

Technical Specification for the Fabrication of the Heat Transfer

Technical specification: NSTXU_1-1-3-3-10_SPEC_100

REVISION 1

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National Spherical Torus eXperiment Upgrade

TECHNICAL SPECIFICATION FOR FABRICATION OF THE HEAT TRANSFER TUBE INLET AND OUTLET LINES

CAT: ☒ A1 ☐ A2 ☐ A3

UNIQUE PROJECT IDENTIFIER: NSTX-U-SPEC-VVIH-003-01

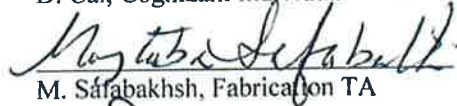
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REVISION 1

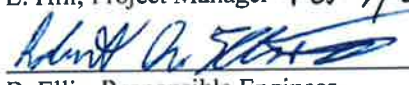
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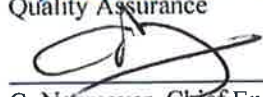
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RECORD OF CHANGES

Rev.	Date	Description of Change(s)
0	03/04/2019	Initial release (§5.1.3) Added note that magnetic permeability testing is to be done by PPPL (§5.1.4c) Added PPPL approval required for acceptance of any scratches exceeding limits (§5.1.7) Removed specifications for heat treatment and quench (§6.1.2) Added note that magnetic permeability testing is to be done by PPPL (§8.2) Removed Notification Requirements Off-Normal Events & Issues
1	07/18/2019	(§8.4) Removed Safety Hazard and Mitigation Plan (§9.5) Removed Subcontractor Quality Assurance Program (§9.12) Removed Submittal of Material Certification (§9.21) Removed Submittal of Completed Process History (§10.0) Removed shock indicator requirements Packing and Shipping Plan now to be provided by PPPL (Table 6) Updated table removing deliverables for removed sections

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LIST OF ACRONYMS

AMS	= <u>A</u> erospace <u>M</u> aterial <u>S</u> pecification	NCR	= <u>N</u> on- <u>C</u> onformance <u>R</u> eport
ASME	= <u>A</u> merican <u>S</u> ociety of <u>M</u> echanical <u>E</u> ngineers	NDT	= <u>N</u> on- <u>D</u> estructive <u>T</u> esting
ASTM	= <u>A</u> merican <u>S</u> ociety for <u>T</u> esting & <u>M</u> aterials	NSTX	= <u>N</u> ational <u>S</u> pherical <u>T</u> orus <u>e</u> Xperiment
CMTR	= <u>C</u> ertified <u>M</u> aterial <u>T</u> est <u>R</u> eport	PPPL	= <u>P</u> rincenton <u>P</u> lasma <u>P</u> hysics <u>L</u> aboratory
GD&T	= <u>G</u> eometric <u>D</u> imensioning & <u>T</u> olerancing	PQR	= <u>P</u> rocedure <u>Q</u> ualification <u>R</u> ecords
HTT	= <u>H</u> eat <u>T</u> ransfer <u>T</u> ube	PTR	= <u>P</u> rincenton <u>T</u> echnical <u>R</u> epresentative
JHA	= <u>J</u> ob <u>H</u> azard <u>A</u> nalysis	QA	= <u>Q</u> uality <u>A</u> ssurance
MIT	= <u>M</u> anufacturing, <u>I</u> nspection & <u>T</u> esting	TA	= <u>T</u> echnical <u>A</u> uthority
MRR	= <u>M</u> anufacturing <u>R</u> eadiness <u>R</u> evue	WPQ	= <u>W</u> elder <u>P</u> erformance <u>Q</u> ualification
		WPS	= <u>W</u> elding <u>P</u> rocedure <u>S</u> pecifications

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1.0 INTRODUCTION & SCOPE

This Technical Specification provides details on the materials, labor, supervision, equipment, and expertise required to fabricate the upper and lower Heat Transfer Tube (HTT) inlet and outlet tubes. These components are used to assemble the completed HTT assemblies used for cooling of the Center Stack Assembly, part of the NSTX-U experimental fusion device.

