

# NCSX

## Statement of Work

### TF Coil Assembly

NCSX-SOW-131-03-00

January 31 2006

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#### **Controlled Document**

*This is a controlled document. Check the NCSX Engineering Web prior to use to assure that this document is current.*

**REVISIONS**

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<b>Revision No.</b>	<b>Description of Change</b>	<b>Date</b>
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## **1 GENERAL INFORMATION**

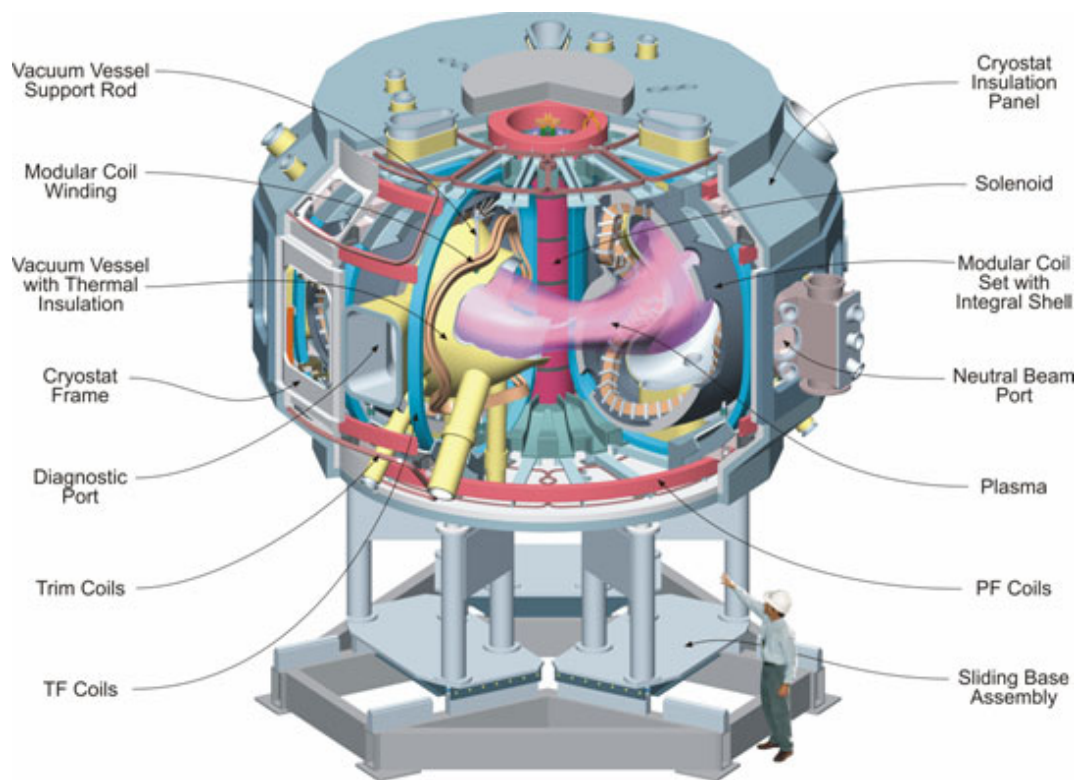
### **1.1 Introduction**

This Statement of Work is for the manufacture of the TF Coil Assemblies for the National Compact Stellarator Experiment (NCSX). A total of eighteen 18 TF Coil Assemblies are required. There are two versions of the TF Coil Assembly 131-003-01 and 131-003-02. The two versions are identical with the only exception being the TF coil lead orientation. We will be procuring nine assemblies of type 131-003-01 and nine of type 131-003-02.

The TF Coil Assemblies are defined in Specification NCSX-CSPEC-131-01.

The National Compact Stellarator Experiment (NCSX) is an experimental research facility that is to be constructed at the Department of Energy's Princeton Plasma Physics Laboratory (PPPL). Its mission is to acquire the physics knowledge needed to evaluate compact stellarators as a fusion concept, and to advance the understanding of three-dimensional plasma physics for fusion and basic science. The TF Coils are a Primary component of the NCSX Device. Eighteen equally spaced D shaped TF Coil Assemblies surround the core of the machine. A TF Coil Assembly consists of the coil itself with a pair of wedge structures vacuum impregnated to the front leg of the coil. When the device is fully assembled this wedged geometry reacts the loads generated as the toroidally placed coils are pressed forward by the electromagnetic loads.

