

# National Compact Stellarator Experiment (NCSX)

## Statement of Work

Vacuum Vessel Sub Assembly (VVSA) Fabrication

NCSX-SOW-121-03-01

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### **Controlled Document**

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## Revisions

Revision No.	Description of Change	Date
0	Initial Issue	6/23/2004
1	Updated paragraphs 2.2, 3, 4.4, 5.1.3, 5.3 to reflect agreement with Major Tool	8/24/2004

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# 1 GENERAL INFORMATION

## 1.1 Introduction

This Statement of Work is for the manufacturing of three (3) Vacuum Vessel Sub-Assemblies (VVSA's) including associated port extensions and spacer assemblies, which are critical components for the National Compact Stellarator Experiment (NCSX). The VVSA's, fabricated of N06625 material, are toroidal (donut-shaped) in major diameter, but highly shaped in the poloidal (short) direction. Three (3) 120° VVSA's comprise the complete NCSX vacuum vessel. Each VVSA includes a field period assembly (the basic vacuum vessel shell), associated port extensions (including blank off flanges, seals, and fasteners) and one connecting spacer assembly.

NCSX is the first of a new class of stellarators known as "compact stellarators." Stellarators are a class of magnetic fusion confinement devices characterized by three-dimensional magnetic fields and plasma shapes and are the best-developed class of magnetic fusion devices after the tokamak. The stellarator concept has greatly advanced since its invention by Dr. Lyman Spitzer, the founding director of the Princeton Plasma Physics Laboratory (PPPL), during the 1950's. Improved fundamental understanding coupled with advanced parallel computers has enabled the design of practical stellarators, optimized for plasma confinement and stability but with an aspect ratio similar to tokamaks. The NCSX design used this capability to combine the best features of both stellarators and tokamaks, providing solutions to the challenges of fusion plasma confinement.

The NCSX project is managed by PPPL in partnership with the Oak Ridge National Laboratory. This Subcontract will be administered by PPPL. Operation of NCSX is scheduled to begin in May 2008. Further description of the NCSX can be found at <http://ncsx.pppl.gov/>.

## 1.2 Background

Figure 1 is a sectional view of the NCSX device showing its major components. Note in particular the vacuum vessel shown in yellow, which is the subject of this Statement of Work. In Figure 2, all but the vacuum vessel and its ports are removed from this drawing so the vessel and its ports can be clearly viewed. Note the symmetry in the vessel. It is comprised of 3 identical 120° vessel segments in the toroidal direction. Figure 3 shows that each segment is symmetric around its vertical midplane – the right 60° half segment is identical to the left half segment, but is inverted. Consequently, the vessel consists of six identical half segments. Figure 3 also shows the three ports that will be installed by the supplier. The remaining ports and spacer pieces

shown in Figure 3 will be fabricated by the supplier, shipped separately, and field installed at PPPL by PPPL; this is necessary to allow assembly of the other machine components around the vessel. The figures below are representative and are only for illustration; they should not be used in the performance of this Scope of Work.