2.0 APPLICABLE DOCUMENTS

- [1] ASTM A 342-04 – *Standard Test Methods for Permeability of Feebly Magnetic Materials*
- [2] ASTM B444 – *Standard Specification for Nickel-Chromium-Molybdenum Columbium Alloy (UNS N06625) Pipe and Tube*

3.0 APPLICABLE DRAWINGS

Table 1. List of PPPL Provided Drawings

Drawing No.	Rev.	Description
E-DC11073	1	Center Stack Heat Transfer Tube Weldment, Top and Bottom
E-DC11074	2	Center Stack Heat Transfer Tube Vertical Clamp, Top and Bottom
E-DC11225	1	Center Stack Heat Transfer Tube Mandrel Ass'y

4.0 RESPONSIBILITIES

4.1 PRINCETON PLASMA PHYSICS LABORATORY

4.1.1 PROJECT MANAGEMENT & OVERSIGHT

- a. PPPL is responsible for this document, and the requirements contained herein.
- b. PPPL will designate a technical contact, the Princeton Technical Representative (PTR) and a Quality Assurance (QA) contact as well as alternate contacts for those individuals at the time of contract award.
- c. PPPL will oversee and witness various phases of this work scope. Hold and witness points requested by PPPL are outlined in §6.3. The subcontractor shall provide a minimum one weeks' notice to PPPL of the anticipated date of the performance of these steps.

4.1.2 PPPL DELIVERABLES TO SUBCONTRACTOR

- a. All drawings outlined in §3.0.
- b. All parts/sub-assemblies and quantities listed in Table 2. *NOTE:* Any parts and unused consumables provided by PPPL shall be returned after completion of this work scope.
- c. PPPL Shipping Release Form (Attachment A).

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Table 2. List of Materials/Equipment Provided by PPPL

Part No.	Description	Quantity	Material
E-DC11074-25	Cooling Coil Vertical Clamp Before Split	1	Inconel 625
E-DC11225-1	Heat Transfer Tube Mandrel Outerform	1	Inconel 625
—	Tube, Ø3/8" OD × .035" Wall, 125' LG on Ø30" spools	2	Inconel 625
—	Tube, Ø1/4" OD × .035" Wall, 5' straight section	1	Inconel 625
—	Test Fit Jig for Outer-most Turn of HTT	1	3D Printed Plastic

4.2 SUBCONTRACTOR

4.2.1 PROJECT MANAGEMENT

The subcontractor shall provide a single-point of contact and an alternate for any communication between PPPL and the subcontractor.

4.2.2 DELIVERABLES TO PPPL

The subcontractor is responsible for providing the physical and document deliverables in §11.0 to PPPL when noted and as required.

4.2.3 MATERIAL ACQUISITION

Unless otherwise noted, the subcontractor shall be responsible for purchasing all raw and shop materials necessary for the fabrication of all subcontractor furnished components and subassemblies (see Table 3).

4.2.4 MANUFACTURING

The subcontractor is responsible for the fabrication of all subcontractor furnished components/subassemblies (see Table 3) per the drawings supplied by PPPL, and any other instructions/standards/etc., referenced in this Technical Specification.

4.2.5 DOCUMENTATION

The subcontractor shall thoroughly document calibration records, manufacturing plans, personnel certifications and qualifications, and all inspections performed. Inspection reports shall be submitted to PPPL as noted in §12.0. The report shall include type of test, location of test and results and photos of the setup.

4.2.6 START OF WORK

The actual fabrication work shall not start, until the following are met:

- a. PPPL has reviewed, and approved all required documents, including the subcontractors MIT plan, §9.8.
- b. Successful completion of a Manufacturing Readiness Review per §9.6.

4.2.7 DIMENSIONAL VERIFICATION

The subcontractor shall verify all dimensions noted in the drawing package and document the results throughout the component fabrication process per §6.1.1.