The NCSX project is managed by PPPL in partnership with the Oak Ridge National Laboratory. This Subcontract will be administered by PPPL. Further description of the NCSX can be found at <http://www.pppl.gov/ncsx/>.



**Figure 1 - The NCSX Device and Identification of Major Components**

*Note in particular the TF Coils (labeled). There are 18 TF Coils spaced equally around the assembly. The pair of wedge structures attached to each of these coils complete the TF Coil Assemblies. Note: This Figure is only for illustration and should not be used in the performance of this Scope of Work*

## 2 APPLICABLE DOCUMENTS

NCSX-CSPEC-131-01, TF Coil Assembly

NCSX-CSPEC-131-02, TF Coil Conductor Specification

NCSX-CSPEC-131-03, TF Coil Wedge Castings

NCSX-CSPEC-131-04, TF Coil Wedge Structure Weldment

## 3 WORK REQUIREMENTS

The supplier shall manufacture, inspect, test and deliver to PPPL (18) TF Coil Assemblies (nine assemblies of type 131-003-01 and nine of type 131-003-02) that shall conform to the requirements of NCSX-CSPEC-131-01-00. Processing shall be in accordance with the supplier's PPPL-approved

Manufacturing, Inspection, Test and Quality Assurance Plan, and associated procedures. Supplier shall provide all process documentation identified in Section 5.

### **3.1 MIT / QA Plan**

The Subcontractor shall provide PPPL with manufacturing, inspection and test information sufficient to convey an overview of the processing and the adequacy of the controls, inspections, and tests that are part of the manufacturing process. The submittal, of the Manufacturing, Inspection, Test, and Quality Assurance Plan (MIT/QA Plan), may consist of the Subcontractor's standard documents such as Travelers/Routers/Process Sheets and procedures or may require development of a new document, as long as the submittal accomplishes the following:

- outlines the sequence of operations,
- identifies critical manufacturing operations,
- identifies inspections, examinations, and tests, and
- include procedures for special processes, inspections, and tests.

The MIT/QA Plan is required for PPPL review and approval prior to start of fabrication. All inspections and tests referenced in the Specifications listed in Section 2 must be addressed in the MIT/QA Plan.

From the plan, PPPL may designate selected operations as mandatory "witness" points. Subcontractor shall provide PPPL with a minimum of ten (10) working days notice in advance of these witness points. Such witness points shall be mutually planned to minimize delays. The MIT / QA Plan shall include steps to address the topics listed in this section.

#### **3.1.1 Weld Qualifications**

Welding Qualifications shall meet the requirements of ASTM A488/A488M-04, Standard Practice for Steel Castings, Welding, Qualifications of Procedures and Personnel if castings are used. Welding Qualifications of Procedures and Personnel are per AWS D1.6 or ASME Section IX if the wedge assembly is manufactured as a weldment

### **3.1.2 Brazing**

3.1.2.1 The subcontractor's braze procedure and each operator must be qualified by demonstrating their ability to perform the brazing operation and successfully pass the inspection criteria.

3.1.2.2 Each operator must submit 4 samples of a brazed joint for inspection at PPPL for qualification prior to the commencement of fabrication.

3.1.2.3 Brazes are to be placed not less than 12 inches from adjacent brazes and equally spaced on either side of the lead area. All brazes are to be located on the back leg of the coil. The location of the brazes is to be measured and recorded and kept consistent from coil to coil.

### **3.1.3 Fabrication**

3.1.3.1 Adequate cleaning and preparation steps shall be included in the procedure. Each spool of copper conductor shall be flushed with a degreasing agent to be approved by PPPL before brazing.

3.1.3.2 Rockwell hardness measurements along the length of the conductor are required. The conductor shall be wiped down with degreasing solvent to remove excess oil, lubricant and grease prior to being wound into the assembly. Cleaned copper, whether bare or insulated, shall be stored and processed in an environment free from metallic dust or other contaminants. After cleaning, the copper surface and insulating materials shall be protected from skin oil, etc., by requiring shop personnel to handle conductors only while wearing clean, lint free, white cotton gloves.

