



# **SOW - STATEMENT OF WORK**

## **STATEMENT OF WORK FOR NSTX-U METAL MANUFACTURING PLASMA FACING COMPONENTS**

***NSTXU\_1-1-1-1\_SOW\_100***

*Rev. 2*

Work Planning #: **2317**  
Effective Date: **12/13/2019**  
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**STATEMENT OF WORK**  
**FOR**  
**NSTX-U METAL MANUFACTURING**  
**PLASMA FACING COMPONENTS**  
**NSTXU\_1-1-1-1\_SOW\_100**  
**CAT: ☒ A1 ☐ A2 ☐ A3**  
**Reference Work Planning #: 2317**  
**REVISION 2**  
**DATED *December 11, 2019***

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## **1.0 INTRODUCTION & SCOPE**

This document establishes the manufacturing and acceptance requirements for the Plasma Facing Components (PFC) metal hardware that will be used to assemble the graphite tiles within the National Spherical Torus eXperiment Upgrade (NSTX-U) device. NSTX-U is an innovative magnetic fusion device that was constructed by PPPL in collaboration with the Oak Ridge National Laboratory, Columbia University, and the University of Washington at Seattle. NSTX-U will include an internal plasma facing wall that will be mainly constructed out of graphite tiles. These tiles are intended to survive extremely large pulsed heat fluxes, while cooling within a short amount of time to allow for multiple consecutive shots.

The scope of this document covers the manufacturing of the various metal components used in the assembly of the PFC's. Strict conformance to the requirements given in this specification 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 the Documents that the Subcontractor may need to reference for proper completion of the awarded contract:

- 2.1 ASME Y14.5-2009, Dimensioning and Tolerancing
- 2.2 ASTM-B571, Qualitative Adhesion Testing of Metallic Coatings
- 2.3 PPPL Attachment I "Metal Component Deliverables List"
- 2.4 PPPL Attachment II – "Product Quality Certification and Shipping Release"
- 2.5 PPPL Attachment III – "PPPL Dimensional Inspection Form"

## **3.0 APPLICABLE DRAWINGS**

See Section 5.2.2, Table 1.

## **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.
- 4.2.1.2 The Subcontractor shall ensure their appointed contacts are available to attend regularly scheduled status update meetings (biweekly at a minimum). Dates and times for these meetings will be established with the PTR prior to starting work. Additional status update meetings may be requested by PPPL or by the Subcontractor as needed based on project progress and/or identified issues.

#### *4.2.2 SUBCONTRACTOR CONFORMANCE*

- 4.2.2.1 The Subcontractor shall conform to all requirements of this document and process the components in full conformance with this specification.
- 4.2.2.2 The Subcontractor shall accommodate PPPL representatives during on-site visits (per Section 9.1), including the provision of any requisite safety related training and PPE (per Section 8.0).
- 4.2.2.3 The Subcontractor shall promptly document and report any non-conformances to PPPL (per Section 9.9).
- 4.2.2.4 The Subcontractor shall submit their Manufacturing, Inspection, and Testing (MIT) plan within 10 working days of the award of contract, subject to PPPL approval (per Section 9.12).
- 4.2.2.5 The Subcontractor shall address any questions or concerns regarding the requirements of this Statement of Work "SOW" to any of the designated PPPL representatives (per Section 4.1.1).

## **5.0 REQUIREMENTS**

### **5.1 PERFORMANCE REQUIREMENTS**

PFC component designs have been qualified based on the dimensions and tolerancing shown on the fabrication drawings. The performance of the PFC components is dependent upon their conformance to the provided drawings. Therefore, strict conformance to the requirements is paramount.

#### *5.1.1 PERFORMANCE CHARACTERISTICS*

All components fabricated shall conform to the dimensions and tolerancing shown on the applicable fabrication drawing. All workmanship requirements within Section 5.2.6 shall be followed to ensure dimensional and quality conformance of Subcontractor produced parts.

#### *5.1.2 DESIGN LIFE*

Not Applicable.

#### *5.1.3 RELIABILITY*

Not Applicable.

#### 5.1.4 MAINTAINABILITY

Not Applicable

#### 5.1.5 HUMAN FACTORS

Not Applicable.

#### 5.1.6 SUSTAINABILITY

Not Applicable.

### 5.2 EQUIPMENT DEFINITION

#### 5.2.1 SPECIFICATIONS AND STANDARDS

The Specification and Standards that are incorporated within this document are as follows:

5.2.3.1 ASME Y14.5-2009, Dimensioning and Tolerancing

5.2.1.2 ASTM-B571, Qualitative Adhesion Testing of Metallic Coatings\_

Note: Applicability of 5.2.1.2 is part specific and is defined within the drawings.

