

Technical Specification for Purchase of Plasma Facing Component

Technical specification: NSTXU_1-1-1-1_SPEC_100

REVISION 1

August 26, 2019

PREPARED BY: **Kathleen Lukazik** 8/15/2019 11:05:12 AM

Kathleen Lukazik,

REVIEWED BY: **Jonathan Klabacha** 8/15/2019 11:10:02 AM

Jonathan Klabacha,

REVIEWED BY: **Andres Castaneda** 8/15/2019 11:51:21 AM

Andres Castaneda,

REVIEWED BY: **George D. Loesser** 8/15/2019 3:19:59 PM

George D. Loesser,

REVIEWED BY: **Leslie Hill** 8/22/2019 12:31:55 PM

Leslie Hill,

REVIEWED BY: **Mojtaba Safabakhsh** 8/26/2019 2:59:55 PM

Mojtaba Safabakhsh,

APPROVED BY: **Robert A. Ellis** 8/26/2019 3:03:11 PM

Robert A. Ellis,

PRINCETON PLASMA PHYSICS LABORATORY
P.O. BOX 451
PRINCETON, N.J. 08543

TECHNICAL SPECIFICATION

FOR

Purchase of Plasma Facing Component Material

Spec 3

CAT: ☒A1 ☐A2 ☐A3

UNIQUE IDENTIFIER: NSTXU_1-1-1-1_SPEC_100

Reference Work Planning #: 2317

REVISION 1

DATED *August 14, 2019*

PREPARED BY: Jonathan Klabacha, COG

REVIEWED BY: Doug Loesser, Responsible Engineer

REVIEWED BY: Andres Castaneda, Quality Assurance

REVIEWED BY: Les Hill, Project Manager

REVIEWED BY: Mojtaba Safabakhsh, Manufacturing Technical Authority

APPROVED BY: Bob Ellis, Chief Engineer

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

NSTX-U Specification

Record of Changes

Rev.	Date	Description of Changes
0	02/27/19	Issued
1	08/14/19	Included wording in section 4.13 to include provision for two phase shipping release (ship in place and physical shipment)

NSTX-U Specification

Table of Contents

1	Introduction & Scope	5
2	Responsibilities	5
2.1	Princeton Plasma Physics Laboratory	5
2.2	Subcontractor.....	6
3	Requirements.....	6
3.1	Performance Characteristics.....	6
3.2	Equipment Definition	6
3.3	Performance Tests.....	7
3.4	Quality Control Receipt Inspections	7
4	Quality Assurance Requirements	8
4.1	Changes to PPPL Approved Documents.....	8
4.2	Submittal of Manufacturing/Inspection/Test (MIT) Plan	8
4.3	Measuring Equipment/Calibration.....	8
4.4	Equipment/Material Identification and Status.....	8
4.5	Inspection and Test Control	8
4.6	Performance and Documentation of Inspections & Tests	8
4.7	Inspection/Surveillance/Audit by Princeton	9
4.8	Subcontractor's Responsibility for Conformance	9
4.9	Subcontractor Quality Assurance Program.....	9
4.10	Document Traceability and Records	9
4.11	Non-Conformances and Corrective Actions.....	10
4.12	Release for Shipment Form	10
4.13	Process History	10
5	Shipping Storage and Handling	11
6	Attachments	12
7	Documentation & Deliverables	12
	Deliverables Checklist	13

1 Introduction & Scope

This Specification establishes the manufacturing and acceptance requirements for the Plasma Facing Component (PFC) Carbon Fiber Composite (CFC) that will be used to produce PFC tiles (Figure 1) within the National Spherical Torus eXperiment Upgrade (NSTX-U) device.

