

SPECIFICATION

FOR

**Plasma Spray Ceramic Coating NCSX Prototype Modular Coil
Shims**

NCSX-CSPEC-142-07-01

Revision 1

Dated 8 August 2007

PREPARED BY: _____
Cognizant Individual: R. Ellis

REVIEWED BY: _____
Quality Assurance: F. Malinowski

REVIEWED BY: _____
ES&H: J. Levine

APPROVED BY: _____
RLM: L. Dudek

**PRINCETON UNIVERSITY
PLASMA PHYSICS LABORATORY
P. O. BOX 451
PRINCETON, N. J. 08543
609-243-2000**

1.0 SCOPE

This document describes the plasma sprayed ceramic coating of various *prototype* modular coil shims for the National Compact Stellarator Experiment (NCSX). The ceramic coating is to be used as a high friction surface as well as an insulator.

2.0 APPLICABLE DOCUMENTS

None

3.0 REQUIREMENTS

3.1 STATEMENT OF WORK ACTIVITY

Ceramic coat components provided with Al_2O_3 and an appropriate shear-enhancing bond coat, to a total thickness, including the bonding layer, of 0.025", with a tolerance of +.003"/- .002", on the surfaces indicated on a marked up sketch of each component. The marked up sketches, and quantities of each component, shall be provided by PPPL as part of the procurement documentation.

The inside of any through hole shall be masked from coating.

The surface roughness on the outer surface shall be in an interval between 125microinches rms and 400microinches rms.

The vendor shall submit the chemical composition of the coating and bond coat for approval as part of the purchase.

All parts are 300 series stainless steel.

3.2 MATERIALS

The material used for coating shall be Aluminum Oxide (Al_2O_3). Purity shall be at least 99.4%. The shear-enhancing bond coat shall be selected by the vendor and submitted to PPPL for approval.

3.3 Pre-qualification samples

No pre-qualification samples are required.

4.0 TEST AND INSPECTION REQUIREMENTS

4.1 INSPECTION

Thickness measurements, between the large flat faces, shall be taken and recorded at two locations on each part before and after coating. These measurements shall be used to verify the coating thickness. A height gauge on a surface plate shall be used to verify the coating thickness on each face.

The surface roughness shall be measured using a profilometer.

4.2 ACCEPTANCE TEST

The following tests will be performed by PPPL on 100% of the production:

The coated parts will be vacuum baked by PPPL to 300 degrees Celsius. The rate of temperature rise during the acceptance test will not exceed five degrees Celsius per minute. Acceptable parts will not show any peeling or cracking.

The coated parts will be subjected to a cryogenic thermal shock test by sudden immersion into a liquid nitrogen bath. [70degrees Kelvin] Acceptable parts will not show any peeling or cracking.

The coating shall give a voltage standoff of at least 9V after the thermal acceptance tests. The electrical acceptance test shall be performed with two soft electrodes that conform to the large flat surfaces of the shim, and cover the full area of both surfaces. Acceptable parts will show a resistance of at least 100k Ω between each soft electrode and the parent metal.

4.3 Destructive tests: 5% sampling

No destructive tests are required.

5.0 QUALITY ASSURANCE REQUIREMENTS

5.1 Inspection/ Surveillance/Audit By Princeton

Authorized representatives of Princeton 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 procurement 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 Princeton and/or U. S. Government representatives in the performance of their duties. Princeton and the U. S. Government recognize the Subcontractor's right to withhold information concerning proprietary processes. The Subcontractor agrees to insert the paragraph above into each lower-tier procurement issued hereunder.

5.2 Subcontractor's Responsibility For Conformance

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

purchase order/contract.

The Subcontractor is responsible for assuring that all requirements and restrictions are imposed on any subtier suppliers.

5.3 Nonconformances & Corrective Actions And Notification Of Princeton

Nonconforming items shall be positively identified, and, where possible, segregated to prevent use. The Subcontractor shall document each nonconformance. The written approval of Princeton is required prior to the use of the nonconforming item or service.

5.4 Measuring and Test 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.

5.5 Submittal of Completed Release For Shipment Form

Subcontractor shall have a signed "Product Quality Certification and Shipping Release" Form to be provided by Princeton's Quality Assurance Representative prior to acceptance of procured items for full or partial shipment. Princeton reserves the right to refuse to accept shipments unless accompanied by a signed "Shipping Release" Form (Exhibit 1).

5.6 Submittal of Completed Process History (Documentation Package)

Subcontractor shall deliver, along with each shipment of completed item(s), two (2) copies of the Process History, a compilation of documents, detailing the objective evidence of the acceptability of the work performed. Some parts of the Process History, typically inspection and test reports, may be required with the Shipping Release request. The Process History shall include as a minimum, but not be limited to, the following:

5.6.1 Submittal of Subcontractor's Certificate Of Compliance (CofC)

Subcontractor's CofC, stating that the work performed conforms in every respect to the physical configuration and functional inspection/test requirements. Subcontractor's Quality Assurance (QA) Manager shall sign the CofC. Where the Subcontractor has used Princeton-furnished material, such certification shall also include the statement: "Material furnished by Princeton has been inspected by the Subcontractor and used by the Subcontractor as specified by Princeton with no unauthorized substitutions".

5.6.2 Submittal Of Material Certifications

The Subcontractor shall submit Material Test Reports showing actual relevant chemical, mechanical, and electrical properties of materials used and providing traceability to the actual material. One copy is to be submitted upon Subcontractor acceptance for use.

5.6.3 Submittal of Completed Inspection & Test Reports

Copies of the original reports of all required inspections and tests, properly validated by authorized personnel.

5.6.4 Submittal Of Completed Discrepancy Reports (Nonconformances, Corrective Actions)

The Subcontractor must submit copies of discrepancy reports, those affecting form, fit or function.

5.7 Handling, Packaging, Shipping And Storage

Subcontractor shall control items during handling and shipping and while in storage, including Princeton-furnished items, and shall assure that materials and items are adequately protected from damage or deterioration, with special attention to packaging for shipment. Such protection shall include special environmental packaging requirements as specified. Packaging, shipping and storage procedures shall provide for adequate marking or labeling to clearly and readily identify the items. Release from storage shall be controlled to prevent accidental or inadvertent use of incorrect or unacceptable items. Procedures may be subject to Princeton review and approval.

5.8 Princeton Receiving/ Inspection

Princeton will perform Receiving Inspection on items 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 Princeton.

6.0 DOCUMENTATION

Dimensional inspection reports [4.1] shall be documented and forwarded to PPPL. One copy will be provided as part of the shipping release process [5.5] and two copies shall be delivered with the parts.

7.0 DELIVERABLES

The ceramic coated parts, inspection reports, process histories including materials certifications, and a certificate of compliance will constitute the deliverables.