#### 5.2.2 GENERAL DESIGN FEATURES

Components shall meet all requirements specified within the approved drawings (see Table 1), including but not limited to geometry, orientation, dimensions, tolerances, and surface finishes.

Table 1: NSTX Upgrade PFC Metal Components								
Item No.	Tile Row	DWG No.	Sheet No.	Part No.	Description	Mat. Grade	Qty	Sample Size
1	OBD Rows 3,4,5 All Styles	E-ED1414	1 of 3	E-ED1414-1	Base T-Bar (Inconel 625)	Inconel 625	500	50
2			2 of 3	E-ED1414-2	Row 4 Spectrometer T-Bar	Inconel 625	8	2
3			2 of 3	E-ED1414-3	Row 5 Spectrometer T-Bar	Inconel 625	9	3
4			3 of 3	E-ED1414-4	RF Probe T-Bar	Inconel 625	6	2
5			3 of 3	E-ED1414-5	Mirnov T-Bar	Inconel 625	11	3
6			3 of 3	E-ED1414-6	Shunt T-Bar	Inconel 625	14	3
7			3 of 3	E-ED1414-7	Base T-Bar (Inconel 718)	Inconel 718	40	8
8	OBD Rows 1,2 All Styles	E-ED1408	8 of 8	E-ED1408-6	Square Retainer	316 SS	110	20
9			8 of 8	E-ED1408-21	Rectangular Retainer	316 SS	110	20
10			8 of 8	E-ED1408-19	Compressible Keeper	UNS C10700	210	32
11			8 of 8	E-ED1408-5	Row 10, Rev 2 DIA	316 SS/STL	210	32

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12	CSFW Rows 7-21, All Styles	E-ED1451	1 of 1	E-D1451-1	Centercase Section Backing Plate	Inconel 718	195	32
13		C-ED1448	1 of 2	E-D1448-1	T20 Drive Nut Tile Row 7-21	A286	380	50
14		E-ED1454	1 of 1	E-D1454-1	Locating Pin	Inconel 625	610	50
15			1 of 1	E-D1454-2	Locating Pin - 2-Sides Coated	Inconel 625	12	3
16			1 of 1	E-D1454-3	Locating Pin - 1-Side Coated	Inconel 625	140	20
17	CSA, All Styles	E-ED1424	1 of 1	E-D1424-1	T-Bar Rows 5 & 6	Inconel 625	110	20
18	IBDV All Styles	C-ED1448	2 of 2	E-ED1448-2	T20 Drive Nut Tile Row 2	A286	110	20
19		E-ED1431	1 of 1	E-ED1431-1	T Bar Row 2	Inconel 625	55	13
20	IBDV/IBDH Shared Parts All Styles	E-ED1432	1 of 2	ED1432-1	Locking Post	Inconel 718	505	80
21			2 of 2	ED1432-2	Spacer Style 1 (.020 THK)	Inconel 718	995	80
22			2 of 2	ED1432-4	Spacer Style 2 (.135 THK)	Inconel 718	210	32
23			2 of 2	ED1432-5	Spacer Style 3 (.045 THK)	Inconel 718	210	32
24			2 of 2	ED1432-6	Spacer Style 4 (.090 THK)	Inconel 718	110	20
25		E-ED1435	2 of 3	ED1435-1	IBDV Frame Style 1	Inconel 625	10	10
26			3 of 3	ED1435-2	IBDV Frame Style 2	Inconel 625	2	2
27		E-ED1443	1 of 1	ED1443-1	IBDH Locking Rod	Inconel 625	110	20
28		E-ED1444	1 of 1	ED1444-1	IBDV Locking Rod	Inconel 625	110	20

**Note:**

- 1) Quantities listed on the fabrication drawings are for reference only. The Subcontractor shall manufacture the quantities listed within the award. Quantities listed on the award shall supersede all other quantities.
- 2) 100% inspection shall be required for item 25 in Table 1.
- 3) Sample sizes provided in Table 1 are for reference only and assume single lots/batches of each part number. See Note 1 in Section 6.2.2 for lot/batch definition.

**5.2.3 MATERIALS & TRACEABILITY**

5.2.3.1 Material grades can be found within Section 5.2.2, Table 1. The Subcontractor is responsible for sourcing all materials needed for completion of the work defined within this SOW.

5.2.3.2 The Subcontractor shall detail within their MIT plan their process for maintaining material traceability between all stages of manufacturing.