### **3.1.4 Winding Operation**

3.1.4.1 The Oversight of the winding operation is to ensure the even distribution of the half lap layers and guarantee the proper insulation coverage for both turn to turn and ground wrap insulation. Hold points for measurements of the insulation thickness are to be incorporated into the winding procedure identified in the MIT plan.

3.1.4.2 The Lead Spur insulation is custom wound and as such may vary or be improved with subsequent TF coil fabrications. Each lead spur is to be inspected for conformance with the electrical standoff requirements to guarantee the minimum number of layers of Kapton and glass while layers of Kapton are still visible as well as after the VPI.

## **4 QUALITY ASSURANCE**

### **4.1 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 Subcontract 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.

#### **4.2 Subcontractor's Responsibility for Conformance**

Neither PPPL review and/or approval of Subcontractor's documents nor PPPL inspection of Subcontractor's items or services shall relieve the Subcontractor of responsibility for full compliance with requirements of the purchase order/contract. The Subcontractor is responsible for assuring that all requirements and restrictions are imposed on any sub-tier suppliers.

#### **4.3 Nonconforming Items**

Nonconforming items shall be positively identified, and, where possible, segregated to prevent use. PPPL must be notified of nonconformances within one (1) business day. The Subcontractor shall document each nonconformance, identifying the extent and location of the nonconformance and proposing a disposition. The written concurrence of PPPL is required prior to implementing the disposition. The Subcontractor's system shall provide not only for timely resolution of nonconformances but also for analysis of nonconformances to determine root causes and to implement appropriate and effective corrective actions.

#### **4.4 Subcontractor's Quality Assurance Program**

The Subcontractor shall maintain an effective Quality Assurance Program to assure that the Subcontractor's work meets the standards in NCSX-CSPEC-131-01 and is performed in accordance with contractual requirements. Subcontractor's quality assurance function shall be actively involved in the planning, processing oversight, problem resolution, and determination of acceptability of all work under this SOW. The 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.

#### **4.5 Inspection and Test Procedures**

Inspections and tests shall be performed in accordance with written procedures referencing criteria for acceptance or rejection. Except where specifically stated otherwise, actual data and accept/reject status

for each inspection and test shall be documented. Reports shall clearly identify the item inspected, the locations or areas covered by the report, the performing individual, the date performed, equipment used (with calibration status), and the signature of the authorized individual. A test plan (may be part of the MIT / QA Plan) shall be submitted for approval prior to testing. The Test Plan shall include steps to address the topics listed in this section

#### **4.5.1 Geometry**

Each completed TF Coil assembly is to be measured with all dimensions documented. The first TF Coil Assembly is to be measured before and after thermal cycling at LN2 temperatures. Critical assembled wedge geometry measurements must be taken along the entire wedge surface. Inspection reports are to note nominal dimensions and deviations from those dimensions along with allowable tolerances.

#### **4.5.2 Brazes**

4.5.2.1 Each braze joint must be inspected and tested prior to proceeding with winding operations.

4.5.2.2 After the brazed joint is complete it shall be tested for leaks. First the braze area must be cleaned to remove excess braze material and allow for adequate inspection. Then with the conductor placed in tension at 14,000 psi (8,500 lb) the brazed joint shall be tested by pressurizing with helium at 50 psi. A mass spectrometer "sniffer" capable of detecting leaks <10 -5 cc/sec is to be used to detect leakage. Bad joints must be cut out beyond the heat affected zone and re-brazed.

4.5.2.3 Each conductor joint shall be visually inspected for full flow and wetting of the braze material and no cracks. The inspection shall be documented. Photographs of each braze are required for the inspection reports.

#### **4.6 Deviations to the Approved MIT / QA Plan or Procedures**

Deviations to the approved documents shall be included in the weekly report. The Subcontractor is required to obtain PPPL's written approval for deviations which may adversely affect conformance to the contracted delivery schedule or product specification. Deviations requiring written approval shall be submitted on the PPPL Request for Deviation form (Attachment II).

#### **4.7 Document Traceability and Records**

The Subcontractor shall maintain a system of documentation whereby objective evidence of required operations, inspections, examinations, and tests is systematically compiled, indexed, stored and ultimately provided to PPPL per paragraph 6.4.3, Process History. Such objective evidence may include "travelers" and material test, certification, inspection, examination, test and nonconformance reports. All documents

which shall be complete, legible, and validated by responsible personnel and shall be traceable to subject items.

