and/or obtaining any required information as may be necessary to assure that items or services are being furnished in accordance with specified requirements. Such visits shall be coordinated with the Subcontractor's personnel to minimize interference with the normal operations of said premises. The Subcontractor shall make available records and documentation necessary for this function and shall provide all reasonable facilities and assistance for the safety and convenience of PPPL and/or U. S. Government representatives in the performance of their duties. PPPL and the U. S. Government recognize the Subcontractor's right to withhold information concerning proprietary processes. The Subcontractor agrees to insert the paragraph above in each lower-tier-procurement issued hereunder.

5.2 Subcontractor's Responsibility For Conformance

Neither PPPL's review and/or approval of Subcontractor's documents nor PPPL's inspection of Subcontractor's items or services shall relieve the Subcontractor of responsibility for full compliance with requirements of the purchase order/contract.

5.3 Subcontractor Quality Assurance Program

The Subcontractor shall have and maintain an effective Quality Assurance Program. The objectives of such a program are to assure that the Subcontractor's work meets the required level of quality and is performed in accordance with contractual requirements.

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5.4 Inspection/Test Plan

Subcontractor shall prepare and submit for PPPL review and approval ten (10) days after award and prior to first article fabrication, two (2) copies of an Inspection/Test Plan which identifies critical inspections and tests. Preparing the Plan may include developing a flow chart and generating Process Sheets/Shop Travelers, etc. PPPL may designate selected inspection and/or test operations as mandatory "witness" points based on the plan.

5.5 Inspection and Test Procedures

Inspections and tests shall be performed in accordance with vendors written procedures referencing criteria for acceptance or rejection. Adequate records shall be maintained and available for PPPL's review.

5.6 Material Identification and Status

Material identification shall be maintained throughout the program and be traceable to the records. Status of acceptability shall be readily discernible through the Subcontractor's use of tags, stamps, serial numbers or other positive means.

5.7 Document Review, Approval and Control

The Subcontractor shall provide a system that provides for review and approval of design documents (drawings, specifications, etc.), prior to issuance for use, and for approval and incorporation of changes in a formal and orderly manner. The system shall control obsolete documents to prevent inadvertent use.

5.8 Calibration of Test and Measuring Equipment

Inspections and tests shall be performed using properly calibrated measuring and test equipment. Subcontractor shall have in its possession the necessary equipment to perform the required inspections and tests. Calibration standards shall be traceable to the National Institute for Standards and Technology (NIST) or equivalent. Subcontractor shall impose these calibration requirements on sub-tier suppliers.

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5.9 Nonconforming Items or Services

The Subcontractor must have a system to identify instances where the subcontract requirements are not met (i.e. non-conformances). Nonconforming items shall be segregated or tagged to prevent use until the nonconformance has been dispositioned and the disposition approved by PPPL. The nonconforming condition and subcontractor's proposed disposition shall be documented on a report with provision for two PPPL concurrence signatures.

5.10 Release for Shipment Form

Prior to each shipment, the Subcontractor shall submit to PPPL a completed and signed "Product Quality Certification and Shipping Release" form (Attachment 1 of this SOW), along with a copy of the Process History (ref. Paragraph 5.10, and shall have received from PPPL written acceptance to ship. Shipping shall not commence until subcontractor receives PPPL's written acceptance to ship.

5.11 Process History

Subcontractor shall provide, at or prior to delivery, PPPL with two (2) copies of the Process History, a compilation of documents, detailing the objective evidence of the acceptability of the work performed. The Process History shall include as a minimum, but not be limited to, the following:

5.11.1 Material Certifications

The Subcontractor shall submit certified copies of inspection reports, test data, showing relevant chemical, mechanical and electrical properties of materials used. Material Test Reports from sub-tier suppliers shall also be submitted.

5.11.2 Inspection & Test Reports

Copies of the original reports of required inspections, tests and examinations, which are properly validated by authorized personnel. Reports shall include actual values measured and, where applicable, digital photographs.

5.11.3 Non-conformance Reports

Reports of any non-conformances identified in accordance with Section 5.9.