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4.2.8 NOTIFICATION REQUIREMENTS

The subcontractor shall immediately contact PPPL regarding non-compliance or damage to any part or assembly. Details of the damage, including pictures, shall be discussed and documented, and a mitigation plan shall be developed. Work shall not resume on the damaged items, until an NCR is approved and issued by PPPL.

4.2.9 TOOLING ACCOUNTABILITY

Any custom tool/fixture needed in the execution of the work scope shall be the property of PPPL. The subcontractor shall label, and ship these items to PPPL upon completion of the work. The subcontractor shall make a list of this tooling and the tooling shall be identified in the applicable step(s) in the MIT Plan. This list shall include the unique identifier for each tool, plus what step, and which part in the manufacturing process, it was used. Pictures shall be taken of the tool(s), showing how the tool was used to make/hold the part. The general requirements outlined in §9.1 apply to all tooling and fixture materials and hardware.

4.2.10 WEEKLY UPDATES

The subcontractor shall submit weekly updates on the status of fabrication process. These updates shall include, which part is being worked on, the estimated completion date for each part, any delays, and the reason for the delay. These updates are to be emailed every Monday. The subcontractor shall schedule a weekly meeting with PPPL to discuss these updates as well.

4.2.11 PHOTOGRAPHS OF PROCESSES, HANDLING, PACKAGING & CRATING

Photographs shall be submitted to PPPL of each step of the various processes (i.e. machining, handling, welding, inspection, packaging, and crating). These steps shall be detailed in the MIT plan. If the part is moved during the process, new photos shall be taken.

4.2.12 SHIPPING RELEASE FORM

Before shipping, the subcontractor must complete the Shipping Release Form, see §9.22 and Attachment A, and send it to PPPL's QA department. The subcontractor shall not ship the physical deliverables back to PPPL until PPPL returns the signed form and provides written authorization.

Table 3. List of Vendor Fabricated Components/Assemblies to be delivered to PPPL

Part No.	Description	Quantity	Material
E-DC11073-2	Cooling Tube, 3/8" OD	2	Inconel 625*
E-DC11073-3	Outlet Tube, 1/4" OD	2	Inconel 625

* Base materials are provided by PPPL, see Table 2

5.0 **REQUIREMENTS**

5.1 DESIGN PERFORMANCE REQUIREMENTS

5.1.1 PERFORMANCE CHARACTERISTICS

- a. All parts fabricated in the execution of this project scope shall meet or exceed all tolerance requirements listed in the provided drawing package.

5.1.2 SUBCONTRACTOR SUPPLIED MATERIALS

5.1.2.1 General Requirements

All materials shall meet the magnetic permeability limits in §5.1.3.

5.1.2.2 Specific Requirements

All Inconel 625 tubing used in the execution of this Technical Specification shall be seamless and meet ASTM B444.

5.1.3 ELECTROMAGNETIC INTERFERENCE AND SUSCEPTIBILITY

All work performed in the execution of this Technical Specification shall meet the magnetic permeability Limits, as determined per §6.1.2, listed on the drawing. If the drawings do not list a magnetic permeability limit, then use the following:

Base Material: $\leq 1.04\mu$ for all materials

Magnetic permeability testing shall be performed by PPPL at the subcontractor's facility.

5.1.4 WORKMANSHIP

- a. General shop cleanliness and housekeeping shall be adequately maintained to prevent contamination components.
- b. Careful handling of the all parts/assemblies is required so as not to damage material or machined surfaces. The Heat Transfer Tube surface finish must be maintained with minimal scratches. For any scratches exceeding 0.001" in depth, acceptance requires PPPL approval.
- c. All fabricated parts shall be free from sharp edges and burrs.
- d. All surfaces shall be cleaned to remove all oil, grease, dirt, loose mill scale, residue from protective covering and other foreign substances. Cleaning shall be performed using acetone and then finished with alcohol.
- e. Tubing shall be bent with care to avoid kinking.