#### **4.8 Material Certifications**

Material certifications shall be provided for any insulation or epoxy procured by the vendor as well as for stainless steel and weld wire procured to fabricate wedge structures.

#### **4.9 Equipment/Material Identification and Status**

Material and equipment identification shall be maintained throughout the program and be traceable to records. Status of acceptability shall be readily discernible through the Subcontractor's use of tags, stamps, serial numbers or other positive means.

#### **4.10 Calibration of Test and Measuring Equipment**

Inspections and tests shall be performed using properly calibrated measuring and test equipment. Subcontractor shall have in its possession the necessary equipment to perform the required inspections and tests. Calibration standards shall be traceable to the National Institute for Standards and Technology (NIST) or equivalent acceptable to PPPL and shall not be used for shop inspections, but instead be protected against damage or degradation.

#### **4.11 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, welding, brazing, dimensional inspection, heat treatment, nondestructive examination, etc. Copies of special process procedures and personnel qualifications shall be submitted to PPPL for review and approval a minimum of ten (10) working days prior to performance of the work. Welding procedures and personnel shall be qualified in accordance with ASTM A488/A488M-04, Standard Practice for Steel Castings. Welding Qualifications of Procedures and Personnel are per AWS D1.6 Structural Welding Code – Stainless Steel if the wedge structure is manufactured as a weldment.

#### **4.12 Shipping**

The subcontractor shall provide a shipping container adequate to maintain the TF Coil Assembly geometry within tolerances and to guarantee that the TF Coil Assembly is not damaged in transit.

#### **4.13 PPPL Receiving and Inspection**

PPPL will perform Receiving Inspection on items supplied by Subcontractor.

**5 PARTS SUPPLIED BY PPPL**

PPPL will ship the following items within four weeks of award of contract with the following exceptions:  
(Note, PPPL will not supply the CTD 101K Epoxy):

TF Coil Leads within two months of award of contract.

Diagnostic Loop Wire and box within four months of award of contract

<b>Drawing Reference</b>	<b>Qty</b>	<b>Description</b>
se131-014.prt	77 Spools	TF COIL CONDUCTOR DETAIL
se131-031.prt	18	TF COIL TRANSITION FILLER CENTER
se131-032.prt	36	TF COIL TRANSITION FILLER LEFT/RIGHT
se131-041.prt	36	LEAD FILLER
se131-047.prt	18	TF COIL LEAD BLOCK SUPPORT
se131-053.prt	9	TF COIL LEAD LONG RIGHT(BENT)
se131-054.prt	9	TF COIL LEAD SHORT RIGHT(BENT)
se131-057.prt	9	TF COIL LEAD LONG LEFT(BENT)
se131-058.prt	9	TF COIL LEAD SHORT LEFT(BENT)
se131-078.prt	18	LEAD SUPPORT LOCKING BLOCK TYPE "A"
se131-079.prt	18	LEAD SUPPORT BLOCK LOCKING
se131-084.prt	18	LEAD SUPPORT BLOCK LOCKING
se131-087.prt	18	SPACER FILLER BLOCK
se131-091.prt	18	CENTER TRANSITION FILLER
se131-035 item 14	18,000 yards	1" Wide x .0035" Thick Kapton, 18,000 yards
se131-035 item 15	53,000 yards	1" Wide x .007" Thick S2 Glass, 53,000 yards
se131-005 item 4	35,000 yards	2" Wide x .015" Thick S2 Glass, 35,500 yards
Spare Insulation	1,900 yards	2" Wide x .010" Thick S2 Glass, 1,900 yards
Se131-005 item 2	18	DIAGNOSTIC LOOP WIRE SHIPPING BOX
se131-005 item 1	18	DIAGNOSTIC LOOP WIRE

## **6 DELIVERABLES**

### **6.1 Prior to Fabrication Release**

#### **6.1.1 MIT/QA Plan, and Associated Procedures**

The Supplier shall provide their MIT/QA plan and all associated procedures to PPPL for approval prior to beginning fabrication

### **6.2 Weekly Reports**

Brief weekly status reports covering technical, administrative, and quality activities and notable problems/issues and progress photographs. This report shall be submitted to PPPL on each Friday following subcontract award. The report may be submitted as email.