**5.2.4 MAGNETIC PERMEABILITY**

Components shall meet any magnetic permeability requirements specified in the applicable



drawings. Magnetic permeability may be affected by manufacturing processes. Therefore, magnetic permeability shall be verified on finished components using a calibrated Severn Gauge or PPPL approved equivalent.

#### 5.2.5 IDENTIFICATION AND MARKING

Parts for which the applicable drawing (found in Section 5.2.2, Table 1) calls out specific marking/identification requirements shall be marked in accordance with the corresponding drawing. Each part for which marking/identification is not defined in the corresponding drawing shall have its packaging marked with the applicable drawing number in accordance with the following procedure:

5.2.5.1 Components are to be packaged as per the requirements outlined in Section 10.0.

5.2.5.2 Each package is to have the outside labeled with the applicable Drawing number and lot number of base material to ensure traceability. The Subcontractor's planned marking method shall be included in the MIT (per Section 9.12).

5.2.5.3 Marking parts with any type of ink-marker or paint-stick will contaminate the surface and is not acceptable.

#### 5.2.6 WORKMANSHIP

The Subcontractor's manufacturing shall meet, at minimum, the following expectations for workmanship:

5.2.6.1 Gouged, pitted, chipped, or corroded material will not be acceptable under any circumstances.

5.2.6.2 All machining debris and sharp edges shall be cleaned. Holes, channels, slots, and grooves shall be clear of any machining debris that could affect form, fit, and function.

5.2.6.3 Chatter, cutter, and vibrational marks shall be minimized through proper tooling care, usage, and inspection. Extra care should be taken to ensure that all surface finish requirements are met during manufacturing.

5.2.6.4 Threads shall be fully formed and of the correct size. Acceptable threads shall be free of tears, cracks, loose debris, and other contaminants. All threads shall be protected from potential damage and free of dirt, grease, or debris which could lead to poor assembly.

5.2.6.5 Cross-threading or rolling of any threads is only acceptable for stock materials, such as fasteners, and is not acceptable for fabricated components.

5.2.6.6 Counter sinks and counter bores shall be free from chatter and meet the surface finish requirements of the applicable tile drawing. Any "witness marks", ragged edges, or oblong holes on counter sinks are unacceptable.

5.2.6.7 Any applied metallic coatings shall be tested and verified per: ASTM-B571, Qualitative Adhesion Testing of Metallic Coatings.

5.2.6.8 Although fixture and clamping marks are inherently unavoidable, care should be taken to ensure that any fixture/clamping marks accrued on a part during manufacturing do not conflict with any of the above workmanship requirements.

#### 5.2.7 *SUBCONTRACTOR EQUIPMENT USE*

Not Applicable.

## 6.0 **TEST & INSPECTION REQUIREMENTS**

### 6.1 **PERFORMANCE TESTS**

6.1.1 The Subcontractor shall verify conformance of any Supplier purchased and, if provided, PPPL-furnished items or services to drawing and specification requirements and shall provide objective evidence of such verifications to PPPL as requested.

6.1.2 All produced parts shall be inspected and tested per Section 6.2 requirements unless an alternate plan is agreed upon with PPPL in writing.

Note: Results shall be documented and reported to PPPL in the Subcontractor's Process History (per Section 9.13). Any exceptions to PPPL requirements shall be approved by PPPL in writing.

### 6.2 **ACCEPTANCE TESTS**

Upon receipt of the completed parts from the Subcontractor, PPPL will perform internal inspections, dimensional verifications, and any other quality assurance inspections deemed necessary to verify the conformance of the delivered parts.

#### 6.2.1 *FIRST-ARTICLE INSPECTION PROCESS*

The Subcontractor will be provided a standard "PPPL Dimensional Inspection Form" (Attachment III) to be used for reporting all inspection results. Both First-Article and In-Process inspections use this same form.

The Subcontractor is required to complete a First Article Inspection "FAI" (inspect, verify, and record dimensional accuracy) for the first unit of each unique part number using the PPPL "PPPL Dimensional Inspection Form". FAI approval is a Hold Point (per Section 6.3.3).

The FAI approval process is as follows:

6.2.1.1 The dimensions and tolerances indicated on the applicable drawings are to be interpreted by the Subcontractor in accordance with ASME Y14.5-2009, Dimensioning and Tolerancing.

6.2.1.2 The Subcontractor is responsible for conducting the FAI inspection and providing the completed FAI (using the PPPL Dimensional Inspection

Form”) to their respective PPPL QA contact once complete.

6.2.1.3 PPPL will review the FAI and indicate acceptance by signing and returning the Dimensional Inspection Form.

6.2.1.4 Following acceptance of the FAI by PPPL, the Subcontractor may continue manufacturing subsequent units of the same part number in accordance with the approved MIT plan (per Section 9.12).