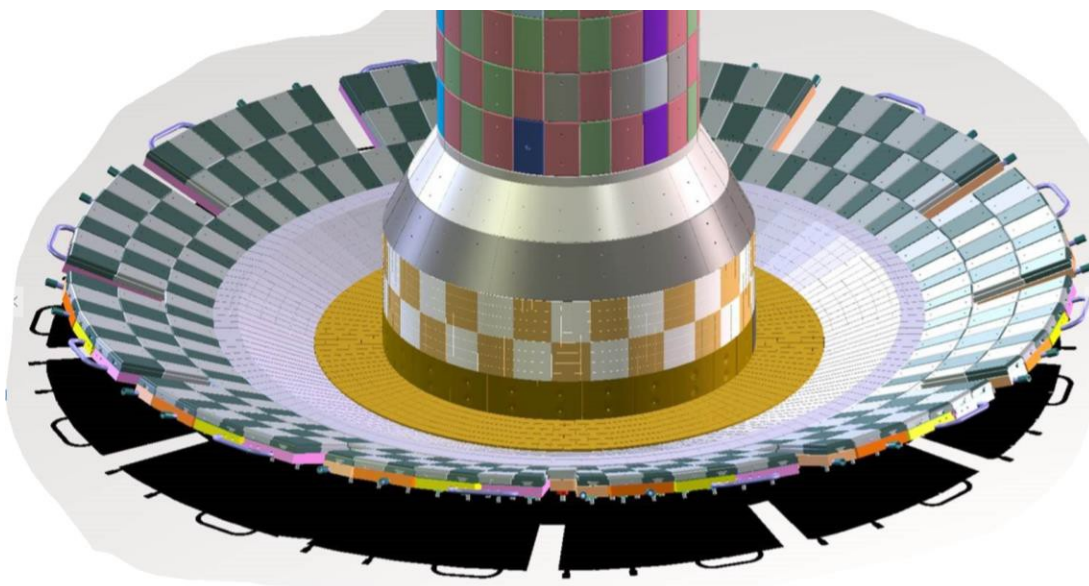


Figure 1 - Visual example of current tiles within NSTX-U

NSTX-U is an innovative magnetic fusion device that was constructed by the Princeton Plasma Physics Laboratory (PPPL) in collaboration with the Oak Ridge National Laboratory, Columbia University, and the University of Washington at Seattle.

The NSTX-U device will include an internal plasma facing wall constructed from several materials including three-directional carbon fiber reinforced carbon tiles. The CFC material will be used for low heat flux outboard divertor tiles adjacent to openings (i.e., gaps) that accommodate the Poloidal Charge Exchange Recombination Spectroscopy (PCHERS) system and other port-mounted diagnostic systems. As these PFC tiles will be in direct contact with the plasma, they will be made from a carbon material.

The scope of this specification covers the purchase of material that will be used in the design and manufacturing of the PFCs.

2 Responsibilities

2.1 Princeton Plasma Physics Laboratory

PPPL shall designate a technical contact, the Princeton Technical Representative (PTR), a Quality Assurance (QA) contact, as well as back-up contacts.

2.2 Subcontractor

2.2.1 Technical & Quality Assurance Contacts

The Contractor shall designate and provide contact information for a primary technical contact, a Quality Assurance contact, and a back-up contact.

2.2.2 Execution of Work Scope

The Contractor shall conform to all requirements of this document and process the carbon fiber composite material in full conformance with this specification. If any portion of this work is to be performed by sub-tier contractors, such plans shall be communicated to PPPL with the Contractor's proposal, and all requirements given in this specification shall flow down to the sub-tier contractor.

3 Requirements

In this section, the technical requirements and characteristics are quantified. PPPL shall be immediately informed of any discrepancies between this specification and the proposed carbon fiber composite material.

3.1 Performance Characteristics

The material offered shall be the three-directional carbon fiber reinforced composite material system (3D AS4 6/6/6, supplied by Fiber Materials, Inc.), and shall have a minimum tensile strength of at least 69.5 MPa at 3000°F in the X, Y, and Z directions.

3.2 Equipment Definition

3.2.1 Specifications and Standards

See Section 3.1.

3.2.2 General Design Features

The minimum billet size of the produced material is 24.50" x 14.00" x 9.50". The dimensional tolerance for length, height, and width of any material procured to this specification is ± 0.25 ". The method by which the produced material will be measured shall be stated within the MIT plan (per Section 4.2).

3.2.3 Materials

See Section 3.1.

3.2.4 Identification And Marking

Each delivered item will be accompanied by a Process History (see Section 4.13). Each delivered item will be identified with a reference number that is unique to the item. The reference number will correspond to the accompanied Process History. The method of item identification shall be included in the MIT Plan.

