



SOW - STATEMENT OF WORK

X-Ray Photoelectron Spectroscopy (XPS)

Surface Analysis of NSTX-U Recovery Tiles

NSTXU_1-1-1-1_SOW_103

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PRINCETON
PLASMA PHYSICS
LABORATORY

Statement of Work for X-Ray Photoelectron Spectroscopy

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1.0 **Introduction & Scope**

This document covers the X-Ray Photoelectron Spectroscopy (XPS) analysis of graphite coupons that will be used to verify and accept oven-baked graphite tiles. The graphite tiles will be used for the Plasma Facing Components (PFCs) of the National Spherical Torus Experiment Upgrade (NSTX-U). The analysis reports of the X-Ray Photoelectron Spectroscopy test coupons from the trial bakeout and bakeout will be used to determine whether or not the carbon fiber composite (CFC) tiles and graphite (R6510, ET10, T953) tiles are acceptable. Strict conformance to the requirements given in this document is essential. However, the Subcontractor is encouraged to submit, with their proposal, suggestions to improve product quality, reduce cost, or improve schedule, subject to approval by PPPL.

2.0 **Applicable Documents**

Below is a listing of Documents the Subcontractor may need to reference for proper completion of the awarded contract:

- 2.1 The Subcontractor shall adhere to ASTM E1078 – 14 “Standard Guide for Specimen Preparation and Mounting in Surface Analysis”.
- 2.2 The Subcontractor may need to reference ASTM E1829 – 14 “Standard Guide for Handling Specimens Prior to Surface Analysis”

3.0 **Applicable Drawings**

The marking and dimensions of the coupons are as indicated in Drawing Number C-ED1486.

4.0 **Responsibilities**

4.1 **Princeton Plasma & Physics Laboratory**

4.1.1 **PPPL Contacts**

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

4.2 **Subcontractor**

4.2.1 **Subcontractor Contacts**

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

4.2.2 **Subcontractor Conformance**

- 4.2.2.1 The Subcontractor shall submit a proposal of the report contents to PPPL for approval prior to execution of work. Proposed report contents shall include, at a minimum, identification of isotopes detected on coupon surfaces and their respective concentrations following the procedure listing within Section 5.1.2.
- 4.2.2.2 The Subcontractor shall conform to all requirements of this document and perform the work in full conformance with this Statement of Work. If any portion of this

work is to be performed by sub-tier contractors, such plans shall be communicated to and approved by PPPL prior to execution of work and all requirements given in this Statement of Work shall flow down to the approved sub-tier contractor.

5.0 X-Ray Photoelectron Spectroscopy Requirements

5.1 Performance Requirements

5.1.1 Performance Characteristics

The Subcontractor shall perform surface analysis by X-Ray Photoelectron Spectroscopy as the coupons are received and shall submit an analysis report detailing the surface composition of the test coupons.

5.1.2 Test Coupons Analysis

The procedures below shall be followed to analyze the bakeout test coupons:

- 5.1.2.1** Three test coupons, C-ED1486-1, C-ED1486-2, and C-ED1486-3, shall be analyzed in accordance with ASTM E1078 - 14 “Standard Guide for Specimen Preparation and Mounting in Surface Analysis”.

Note: Powder-free latex or silicon gloves shall be worn to prevent contamination of the coupons.

- 5.1.2.2** In preparation for X-Ray Photoelectron Spectroscopy testing, the coupon analysis area shall be exposed and expanded using a suitable method, as per ASTM 1078 – 14, Sections 10.5.6 – 10. Subsurface layers shall be exposed using sputtering as described in Sections 10.9.2-12 of ASTM 1078- 14.

- 5.1.2.3** The presence of any elements of $Z \geq 20$ in concentrations $\geq 3\%$ atomic percentage of the sample area in the results of the X-Ray Photoelectron Spectroscopy test for any of the coupons shall be reported to PPPL immediately.

- 5.1.2.4** After X-Ray Photoelectron Spectroscopy tests are completed, the test coupons shall be returned in their original wafer carrier trays.

- 5.1.2.5** Once the analysis is completed, a report shall be provided to PPPL for evaluation.

5.1.3 Operating Requirements

Not Applicable.

5.1.4 Design Life

Not Applicable.

5.1.5 Reliability

Not Applicable.

5.1.6 Maintainability

Not Applicable.

5.1.7 Human Factors

Not Applicable.

5.1.8 Sustainability

Not Applicable.

5.2 Equipment Definition

5.2.1 Specifications and Standards

5.2.1.1 ASTM E1078 – 14 “Standard Guide for Specimen Preparation and Mounting in Surface Analysis”.

5.2.1.2 ASTM E1829 – 14 “Standard Guide for Handling Specimens Prior to Surface Analysis”

5.2.2 General Design Features

Not Applicable.

5.2.3 Materials & Traceability

Three graphite test coupons (C-ED1486-1, C-ED1486-2, and C-ED1486-3).

5.2.4 Electromagnetic Interference and Susceptibility

Not Applicable.