After acceptance of the FAI by PPPL, the remaining units required by the purchase order shall be produced using the same design, materials, processes, methods, and tooling that were used to manufacture the approved FAI components. Any changes to the approved process require PPPL approval prior to implementation.

Note: PPPL reserves the right to designate the FAI a mandatory witness point.

## 6.2.2 SAMPLING AND INSPECTION PLANNING

With the exception of item 25 in Table 1 (see Section 5.2.2), all components produced by the Subcontractor shall be inspected per the below sampling plan based upon the respective lot or batch size as outlined within Table 1:

**Table 2: Sampling Plan for Non-Critical Features**

Lot or Batch Size	Sample Size
2 to 8	2
9 to 15	3
16 to 25	5
26 to 50	8
51 to 90	13
91 to 150	20
151 to 280	32
281 to 500	50
501 to 1,200	80

*Sampling plan based on ANSI/ASQ Z1.4-2003, single sampling plan for normal inspection, general inspection level II.*

Samples shall be chosen such that the inspected units are approximately evenly distributed through the manufacturing run. Each sampled lot shall include inspection of the first unit (FAI per Section 6.2.1) and the last unit. Sampling inspection and FAI documentation shall both be completed with the provided “PPPL Dimensional Inspection Form” attached at the end of this document (Attachment III).

**Note 1:** For the purposes of executing the above defined sampling plan, a lot/batch shall be defined as a series of components of the same Part Number manufactured under a continuous

process using the same material (same material heat/lot number), fixturing, tooling, and machine. Any change in any of these four characteristics of the machining process shall constitute the end of a lot/batch.

**Note 2:** Item 25 within Table 1, the IBDV Frame Style 1, shall be 100% inspected (all 10 pieces) by the Subcontractor to ensure strict dimensional conformance.

### 6.3 SUPPLIER HOLD POINTS

The following hold points require written PPPL approval prior to continuance of work:

- 6.3.1 Approval of MIT Plan (per Section 9.12) – Initial MIT Plan, as well as revisions to previously approved MIT Plan shall be approved prior to implementation. Approval will be provided by the PPPL Responsible Engineer (RE) and communicated to Subcontractor by the PTR or QA Representative.
- 6.3.2 Verification of Certified Material Test Reports (CMTRs, per Section 9.13.2) – Subcontractor shall submit CMTRs for approval prior to manufacturing components. Approval will be provided by the PTR.
- 6.3.3 Approval of FAI Forms (per Section 6.2.1) – Subcontractor shall submit FAI forms for the first of each part number manufactured per this SOW for approval prior to manufacturing subsequent components of the same part number being reported. Approval will be provided by the PTR.
- 6.3.4 Approval of Nonconformance Disposition and Corrective Action (as applicable, per Section 9.9) – Subcontractor shall submit Non-conformance Reports for PPPL review and approval of Disposition and Corrective Action for any non-conforming items. Approval shall be provided prior to manufacturing subsequent components. Approval will be provided by the PTR.
- 6.3.5 Approval of Process History documentation (per Section 9.13) – Subcontractor shall submit Process History documentation for approval prior to shipment of product. Approval will be provided by PPPL QA representative via the “Product Quality Certification & Shipping Release Form” (per Section 9.11).

## 7.0 QUALIFICATIONS

Personnel performing work to this SOW are required to have been trained in the operation of the equipment being used. Training records shall be maintained on file and shall be available for review upon PPPL request.

The Subcontractor shall maintain documentation outlining the training of their employees responsible for completing the contract manufacturing with the MIT plan and all requirements of this SOW. Documentation of training to the MIT plan and SOW requirements shall include, at minimum, the following:

- 7.1 A Pre-Production Kick-Off meeting with any Subcontractor employees responsible for completing work to this contract and SOW in attendance (either physically or remotely).

- 7.2 A formal sign-in sheet recording the names and dates of employees present for the meeting (physical or electronic signatures are acceptable).
- 7.3 A formal Presentation in the Subcontractor's preferred format (Microsoft slides, word, excel, etc.) detailing the training covered during the meeting.

Documentation of these training records shall be presented to PPPL upon request; it is established that the PTR shall review this documentation during Subcontractor Audit(s).

## **8.0 ENVIRONMENT, SAFETY, AND HEALTH**

The Subcontractor's safety record may be considered in proposal/bid evaluations; PPPL may request information deemed necessary to evaluate Subcontractor safety record at any time.