3.3 Performance Tests

Certified Material Test Reports (CMTRs) shall be provided for the materials used. The subcontractor is required to carry out and/or include the manufacturer's inspections/tests to provide material properties specified within the CMTRs. CMTRs shall, at minimum, include tensile strength, composition, density, flexural strength, thermal conductivity, compressive strength, and verification of the type and/or grade of the material. Each CMTR shall reference the unique number(s) (assigned per section 3.2.4) of all items which were manufactured under the same manufacturing run for which the CMTR applies. If a CMTR covers multiple reference numbers, a cross-reference of the reference numbers to the manufacturing run shall be provided. Alternate material properties for testing and inclusion in the CMTRs may be accepted with written approval by the PPPL PTR, as defined in section 2.1.

3.4 Quality Control Receipt Inspections

PPPL's Cognizant Individual (COG) will provide visual inspection upon receipt of the carbon fiber composite material for possible damage during transport, which includes but is not limited to chips, nicks or cracks prior to accepting the deliverables. The COG shall also be responsible for checking the delivery notes, final documentation, identification and dimensional accuracy of the delivered material. Photographs provided by the subcontractor prior to shipment will be used to validate that no excessive damage was obtained during the shipping process. Excessive damage is damage that would reduce the usable material beyond that which would be allowable by the nominal size and dimensional tolerances as specified in section 3.2.2.

The subcontractor shall be notified of acceptance of the delivery by the COG after the receipt inspection is complete.

4 Quality Assurance Requirements

4.1 Changes to PPPL Approved Documents

Revisions or changes by the Subcontractor to documents approved by PPPL shall be reviewed and approved by PPPL prior to use.

4.2 Submittal of Manufacturing/Inspection/Test (MIT) Plan

Subcontractor shall submit a Manufacturing/Inspection/Test Plan within 10 working days after receipt of order for PPPL approval prior to start of manufacturing. The plan shall identify parts; show their integrated flow into end items; identify critical manufacturing operations; and show inspections and the characteristics/dimensions to be inspected. The Plan may include flow chart(s), Process Sheets, Shop Travelers, and Inspection Sheets, etc. Revisions or changes to the approved MIT shall be reviewed and approved by PPPL prior to use.

4.3 Measuring Equipment/Calibration

Acceptance inspections and tests shall be performed using properly calibrated measuring equipment. Calibration standards shall be traceable to the National Institute for Standards and Technology (NIST) or equivalent. Where such standards do not exist, the basis used for calibration shall be documented. Standards used for calibration shall not be used for shop inspections and shall be protected against damage or degradation. Calibration records shall be maintained and made available to PPPL upon request.

4.4 Equipment/Material Identification and Status

Material and equipment identification shall be maintained throughout processing 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.

4.5 Inspection and Test Control

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

4.6 Performance and Documentation of Inspections & Tests

Each item to be delivered to PPPL shall be inspected and tested by the Subcontractor to verify that it meets PPPL's requirements. All produced parts must be inspected and tested unless an alternate plan is agreed upon with PPPL in writing. Results shall be documented and reported to PPPL. Any exceptions to PPPL requirements must be approved by PPPL in writing. The inspection/test report(s) shall indicate the results of all tests and compliance with all drawing notes. Actual values for all drawing dimensions,

including Basic, but excluding Reference, must be reported. The report shall reference the measurement and/or test equipment ID and calibration status (due date) of the equipment used to verify/validate each requirement. Either a drawing copy or an inspection report may be used as the report, but the drawing zone and actual measured values must be clearly indicated. Regardless of format, the report must be dated and signed.

4.7 Inspection/Surveillance/Audit by Princeton

Authorized representatives of PPPL shall have the right at all reasonable times to visit the Subcontractor's premises and those of the 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 PPPL representatives in the performance of their duties. PPPL recognizes the Subcontractor's right to withhold information concerning proprietary processes.

4.8 Subcontractor's Responsibility for Conformance

Neither PPPL's review and/or approval of Subcontractor's documents nor PPPL's inspection of Subcontractor's items 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 sub-tier suppliers.