5.1.5 SUBCONTRACTOR USE OF EQUIPMENT

Subcontractors must provide their own equipment and not use government equipment. It is the subcontractor's responsibility to qualify/calibrate all equipment necessary to perform the work outlined in this document.

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5.1.6 PROPOSED MANUFACTURING SEQUENCE

- a. The subcontractor shall fabricate two Cooling Tubes (E-DC11073-2)
 - (i) The subcontractor shall wind the supplied Inconel 625 tubing around the provided mandrel (E-DC11074-25) making sure that the tube sits properly in each groove to meet the dimensions outlined in the associated drawing.
 - (ii) The subcontractor shall surround the wound tube and mandrel with the supplied Heat Treatment Mandrel Outerform (E-DC11225-1) making sure that none of the turns fall outside of the groove.
 - (iii) The subcontractor shall heat treat (see §5.1.7) the temporary assembly created in Step (ii) to remove any residual stresses from the forming process.
 - (iv) The subcontractor shall remove the sleeve and “unscrew” the coiled tube from the mandrel and finish the rest of the bending work.
- b. The subcontractor shall fabricate the Outlet Tubes, 1/4" per the associated drawing (E-DC11073-3).

5.1.7 HEAT TRANSFER TUBE HEAT TREATMENT

The assembly, E-DC11225-01 shall be vacuum heat treated to remove stress. The detailed heat treatment procedure shall be provided as part of the subcontractor's MIT plan and approved by PPPL prior to execution.

6.0 TEST AND INSPECTION REQUIREMENTS

6.1 PERFORMANCE TESTS

6.1.1 DIMENSIONAL INSPECTION

Tolerances are indicated on the manufacturing drawings. Strict adherence to these dimensions and tolerances are critical to the assembly and performance of the subject equipment. All dimensional measurements shall be performed in a temperature controlled environment. See §9.13 for more details.

The subcontractor shall include the sequence and measurement methodology as part of their MIT Plan. The subcontractor shall also note what best-fit methodology is used to confirm compliance with the drawing tolerances.

6.1.2 MAGNETIC PERMEABILITY TEST

Magnetic permeability testing shall be performed by a PPPL employee or designee at the subcontractor's facility. The subcontractor shall notify PPPL at least one week in advance of the expected completion of the tube bending in order to schedule this test. PPPL shall verify all deliverables conform to the magnetic permeability limits provided in accordance with the requirements of ASTM A 342, Test Method No. 3.

- a. The magnetic permeability limits shall be per §5.1.3.
- b. Testing shall use a Severn Engineering Low Mu Permeability Indicator (Available from Severn Engineering Co. Auburn, Alabama), which has been calibrated within the past 12 months.
- c. All tubes shall be inspected every 10 feet along their length. Record on the drawing measured values and their locations. Include dimensions to the nearest edge/surface so that it can be double-checked by the PTR or designee.

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6.1.3 LEAK TESTING

All Helium Leak testing shall be performed following ASTM E498/E498M utilizing Test Method A. The maximum allowable helium leak rate, unless otherwise noted, is 1×10^{-9} ATM cc/sec (air equivalent) on all vacuum boundary welds. It is required that a global test of the entire weld with 1 atmosphere of helium be completed (see §10.8 of ASTM E498/498M). Helium detection shall be performed utilizing a Helium Mass Spectrometer Leak Detector (HMSLD).

All leak testing is subjected to witness by a qualified PPPL employee (as designated by PPPL). The subcontractor shall give one week's notice to PPPL for any upcoming leak tests.

Leak testing shall be performed on all items outlined in Table 3 after bending and heat treatment.