The Subcontractor shall:

- 8.1 Comply with all OSHA regulations to ensure the safety of any potential PPPL visitors to the Subcontractor's facility.
- 8.2 Be responsible for ensuring the safety of PPPL visitors; and providing any necessary personal protective equipment (PPE) and safety related training to PPPL visitors who have been tasked with overseeing the Subcontractor's manufacturing.

## **9.0 QUALITY ASSURANCE REQUIREMENTS**

### **9.1 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 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.

**Note:** PPPL plans to have a representative at the Subcontractor's facility one day per month to review project progress/status and verify conformance to requirements. PPPL may modify the frequency of visits at any time and will provide the Subcontractor with as much notification as possible for planning purposes.

## **9.2 SUBCONTRACTOR'S RESPONSIBILITY FOR CONFORMANCE**

Neither PPPL's review and/or approval of the Subcontractor's documents nor PPPL's inspection of Subcontractor's items or services shall relieve the Subcontractor of responsibility for full compliance with the requirements of the purchase order/contract. If any portion of this work is planned to be performed by sub-tier contractors, such plans shall be communicated to PPPL with the contractor's quotation proposal and shall be approved by PPPL prior to execution of work. The Subcontractor is responsible for ensuring that all requirements and restrictions within this specification are imposed on any sub-tier suppliers.

## **9.3 SUBCONTRACTOR 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.
- 9.3.4 The subcontractor shall submit with the proposal, a copy of its quality assurance program manual, describing the subcontractor's quality capability and general approach to quality assurance. The manual shall be subject to PPPL's review and acceptance prior to contract award.

## **9.4 ACCEPTANCE INSPECTIONS AND TESTS**

Inspections and tests shall be performed in accordance with written procedures referencing criteria for acceptance or rejection. PPPL internal inspections may include dimensional verification, material property verification, or verification of any other applicable conformance requirements. Adequate records shall be maintained by the Subcontractor and made available for PPPL's review upon request in to ensure the conformance of delivered parts.

## **9.5 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", certifications, examinations, and discrepancy reports,

which shall be complete, legible, and validated by responsible personnel and shall be traceable to the subject items. This documentation shall be made available to PPPL upon request.

## **9.6 ACCEPTIBILITY OF PURCHASED ITEMS AND SERVICES**

The Subcontractor shall notify PPPL of any damage to finished parts within 2 business days of discovery. Documentation of any damaged PPPL parts shall be maintained by the Subcontractor and made available to PPPL upon request (see Section 9.5).

## **9.7 MATERIAL IDENTIFICATION AND STATUS**

Material 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. See Section 5.2.5 for specific instructions regarding identification and marking; and Section 9.13.2 regarding material traceability.

## **9.8 DOCUMENT REVIEW, APPROVAL AND CONTROL**

The Subcontractor shall implement a system 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. The system shall also control PPPL-furnished design documents to ensure that models are in sync with the applicable drawings, and that obsolete information is not used.

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

## **9.9 NONCONFORMANCES & CORRECTIVE ACTIONS**

The Subcontractor shall promptly identify and control nonconforming items or services. Nonconforming items or services shall be positively identified, and segregated where possible, to prevent use. The Subcontractor shall document each non-conformance on a Non-Conformance Report "NCR".

Non-Conformance Reports (NCRs) shall, at a minimum, contain the following information:

- 9.9.1 A description of the non-conformance.
- 9.9.2 A determination of the cause of the non-conformance.
- 9.9.3 A proposed resolution/disposition of the non-conformance.
- 9.9.4 A corrective action plan to preclude recurrence.

(Note: The determination of cause and corrective action plan may be waived by PPPL).

Upon the discovery of any non-conforming parts, all work by the Subcontractor on the applicable part/drawing number being produced shall be halted and shall not resume until a NCR has been



processed and a corrective action plan has been established and approved by PPPL.

PPPL shall be notified within 2 business days if upon inspection, the dimensions of any part are found to be noncompliant with the dimensions and tolerances specified on the applicable fabrication drawing, and the Subcontractor shall begin the process of filing a Non-Conformance report following the above minimum requirements. NCRs shall be submitted to PPPL for review within 7 business days of the discovery of the non-conformance.

#### **9.10 CALIBRATION OF TEST AND MEASURING EQUIPMENT**

Inspections and tests shall be performed using properly calibrated measuring and test equipment. Calibration standards shall be traceable to the National Institute for Standards and Technology (NIST) or equivalent.

The usage of reference standards for Subcontractor self-calibration of equipment shall be detailed in the Subcontractor's submitted MIT plan. Examples of this can include: The use of externally calibrated gauge blocks to internally calibrate their own calipers; or the usage of machinery manuals/guides to internally calibrate their own machining equipment. The Subcontractor shall submit calibration records for all externally calibrated equipment and reference standards used to execute the work defined within this SOW. These records shall be submitted with the MIT plan.