4.9 Subcontractor Quality Assurance Program

The Subcontractor shall establish and maintain an effective QA Program to assure that the Subcontractor's work meets the required level of quality and is performed in accordance with contractual requirements. The subcontractor shall submit their company QA Manual describing the quality assurance and quality control procedures and practices, including special process training and qualifications that will be in force to meet the requirements of this specification. Subcontractor's quality assurance function shall have sufficient authority and independence to identify quality problems, verify conformance of supplied items or services to specified requirements and obtain satisfactory resolution of conflicts involving quality.

4.10 Document Traceability and Records

The Subcontractor shall maintain a system of documentation whereby objective evidence of required operations, examinations, and tests is systematically compiled, indexed and stored. Such objective evidence may include "travelers", certification,

examination, and discrepancy reports, which shall be complete, legible, and validated by responsible personnel and shall be traceable to subject items and available to PPPL on request.

4.11 Non-Conformances and Corrective Actions

Non-conforming items or services (affecting fit, form, and/or function) shall be identified, and, where possible, segregated to prevent use. The Subcontractor shall document each non-conformance. The written approval of PPPL is required prior to the use of the non-conforming item or service. The Subcontractor's system shall provide not only for timely resolution of non-conformances, but also for analysis of non-conformances to determine causes and to implement appropriate corrective actions.

4.12 Release for Shipment Form

Subcontractor shall not ship without a "Product Quality Certification and Shipping Release" Form signed by Princeton's Representative. Subcontractor shall complete and sign the certification section, fax or email the form and the Process History items specified below to Princeton's QA Representative, and hold shipment until Princeton signs and returns the form, authorizing shipment. A copy of the fully executed form shall accompany each full or partial shipment.

4.13 Process History

Subcontractor shall provide PPPL with two copies of the Process History (a compilation of documents detailing the objective evidence of the acceptability of the work performed). One digital copy to be provided with the Shipping Release request and one paper copy will be shipped with the material. On each page of the Process History, a reference number(s) will be supplied. This reference number(s) will correspond to the reference number(s) assigned to each applicable item(s) (Section 3.2.4). The Process History shall include as a minimum, but not be limited to, the following:

4.13.1 Certificate of Compliance (C Of C)

Subcontractor's C of C will state that the work performed conforms in every respect to the physical configuration and functional inspection/test requirements. Subcontractor's QA Manager shall sign the C of C.

4.13.2 Inspection Reports

The Subcontractor shall provide validated inspection and test reports for material which include the results of the dimensional checks and visual inspection. Complete shop travelers and/or process sheets shall also be submitted, if applicable. The provided documentation shall be traceable to the corresponding unique identifier assigned per section 3.2.4.

4.13.3 Certified Material Test Reports

See section 3.3.

4.13.4 Discrepancy (Non-Conformance) Reports

The Subcontractor shall submit copies of resolved discrepancy reports, generated in accordance with Section 4.11.

4.13.5 Lot Traceability

The Subcontractor shall submit documentation with each shipment that links the unique identification (assigned per Section 3.2.4) of the provided material to the original manufacturer and the original manufacturer's material certification. Each individual block will be referenced.

4.13.6 Photographs

The Subcontractor shall submit photos of the completed material prior to protective packaging for shipment, as well as photos of the material after having been packaged (displaying the protective packaging and condition of material prior to shipment). These photos will be used to evaluate any shipping damage per Section 3.4.

In the event that the Subcontractor must ship in place in order to complete the material testing as described in section 3.3, Shipping Release per section 4.12 may be performed in two phases as follows:

- Release to ship in place pending the results of material testing. This may be achieved by submittal of the following items from the Process History:
 - o 4.13.1
 - o 4.13.2
 - o 4.13.4
 - o 4.13.5
- Release for physical shipment of the material. This may be achieved by submittal of the remaining items from the Process History:
 - o 4.13.3
 - o 4.13.6

In the event that the above described provision for two phase shipping release is exercised, a separate Release for Shipment Form shall be submitted for each phase, with clear identification of phase (ship in place/physical shipment) on each form. Physical shipment prior to full completion of testing per section 3.3 may be evaluated and approved in writing by PPPL.