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5.12 PPPL RECEIVING/ INSPECTION

PPPL will perform Receiving Inspection on items or services supplied by Subcontractor, using either a sampling plan or 100% inspection. Discrepant items or services will be rejected and returned to Subcontractor or reworked by PPPL.

6.0 DOCUMENTATION REQUIREMENTS

6.1 Proposal Technical Documentation

Subcontractor shall submit as part of his proposal documentation in preliminary or outline form, the Inspection & Test Plan (refer to section 5.4), and procedures for tests on extruded conductors (refer to section 5.5).

6.2 Documentation After Contract Award and Prior to Fabrication

Subcontractor shall submit final versions of the Inspection & Test Plan (refer to section 5.4), and procedures for tests on extruded conductors (refer to section 5.5) for PPPL review and approval in accordance with the schedules given in the referenced sections.

6.3 Documentation Prior to Shipment

Subcontractor shall submit documents identified in section 5.11, Process History.

7.0 SHIPPING STORAGE AND HANDLING

7.1 The conductors shall be crated for shipment. The crates shall be built for moving on rollers, handling with slings from overhead cranes and forklifts.

7.2 The crates shall protect the materials from shock and weather conditions, including precipitation and temperatures below freezing. Seller's name, shipper, purchase order number, contents and gross weight shall be marked on the shipping container. Seller is responsible shipment and for the safe arrival of the OH and PF1 conductors at PPPL in Princeton, New Jersey, USA.

7.3 The materials shall be separated by size, and prepared for shipment in such a manner as to ensure acceptance by common carrier for transportation at the lowest applicable rate and to afford protection from normal hazards of transportation.

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8.0 DELIVERABLES

8.1 Prior to Fabrication Release

8.2 Weekly Reports:

Brief weekly status reports covering technical, administrative, and quality activities and notable problems/issues and progress photographs. This report shall be submitted to PPPL on each Friday following subcontract award. The report may be submitted as email.

8.3 Copper Extrusion Deliverable

8.3.1 Final Product

The vendor shall deliver (80) copper extrusions per this specification.

8.3.2 Shipping Release Form (Section 5.10)

8.3.3 Process History (Section 5.11)

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9.0 ATTACHMENTS: Attachment 1 –Shipping Release Form

PLASMA PHYSIC LABORATORY—PPPL

PRODUCT QUALITY CERTIFICATION AND SHIPPING RELEASE					
PROJECT	ITEM DESCRIPTION			SHIPMENT NUMBER	
PPPL SUBCONTRACT/ ORDER NO.	REV	ITEM NO.	SUPPLIER REFERENCE NO.	REV	QUANTITY SHIPPED
<u>SUPPLIER'S CERTIFICATION</u>					
<p>This is to certify that the products and services identified herein have been produced under a controlled quality assurance program and are in conformance with the procurement requirements including applicable codes, standards and specifications as identified in the above-referenced documents unless noted below. Any supporting documentation will be retained in accordance with the procurement requirements.</p> <p>SIGNED: _____ DATE: _____</p> <p>TITLE: _____ COMPANY: _____</p>					
<u>PPPL (AUTHORIZED REPRESENTATIVE) SHIPPING RELEASE</u>					
<p>This is to certify that evidence supporting the above Supplier's Certification statement has been audited and no product/service non-conformances from procurement requirements have been found unless noted below. This product/service is hereby released for shipment.</p> <p>This section serves as the Quality Assurance release for the above described product for shipment. It does not constitute an acceptance thereof and does not relieve the Vendor, Manufacturer or Contractor of any and all responsibility or obligation imposed by the purchase contract. It does not waive any rights the Purchaser may have under the purchase contract, including the Purchaser's right to reject the above described material upon discovery of any deviations from requirements of the purchase contract, drawings and specifications.</p>					
NONCONFORMANCES FROM PROCUREMENT QUALITY REQUIREMENTS:					
REMARKS/PRODUCT SERIAL NUMBERS:					
BY PPPL QA REPRESENTATIVE (OR DESIGNEE)				DATE	