#### **9.11 SUBMITTAL OF COMPLETED RELEASE FOR SHIPMENT FORM**

The Subcontractor shall not ship without a "Product Quality Certification and Shipping Release" (Attachment II) form signed by PPPL's Representative. Subcontractor shall complete and sign the certification section, fax or email the form to PPPL's Quality Assurance (QA) Representative, and hold shipment until PPPL signs and returns the form, authorizing shipment. A copy of the fully executed form shall accompany each full or partial shipment.

#### **9.12 SUBMITTAL OF MANUFACTURING/INSPECTION/TEST (MIT) PLAN**

The Subcontractor shall submit a Manufacturing/Inspection/Test Plan within 10 working days after receipt of order for PPPL approval prior to start of manufacture. 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. PPPL may designate selected operations as mandatory "witness" points based on the MIT Plan. Subcontractor shall provide PPPL with notice five working days in advance of such witness points. Revisions or changes to the approved MIT plan shall be reviewed and approved by PPPL prior to use.

#### **9.13 PROCESS HISTORY**

Subcontractor shall provide PPPL, along with the completed "Product Quality Certification & Shipping Release Form" (per Section 9.11), a digital copy of the Process History. The Process

History is a compilation of documents, detailing the objective evidence of the acceptability of the



work performed, and shall include as a minimum the following:

#### *9.13.1 CERTIFICATE OF CONFORMANCE*

Subcontractor's Certificate of Conformance, signed by the Subcontractor's Quality Manager (or equally authorized Subcontractor Representative), 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 a statement certifying that the material furnished by PPPL has been inspected by the Subcontractor and used as specified by PPPL with no unauthorized substitutions.

#### *9.13.2 CERTIFIED MATERIAL TEST REPORTS (CMTR)*

The Subcontractor shall submit the manufacturer's CMTR's showing actual relevant chemical, mechanical, and electrical properties of materials used and providing traceability to the actual material. Submitted CMTRs shall be linked to the specific part by referencing the parts list on the drawing. One copy is to be submitted to PPPL upon Subcontractor's receipt of material prior to the beginning of any manufacturing.

9.13.2.1 If PPPL is providing the Subcontractor with the material to be used for fabrication PPPL will provide CMTR's with the material upon delivery to the Subcontractor.

9.13.2.2 It is the responsibility of the Subcontractor to maintain CMTR traceability for any PPPL materials on their floor using the respective material Heat number and Batch number listed on the CMTR's, along with the applicable drawing number.

9.13.2.3 For all applied metallic coatings, a certificate of grade (or otherwise appropriate certificate) shall be provided.

Note: For specialty materials, typically non-metals, where test reports are not readily available from the manufacturer, their certificate of analysis or certificate of grade, as appropriate, may suffice, subject to PPPL concurrence.

#### *9.13.3 INSPECTION REPORTS*

The Subcontractor shall submit all FAI (per Section 6.2.1) and in-process inspection reports (per Section 6.2.2).

#### *9.13.4 NON-CONFORMANCE REPORTS*

The Subcontractor shall submit copies of processed NCRs (per Section 9.9).

### **9.14 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

## **10.0 SHIPPING, STORAGE, AND PACKAGING**

The Subcontractor shall control items during shipping, handling, and storage. Release from storage shall be controlled to prevent accidental or inadvertent use of incorrect or unacceptable items. The following packaging requirements shall be followed for each part being fabricated at the Subcontractor and delivered to PPPL:

- 10.1** All parts are to be packaged separately based upon their respective applicable drawing number. Multiple parts with differing drawing numbers are not to be combined in the same packaging.
- 10.2** All parts are to be packaged in such a way as to prevent exposure to the elements and the forming of corrosion. As mentioned within Section 5.2.6 corroded parts will not be acceptable.
- 10.3** All parts are to be packaged in such a way that the parts cannot freely move and potentially incur damage while in-transit. This can be achieved through the Subcontractor's preferred methods. Methods may include but are not limited to: metal-tension banding, clear plastic wrap, or movement restrictive packaging.
- 10.4** A copy of the Process History documentation (per Section 9.13) shall be enclosed within a weather-safe shipping label accompanying the shipment.

Note: The Subcontractor's planned shipping method and packaging shall be detailed within their MIT submitted to PPPL for approval. PPPL will approve or revise the Subcontractor's recommended shipping method and packaging to ensure conformance with the above requirements.