5 Shipping Storage and Handling

The subcontractor is responsible for the inspection of the carbon fiber composite prior to

shipping the blocks of material to PPPL. The subcontractor shall visually inspect the material for surface damage, including but not limited to chips, nicks, and cracks. The subcontractor shall provide photos of the material prior to protective packaging for shipment, photos of the material after having been packaged, verification of the identification markings of all material, and verification of the dimensional accuracy of the material to PPPL prior to shipment.

Subcontractor shall ship the carbon fiber composite material upon receiving a signed Shipping Release form (Section 4.12) from PPPL. The Subcontractor shall control items during handling, shipping, and while in storage, and shall assure that materials and items are adequately protected from damage or deterioration, with special attention to packaging for shipment.

Packaging, shipping and storage procedures shall minimize cracks or chips to the material. Material shipped within boxes will be surrounded with polystyrene and/or foam. More polystyrene and/or foam will be used to mitigate any movement within the box. Large material shipped on pallets or other large transportation methods will be wrapped in plastic or other material as to mitigate any movement on the transportation vehicle.

Labels will be clearly and readily visible on the shipping container to identify the items. This will include the Subcontractor's name, type and/or grade of the material, quantity of the material, and the reference number that links the provided material to the Process History documentation (Section 4.13). These labels will be placed within a shipping label pouch with the information visible.

6 Attachments

- Deliverable Checklist
- PPPL Shipping Release Form

7 Documentation & Deliverables

Documentation shall be provided for PPPL approval as delineated in the Document Deliverable Checklist.

Revisions or changes by the Subcontractor to documents approved by PPPL shall be reviewed and approved by PPPL prior to use.

Deliverables shall be shipped as soon as they are available, following the Shipping Release process of Section 5. Process History documentation shall be supplied with each individual shipment in accordance with Section 4.13. (See Deliverables Checklist below for more information.)

Deliverables Checklist

PO / Subcontract / BOA / BPA #: _____

#	Physical Deliverables Required	When Deliverable Is Required	Deliverable Received (✓)
1	CFC Material (Section 3)	Contract start + 8 weeks	
Exceptions (Add justification for any missing physical deliverables that will not be received):			

#	Document Deliverables Required	When Deliverable Is Required	Deliverable Format (Paper, Electronic etc.)	Storage Location for Deliverable	Deliverable Received (✓)
1	QA Manual (Section 4.9)	With Bid	Electronic	Ops	
2	MIT Plan (Section 4.2)	Within 10 Days of Contract	Electronic	Ops	
3	Process History (Section 4.13)	Prior to Shipment	Electronic	Ops	
4	Shipping Release Form (Section 4.12)	Prior to Shipment	Electronic	Ops	
Exceptions (Add justification for any missing document deliverables that will not be received):					

Princeton Technical Representative/COG: _____

(Sign-off and provide to the Operations Center when job is completed and deliverables are dispositioned and placed/filed in Operations Center (or other Project, Department or Division designated file center)

PRINCETON UNIVERSITY PLASMA PHYSICS LABORATORY—PPPL PRODUCT QUALITY CERTIFICATION & SHIPPING RELEASE

To be completed by supplier and submitted to PPPL with the Documentation package.

Shipment (full or partial) is not authorized until PPPL returns this form signed.

Completed by Supplier	PPPL SUBCONTRACT/ ORDER #	ITEM #(s)	QUANTITY SHIPPED
	ITEM DESCRIPTION	SUPPLIER REFERENCE #	SHIPMENT #
	<p align="center">SUPPLIER'S CERTIFICATION</p> <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>		

Completed, signed, and returned by PPPL before shipment	PPPL (AUTHORIZED REPRESENTATIVE) SHIPPING RELEASE	
	<p>This is to certify that evidence supporting the above Supplier's Certification statement has been reviewed and no product/service non-conformances from procurement requirements have been identified 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 Supplier, 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>	
	<p>NON-CONFORMANCES FROM PROCUREMENT QUALITY REQUIREMENTS:</p>	
<p>REMARKS/PRODUCT SERIAL NUMBERS:</p>		
<p>BY PPPL QA REPRESENTATIVE (OR DESIGNEE)</p>		<p>DATE</p>