5.2.5 Identification & Marking

The three test coupons will be provided, packaged in individual wafer carrier trays and inscribed per C-ED1486 in order to identify the results for each coupon.

5.2.6 Workmanship

Not Applicable.

5.2.7 Subcontractor Equipment Use

Not Applicable.

6.0 Test & Inspection Requirements

6.1 Performance Tests

The X-Ray Photoelectron Spectroscopy Subcontractor shall inspect the coupons upon receipt and notify PPPL of any damage prior to conducting surface analysis.

6.2 Acceptance Tests

Acceptance of results is based on adherence to this X-Ray Photoelectron Spectroscopy surface analysis SOW and the approved method and reporting (Section 4.2.2.1) for each provided coupon.

6.3 Supplier Hold Points

Not Applicable.

7.0 Qualifications

- 7.1 Personnel are required to be trained in the test methods being performed, as well as the operation of the equipment being used.
- 7.2 A copy of training records of personnel performing work to this SOW shall be provided to PPPL prior to the execution of work.

8.0 Environment Safety & Health

- 8.1 PPPL may request information deemed necessary to evaluate the Subcontractor's safety record at any time.
- 8.2 The Subcontractor shall comply with all OSHA regulations to ensure the safety of any potential PPPL visitors to the Subcontractor's facility. The Subcontractor shall provide all PPPL visitors with the requisite training and PPE to insure their safety.

9.0 Quality Assurance Requirements

9.1 Inspection/Surveillance/Audit by PPPL

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 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 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.

9.2 Subcontractor's Responsibility for Conformance

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

9.3 Subcontractor's Quality Assurance Program

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

- 9.3.1 The Subcontractor's quality assurance function shall be actively involved in the planning, processing, oversight, problem resolution, and determination of the acceptability of all work covered under this sow.

9.3.2 The Subcontractor's quality assurance function shall be organized to 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.

9.3.3 The Subcontractor shall perform planned, periodic audits of the various aspects of its QA program by persons not directly responsible for the area being audited. Written reports of these audits shall be made available to PPPL upon request.

9.4 Document Traceability & 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.

9.5 Control of Special Processes

Subcontractor shall use trained and qualified personnel and qualified written procedures in accordance with specified requirements for the performance of certain special processes, including but not limited to, soldering, electronic assembly, brazing, welding, plating, heat treatment, nondestructive examination, etc. Copies of special process procedures and qualifications shall be available for review by PPPL and submitted to PPPL for acceptance if requested.

9.6 Non-Conformances & Corrective Actions

The Subcontractor shall promptly identify and control non-conforming items or services. Non-conforming items or services shall be positively identified, and segregated where possible, to prevent use. The Subcontractor shall document each non-conformance. The written approval of PPPL is required prior to the use of a non-conforming item or service. The Subcontractor's system shall provide not only for the timely resolution of non-conformances, but also for the analysis of non-conformances to determine root causes and to implement appropriate and effective corrective actions.

9.7 Calibration of Test and Measuring Equipment

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. Records of calibration of equipment to be used to fulfil the requirements of this SOW shall be provided to PPPL prior to execution of work.

9.8 Submittal of Completed Process History

Subcontractor shall deliver, along with the completed item(s), one digital or two hard 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, the following:

9.8.1 Certificate of Compliance (C of C)

Subcontractor's C of C, signed by the Quality Manager, stating that the work performed conforms in every respect to PPPL requirements. Where the Subcontractor has used PPPL-furnished material, such certification shall also include the statement: "Material furnished by PPPL has been inspected by the Subcontractor and used by the Subcontractor as specified by PPPL with no unauthorized substitutions".

9.8.2 Inspection & Test Reports

The Subcontractor shall submit signed and dated reports for all required inspections and tests, as agreed per Section 5.1.2.

9.8.3 Non-Conformance Reports

The Subcontractor shall submit copies of non-conformance reports, as applicable.

10.0 Shipping, Storage, and Packaging

Subcontractor shall control items during handling and shipping and while in storage, including PPPL-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 in Section 5.1.2. 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 PPPL review and approval.

10.1 Test coupons will arrive packaged in wafer carrier trays serialized for inspection and testing.

11.0 Warranty

Not Applicable.

12.0 Documentation and Deliverables

PO / Subcontract / BOA / BPA #: _____

#	Physical Deliverables Required	When Deliverable Is Required	Deliverable Received (✓)
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1	Test Coupons (Section 5.3)	Upon completion of testing	
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 (<input type="checkbox"/>)
1	Calibration Documentation of Test and Measuring Equipment (Section 9.7)	With proposal	Electronic	Ops	
2	Proposal of Analysis Reporting (Section 4.2.2.1)	With proposal	Electronic	Ops	
2	Personnel Training Records (Section 7.2)	With proposal	Electronic	Ops	
3	Process History (Section 9.8)	At conclusion of test(s)	Electronic	Ops	
Exceptions (Add justification for any missing document deliverables that will not be received):					

Princeton Technical Representative/COG:

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