6.2 ACCEPTANCE TESTS

- a. PPPL shall perform a visual check prior to crating, after crating and prior to shipment.
- b. Upon receiving, PPPL shall perform a receipt inspection examining key characteristics (i.e. dimensions, permeability, etc.).
- c. PPPL shall also review all performance tests results for compliance

6.3 SUPPLIER HOLD AND PPPL WITNESS POINTS

The supplier shall provide PPPL with a minimum of 5 days' notice prior to each witness and hold points identified in this technical specification as well as any defined in the approved MIT plan, including but not limited to the following:

- a. The subcontractor shall stop work and pause after the forming each HTT around the mandrel. PPPL shall then witness the installation of the outer form over the tube and mandrel to ensure there is no interference.
- b. The subcontractor shall stop work and pause after performing the heat treatment of each individual HTT. PPPL shall then witness the removal of each HTT from the mandrel and outer form.
- c. The subcontractor shall stop work and inform PPPL prior to crating for shipping
- d. The subcontractor shall stop work and inform PPPL after crating prior to shipping

7.0 QUALIFICATIONS

Personnel are required to be trained in the operation of the equipment such that time is not lost, and material is not damaged, due to preventable mistakes. A copy of training certifications for personnel shall be provided, and approved by PPPL, in writing, before the manufacturing work begins. The training must be up-to-date and maintained by each individual throughout the fabrication performed in the execution of this scope. The certifications shall be per the requirements listed in §2.0, or by a PPPL approved alternative.

8.0 ENVIRONMENT, SAFETY, AND HEALTH

8.1 SAFETY

Work shall be performed under an established safety program including documented policies and procedures subject to PPPL review. Workers shall be trained to these policies and procedures and records of their training shall be auditable.

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8.2 NOTIFICATION REQUIREMENTS OFF-NORMAL EVENTS & ISSUES

N/A

8.3 OVERSIGHT

Supplier shall allow scheduled access to their facility to review manufacturing processes and perform inspections at the discretion of PPPL. Supplier shall work with the PPPL PTR and PPPL visitors to identify the hazards of the work to be reviewed and the hazards of unrelated work in the facility that could affect the visitors, and the safety protocols (including but not limited to training and personal protective equipment) that will apply to protect visitors from the hazards. Supplier shall provide any required training to PPPL visitors to assure observance of the supplier's safety rules and prevent exposure to any hazard at supplier's facility.

8.4 SAFETY HAZARD AND MITIGATION PLAN

N/A

9.0 QUALITY ASSURANCE REQUIREMENTS

9.1 GENERAL REQUIREMENTS

Material(s) and/or product(s), including those components, parts, and materials that are permanently installed into systems, sub-systems, and/or assemblies, etc. furnished under this purchase order/subcontract shall be new. Parts and components that have been rebuilt, refurbished, or modified are specifically prohibited unless approved by PPPL in writing. Evidence of deliberate misrepresentation of any item(s)/component(s)/material(s) provided under this order may result in an investigation by the Office of the Inspector General, U.S. Department of Energy. Examples of such misrepresentation include the following:

- Remanufactured, rebuilt, or used parts represented as new
- Counterfeit parts (fraudulently labeled or marked with another manufacturer's name).
- Misrepresented parts.

9.2 SUBCONTRACTOR'S RESPONSIBILITY FOR CONFORMANCE

PPPL's review and/or approval of subcontractor's documents nor PPPL's inspection of subcontractor's items or services shall not relieve the subcontractor of responsibility for full compliance with requirements of the purchase order/contract.

9.3 PERFORMANCE AND DOCUMENTATION OF INSPECTIONS AND TESTS

Each item to be delivered to PPPL shall be inspected and tested by the subcontractor to verify that they meet 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. 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.

The following values should be measured and recorded:

- a. All non-reference drawing dimensions, including Basic Dimensions
- b. Compliance with drawing notes
- c. Measurements taken in §6.1

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9.4 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.

9.5 SUBCONTRACTOR QUALITY ASSURANCE PROGRAM

N/A

9.6 QUALITY ASSURANCE PLAN

The subcontractor shall submit a Quality Assurance (QA) plan describing the specific quality assurance and quality control procedures and practices, including special process training and qualifications, which will be in force to meet the requirements of this specification. The QA plan and any revisions require review and approval by PPPL prior to the start of design or manufacturing of the equipment under this specification.