### **6.3 Monthly Reports**

The Subcontractor shall prepare and submit monthly e-mail reports indicating schedule progress for each task/deliverable planned.

- The Subcontractor shall submit a milestone schedule that clearly indicates the tasks to be accomplished and the time frame over which each task will be accomplished.
- The Subcontractor shall report (e-mail report satisfactory) schedule progress against each milestone by indicating actual and forecast finish dates. A narrative explanation of schedule delays shall also be provided.
- The report shall be submitted to PPPL prior to the last day of each month after subcontract award.

### **6.4 TF Coil Assembly**

#### **6.4.1 Final Product**

The supplier shall deliver to PPPL eighteen (18) TF Coil Assemblies that shall conform to the applicable specification

#### **6.4.2 Shipping Release Form**

Prior to each shipment, the Subcontractor shall submit to PPPL a completed and signed “Product Quality Certification and Shipping Release” form (Attachment 1 of this SOW), along with a copy of the Process History (ref. Paragraph 5.4.3), and received from PPPL written acceptance to ship. Shipping shall not commence until subcontractor receives PPPL’s written acceptance to ship.

### **6.4.3 Process History**

Subcontractor shall provide to PPPL one (1) "paper" copy or one (1) "electronic" copy of the Process History, which includes a compilation of documents, detailing the objective evidence of the acceptability of the work performed. The Process History shall be complete and available at the time the Subcontractor requests Release for Shipment. The Process History shall include as a minimum, but not be limited to:

- Material certifications
- Heat treatment charts
- Electrical Testing Data
- Flow and Pressure Test Data
- VPI temperature history.
- Brazing procedures and procedure qualification test records
- Welding procedures and procedure qualification test records
- Completed nonconformance reports
- Validated inspection and test reports, including inspection measurements and any digital photographs.
- Completed shop travelers or process sheets with digital photographs.
- Personnel qualifications for Special Processes (Non Destructive Examination, welding, etc.)
- Signed Shipping Release

### **6.5 Tooling and Software**

All tooling and software specially fabricated /generated for the performance of this SOW shall become the property of the United States Government. Disposition will be per direction of PPPL.

The supplier shall maintain any CAD/CAM files generated in the performance of this SOW for a period of at least three years from the end of the subcontract.

**ATTACHMENT 1 –SHIPPING RELEASE FORM**

**PLASMA PHYSIC LABORATORY—PPPL**

PRODUCT QUALITY CERTIFICATION AND SHIPPING RELEASE					
PROJECT	ITEM DESCRIPTION			SHIPMENT NUMBER	
PPPL SUBCONTRACT/ ORDER NO.	REV	ITEM NO.	SUPPLIER REFERENCE NO.	REV	QUANTITY SHIPPED
<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>					
<u>PPPL (AUTHORIZED REPRESENTATIVE) SHIPPING RELEASE</u>					
<p>This is to certify that evidence supporting the above Supplier's Certification statement has been audited and no product/service nonconformances from procurement requirements have been found 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 Vendor, 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	

**ATTACHMENT II. PPPL REQUEST FOR DEVIATION (RFD) FORM**

<p><i>NCSX RFD</i></p> <p><i>Part I</i></p>	<p><b>Number:</b></p>	<p><b>RFD Description:</b></p>
<p><b>Initiator:</b></p>		<p><b>Organization:</b></p>
<p><b>List of Impacted Documents:</b> <i>(Specification, MIT/QA Plan, SOW, drawing, etc.)</i></p>		
<p><b>Cost Impact:</b> <i>(If none, so state)</i></p>		
<p><b>Schedule Impact:</b> <i>(If none, so state)</i></p>		
<p><b>Quality Impact:</b> <i>(If none, so state)</i></p>		
<p><b>State Requirement Deviation is Requested For:</b> <i>(Specification, MIT/QA Plan, SOW, drawing, etc.)</i></p>		
<p><b>Full Description of the Deviation Requested:</b> <i>(Use continuation pages, e-mails, letter, sketches, etc. as needed and include amplifying information as appropriate to support deviation request.)</i></p>		
<p><b>Attachments:</b></p>		
<p><b>Initiator Signature:</b> _____ <b>Date:</b> _____</p>		