The Subcontractor is encouraged to send full-shipments of completed parts as they are completed unless otherwise directed by PPPL. "Product Quality Certification & Shipping Release Form" (Section 9.11) and Process History (Section 9.13) documentation shall be supplied with each shipment.

## **11.0 WARRANTY**

Not Applicable.

## **12.0 ATTACHMENTS**

Attachment I – "Metal Component Deliverables List"

Attachment II – "Product Quality Certification and Shipping Release"

Attachment III – "PPPL Dimensional Inspection Form"

## **13.0 DOCUMENTATION & DELIVERABLES**

- 13.1** Documentation shall be provided for PPPL approval as delineated in the



following table. One original and one duplicate copy of each document shall be provided unless otherwise specified herein. Acceptable documentation formats are PDF, Microsoft Excel, or Microsoft Word. Other formats may be used with PPPL approval.

- 13.2** PPPL Attachment II, the “Product Quality Certification and Shipping Release”, is to be completed, reviewed and approved by PPPL prior to shipment. Physical copies of the form(s) are to be included in all shipments to PPPL.
- 13.3** PPPL Attachment III, the “PPPL Dimensional Inspection Form”, shall serve as the documentation the Subcontractor shall use to report any FAI or sampling inspection results.

## 14.0 DELIVERABLES LIST

PO / Subcontract / BOA / BPA #: \_\_\_\_\_

Date: \_\_\_\_\_

#	Physical Deliverables by Part #	Part Description	Total Quantity Required	Total Quantity Shipped	Deliverable Received (✓)	Damage on Arrival (Y/N)?
1	E-ED1414-1	Base T-Bar (Inconel 625)	500			
2	E-ED1414-2	Row 4 Spectrometer T-Bar	8			
3	E-ED1414-3	Row 5 Spectrometer T-Bar	9			
4	E-ED1414-4	RF Probe T-Bar	6			
5	E-ED1414-5	Mirnov T-Bar	11			
6	E-ED1414-6	Shunt T-Bar	14			
7	E-ED1414-7	Base T-Bar (Inconel 718)	40			
8	E-ED1408-6	Square Retainer	110			
9	E-ED1408-21	Rectangular Retainer	110			
10	E-ED1408-19	Compressible Keeper	210			
11	E-ED1408-5	Rod 3/8" DIA	210			
12	E-D1451-1	Centercase Section Backing Plate	195			
13	E-D1448-1	T20 Drive Nut Tile Row 7-21	380			
14	E-D1454-1	Locating Pin	610			
15	E-D1454-2	Locating Pin - 2-Sides Coated	12			
16	E-D1454-3	Locating Pin - 1-Side Coated	140			
17	E-D1424-1	T-Bar Rows 5 & 6	110			
18	E-ED1448-2	T20 Drive Nut Tile Row 2	110			
19	E-ED1431-1	T Bar Row 2	55			
20	ED1432-1	Locking Post	505			
21	ED1432-2	Spacer Style 1 (.020 THK)	995			
22	ED1432-4	Spacer Style 2 (.135 THK)	210			
23	ED1432-5	Spacer Style 3 (.045 THK)	210			
24	ED1432-6	Spacer Style 4 (.090 THK)	110			
25	ED1435-1	IBDV Frame Style 1	10			
26	ED1435-2	IBDV Frame Style 2	2			
27	ED1443-1	IBDH Locking Rod	110			
28	ED1444-1	IBDV Locking Rod	110			

**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	Deliverable Received (✓)
1	Quality Assurance Program Manual (Section 9.3.4)	With Proposal	Electronic	Ops	
2	Manufacturing, Inspection, and Testing plan (MIT) (Section 9.12)	Within 10 days of Contract Award	Electronic	Ops	
3	Calibration of Test and Measuring Equipment (Section 9.10)	With MIT plan	Electronic	Ops	
4	Certified Material Test Reports (Section 9.13.2)	Prior to Manufacturing	Electronic	Ops	
5	First-Article Inspection Reports (Section 6.2.1)	Upon completion of First-Articles	Electronic	Ops	
6	Non-Conformance Reports (Section 9.9)	Within 7 days of Discovery	Electronic	Ops	
7	Product Quality Certification & Shipping Release Form (Section 9.11)	Prior to Shipment(s)	Electronic	Ops	
8	Process History (Section 9.13)	Prior to Shipment(s)	Electronic	Ops	
<b>Exceptions (Add justification for any missing document deliverables that will not be received):</b>					

Princeton Technical Representative or COG: \_\_\_\_\_

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



**PRINCETON 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 #
	<b>SUPPLIER'S CERTIFICATION</b> 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.		
	SIGNED: _____ DATE: _____  TITLE: _____ COMPANY: _____		