9.7 MANUFACTURING READINESS REVIEW

The subcontractor shall prepare for and participate in an on-site Manufacturing Readiness Review with PPPL at the subcontractor's facility prior to the start of work. This review shall include the proposed process in order to effectively execute the tasks outlined in this Technical Specification, including equipment, work flow and scheduling. As part of this review the subcontractor shall be prepared to provide the necessary deliverables, including but not limited to the following:

- Tooling and fixture drawings
- MIT Plan and associated procedures
- Personnel Certifications/Qualifications
- Safety Plan/JHA
- QA Plan
- Packing and Shipping Plan
- List of subcontractor Supplied Materials

All of required materials are to be submitted to PPPL a maximum of two (2) weeks after contract award. The subcontractor shall be responsible to respond to and/or execute any comments provided by the PTR prior to the scheduled MRR. After successful completion of the MRR, PPPL will authorize the start of fabrication in writing.

9.8 MANUFACTURING, INSPECTION AND TEST PLAN

The subcontractor shall submit a Manufacturing, Inspection and Test (MIT) plan for PPPL approval prior to the start of manufacture. The MIT must delineate the sequence of all processes and operations affecting quality, including in-process and final acceptance inspections and tests. 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. Equipment to be used for all fabrication, inspections and tests shall be specified, including but not limited to the following:

- Equipment to be used for all fabrication, inspections and tests
- Part(s) being made.
- Integrated flow into end items
- Critical manufacturing operations
- Cleaning steps
- Inspections and the characteristics/dimensions to be inspected
- Sign-off and date by designated inspection personnel at specified process, inspection, and test points.
- How the signoffs are traceable to the items being fabricated.
- PPPL designated Hold/Witness Points

The witness/hold points are steps where the manufacturer will temporarily stop work on this particular part in the Technical Specification, until PPPL has had a chance to review the data, and approves continuing with the fabrication. PPPL will designate these "witness" points. Subcontractor shall notify PPPL a minimum of five (5) working days in advance of these witness points.

Revisions or changes to the approved MIT, or its alternate, shall be reviewed and approved by PPPL prior to use including flow chart(s), process and inspection sheets, and shop travelers.

A traveler, whether integral to the MIT Plan or a separate document, shall be used for data entry and operation sign-offs. Relevant data for inspections and tests includes equipment ID and calibration status; acceptance values, actual values obtained, and pass/fail determination.

9.9 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.

9.10 MEASURING AND TEST 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. 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, but instead shall be protected against damage or degradation.

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9.11 NONCONFORMANCE AND CORRECTIVE ACTIONS AND NOTIFICATION OF PPPL

Nonconforming items or services shall be positively identified, and, where possible, segregated to prevent use. The subcontractor shall document each nonconformance. The written approval of PPPL is required in the form of a signed NCR prior to the use or continued fabrication of the nonconforming item or service. The subcontractor's system shall provide not only for timely resolution of nonconformance but also for analysis of nonconformance to determine causes and to implement appropriate and effective corrective actions.

9.12 SUBMITTAL OF MATERIAL CERTIFICATIONS

N/A

9.13 DOCUMENT TRACEABILITY AND RECORDS

The subcontractor shall maintain a system of documentation whereby the results of required operations, inspections, examinations, and tests is systematically compiled, indexed and stored. Such objective evidence may include "travelers"; and material test, certification, inspection, examination, test and discrepancy reports; which shall be complete, legible, signed, and dated and shall be traceable to subject items.

9.14 INSPECTION AND TEST CONTROL

Inspections and tests shall be performed by personnel independent of those doing the work inspected or tested. They 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.

9.15 SUBMITTAL OF COMPLETED INSPECTION AND TEST REPORTS

Reports shall be provided of all required inspections and tests listed in §6.1, showing actual values, properly validated by authorized personnel.

9.16 SUBMITTAL OF ACCEPTANCE TEST PROCEDURES FOR PPPL APPROVAL

The Acceptance Test Procedures (ATPs), including pass/fail criteria, required to demonstrate conformance to PPPL's requirements shall be submitted to PPPL for review and approval prior to use of such procedures.

9.17 PPPL INSPECTION

PPPL reserves the right to inspect items as they are packaged prior to shipment. 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.

9.18 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.

9.19 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 heat treatment and non-destructive testing outlined in §0. Copies of special process procedures and qualifications shall be available for review and approval by PPPL as part of the MIT plan, §9.8.

9.20 PROCESS SEQUENCE

The subcontractor shall maintain a system to define the sequence and document the performance of manufacturing, inspection, installation, and test activities. These shall provide for signoff and date by designated inspection personnel at specified process, inspection, and test points and shall be traceable to the items.

9.21 SUBMITTAL OF COMPLETED PROCESS HISTORY

N/A

9.22 SUBMITTAL OF COMPLETED RELEASE FOR SHIPMENT FORM

Subcontractor shall not ship without a "Product Quality Certification and Shipping Release" Form (Attachment A) 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.

10.0 SHIPPING STORAGE AND HANDLING

The subcontractor shall be responsible for packing crating and shipping all deliverables. A Packing and Shipping plan shall be included in the MRR by PPPL. Once assembly and crating is complete, and PPPL has performed a final inspection, PPPL will sign the Shipping release form (Attachment A).

11.0 ATTACHMENTS

A. Product Quality Certification & Shipping Release Form

12.0 DOCUMENTATION & DELIVERABLES

RFI / PO / Subcontract / BOA / BPA #: _____

Table 4. List of subcontractor Required Deliverables to PPPL

#	Physical Deliverables Required	Date Required	Received (✓)
1	Cooling Tube, 3/8" (E-DC11073-2, Qty 2)	C	
2	Outlet Tube, 1/4" (E-DC11073-3, Qty 2)	C	
3	All fixtures/jigs fabricated while executing this document	C	
4	All unused consumables and jigs provided by PPPL (Table 1)	C	

*Exceptions: None**Table 5. List of Required Meetings between the subcontractor and PPPL*

#	Meetings Required	Date Required	Complete (✓)
1	Manufacturing Readiness Review	PS	
2	NCR Meeting	D	
3	Weekly Status Update (for duration of executing scope)	D	

*Exceptions: None**Table 6. List of Subcontractor Document Deliverables*

#	Document Deliverables Required	Date Required	Format	Storage Location	Rcvd (✓)
1	Training Certifications of Personnel per §7.0	PS	E	Ops Center	
2	Manufacturing, Inspection & Test Plan per §9.8	PS	E	Ops Center	
3	Heat Treatment Procedures per §5.1.7	PS	E	Ops Center	
4	Quality Assurance Plan §9.6	PS	E	Ops Center	
5	Design & Drawing Details for Auxiliary Components (e.g. Shipping fixtures/jigs etc.) per §4.2.9	N	E	Ops Center	
6	Dimensional Inspection Report per §6.1.1	D	E	Ops Center	
7	Leak Test Report per §6.1.3	C	E	Ops Center	
8	Product Quality Certification & Shipping Release Form per §9.22	C	E	Ops Center	

Legend*N = Notice to Proceed Requirement**PS = Prior to Start of Construction**D = During Construction/As Required**C = Project Completion**P, E = Paper or Electronic*

Princeton Technical Representative: _____

(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).)

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ATTACHMENT A. 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 #
	<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>		

Completed, signed, and returned by PPPL before shipment	<u>PPPL (AUTHORIZED REPRESENTATIVE) SHIPPING RELEASE</u>	
	<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>	
	NONCONFORMANCES FROM PROCUREMENT QUALITY REQUIREMENTS:	
	REMARKS/PRODUCT SERIAL NUMBERS:	
	BY PPPL QA REPRESENTATIVE (OR DESIGNEE)	DATE

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