Completed, signed, and returned by PPPL before shipment	<b>PPPL (AUTHORIZED REPRESENTATIVE) SHIPPING RELEASE</b> This is to certify that evidence supporting the above Supplier's Certification statement has been reviewed and no product/service nonconformances from procurement requirements have been identified unless noted below. This product/service is hereby released for shipment.  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.	
	NONCONFORMANCES FROM PROCUREMENT QUALITY REQUIREMENTS:	
	REMARKS/PRODUCT SERIAL NUMBERS:	
	BY PPPL QA REPRESENTATIVE (OR DESIGNEE)	DATE

Rev. 1 November 15, 2010

PPPL DIMENSIONAL INSPECTION FORM						
1. Subcontractor/Company:			4. Drawing# & Rev.:			7. Sheet___of ___
2. Purchase Order#:			5. Part Name:			
3. Line Item:			6. First Article Inspection		In-Process	
FEATURE CHARACTERISTICS			INSPECTION/TEST RESULTS			
8. Feature Number	9. Reference Location	10. Requirement	11. Results	12. M&TE Identification	13. Nonconformance Number	14. Comments:
A signature below indicates that all applicable drawing characteristics are accounted for and are properly documented.						
<b>SUBCONTRACTOR USE ONLY:</b>						
15. Inspected and Documented by:				16. Date:		
<b>PPPL USE ONLY (APPLICABLE TO FAI):</b>						
Approved 12/13/2019 17. Reviewed and Approved by:		NSTXU_1-1-1-SOW_100, Rev. 2			18. Date:	



The PPPL Dimensional Inspection form is used to document results of inspections and any applicable nonconformances. The following are instructions for the completion of each field. Fields marked **(R)** are required. Fields marked **(CR)** are conditionally required, with the fields' instructions providing guidance regarding the applicability of the requirement. Fields marked **(O)** are optional.

1. **(R) Subcontractor/Company:** Name of the organization performing the inspection.
2. **(R) Purchase Order#:** Customer purchase order number.
3. **(R) Line Item:** Purchase order line item of the component being inspected.
4. **(R) Drawing# & Rev.:** Drawing number (including revision) of the drawing identifying the dimensions and tolerances of the component being inspected.
5. **(R) Part Name:** Part name/description as identified on the drawing's title block, part list, or purchase order line item.
6. **(R) FAI/In-Process:** Identification of type of dimensional inspection being reported. Only one option may be selected to indicate whether the inspection is an FAI or In-Process inspection.
7. **(R) Sheet#:** Multiple sheets may be used as necessary to document all applicable requirements. Each sheet is marked to indicate its sheet number and the total number of sheets comprising the report.
8. **(R) Feature Number:** Unique number assigned to each design characteristic. This number shall match the corresponding number assigned to the feature on the accompanying bubbled drawing.
9. **(CR) Reference Location:** Location of the feature on the drawing (sheet number and zone). This field is optional in cases where features are identified via a bubbled drawing. In the event that, with PPPL approval, a bubbled drawing is not included, this field is required.
10. **(R) Requirement:** Specified requirement for the design characteristic (e.g. drawing dimensional characteristic with associated nominal dimension and tolerances, drawing notes, specification requirements).
11. **(R) Results:** A listing of the measurement(s) obtained for the design characteristics.
  - In the event that a single Feature Number covers multiple features, the results may either be reported individually or as a range identifying the minimum and maximum measured values. Any features that are found to be nonconforming shall be listed separately.
  - When pin gages are used to verify hole diameters, the largest "go" pin and smallest "no-go" pin diameters shall be reported.
  - When qualified tooling (e.g. radius gage) is used as a go/no-go gage, the results are identified on an attribute basis (e.g. pass/fail).
12. **(R) M&TE Identification:** The unique identification assigned to the tooling used to take the reported measurements.
13. **(CR) Nonconformance Number:** As applicable, reference number of any nonconformance document.
14. **(O) Comments:** This field is used to document any noteworthy observations or comments.
15. **(R) Inspected and Documented by:** Printed name and signature of the person who prepared and approved the form. The signature may be in electronic format only if the signature is uniquely, positively, and securely associated with the approving individual.
16. **(CR) Date:** The date when field 15 was signed. If an electronic signature with a date stamp was used in field 15, this field is optional.
17. **(CR) Reviewed and Approved by:** Printed name and signature or electronic signature (as defined for field 15) of the PPPL representative who reviewed and approved the form. When First Article Inspection is indicated in field 6, this field is required.
18. **(CR) Date:** The date when field 17 was signed. If an electronic signature with a date stamp was used in field 17, this field is optional.