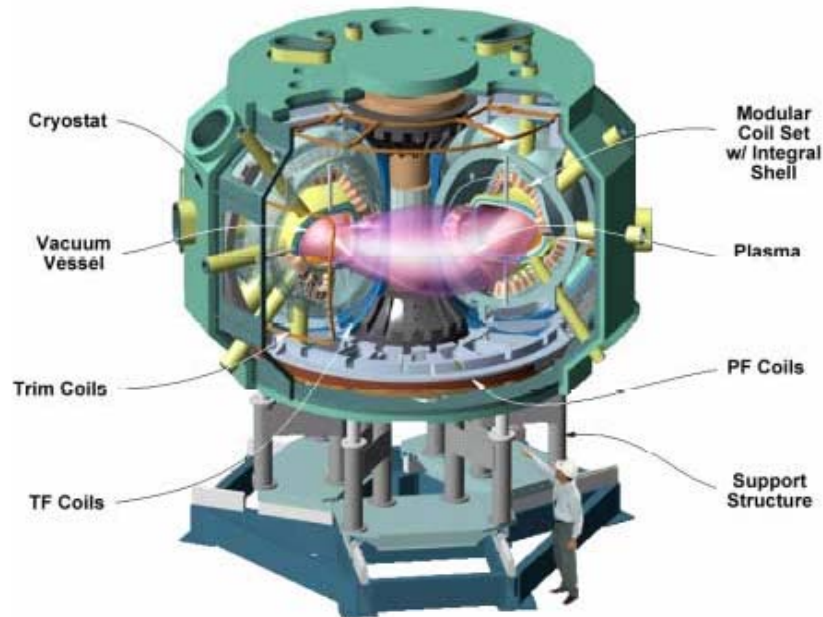


Figure 1 - The NCSX device and definition of its major components

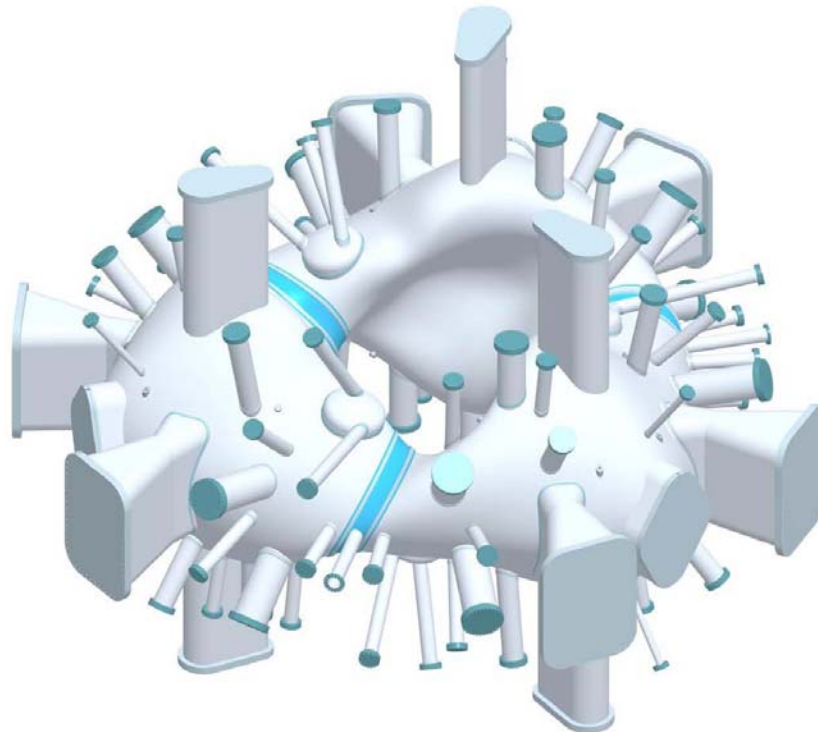
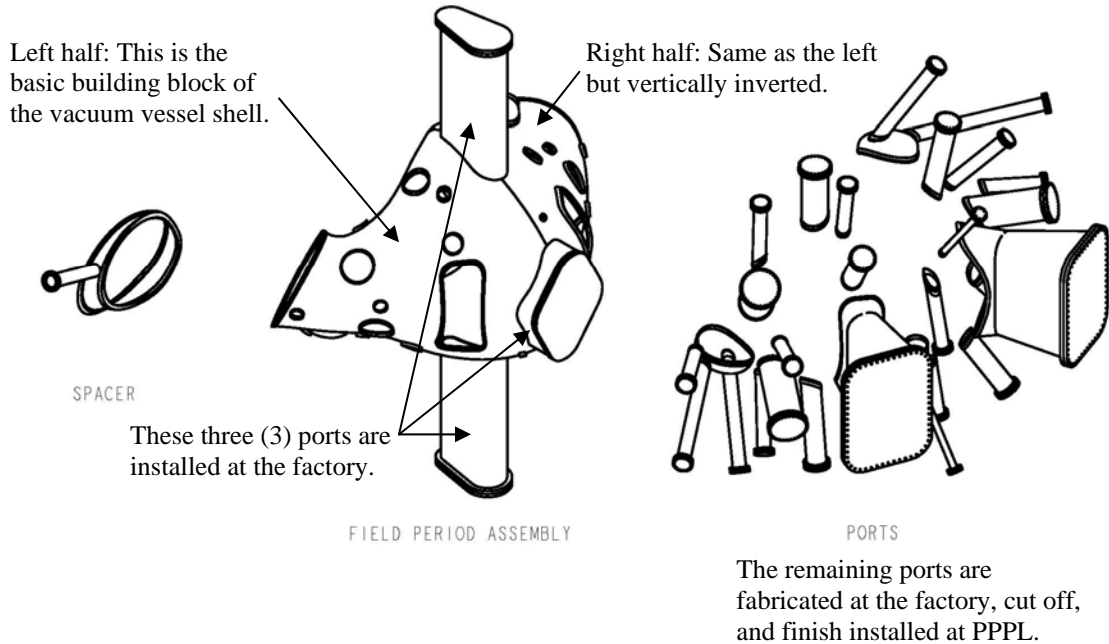


Figure 2 - NCSX with all components removed except the vacuum vessel and its ports



**Figure 3 - Vacuum Vessel Sub-Assembly (VVSA) Components**

### 1.3 Scope

This SOW defines the production of the three Vacuum Vessel Sub-Assemblies (VVSA's) each consisting of a field period assembly, the associated port extensions and a connecting spacer assembly. The VVSA is defined in product specification NCSX-CSPEC-121-02.

The due dates for all deliverables are defined in the Subcontract.

## 2 APPLICABLE DOCUMENTS

### 2.1 Product Specification

The applicable version of the product specification NCSX-CSPEC-121-02 and can be found at:

[ftp://ftp.pppl.gov/pub/ncsx/manuf/production\\_vessel/](ftp://ftp.pppl.gov/pub/ncsx/manuf/production_vessel/)

## **2.2 Supplier Documents**

The supplier, Major Tool and Machine (MTM) is to provide their Visual Manufacturing System (VMS) cards in pdf format to PPPL for reference. Prior to the beginning of manufacturing operations, MTM shall submit a Processing Outline (see form in Appendix 2) which lists: the major processing steps, inspections, tests, and the associated procedures referenced to the VMS cards. The Processing Outline and supporting procedures shall be submitted to PPPL for approval prior to use. All supplier's documentation provided to PPPL shall be maintained current throughout the period of performance.

## **3 WORK REQUIREMENTS**

The supplier shall manufacture, inspect, test and deliver to PPPL three (3) VVSA's that conform to the applicable version of the product specification, the supplier's Visual Manufacturing System (VMS) Plan as described and summarized in the Processing Outline for the VVSA, and to the associated MTM procedures. Supplier shall provide all process documentation identified in Section 5 of this SOW.

## **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 Subcontract. 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 Deviations to the Approved Processing Outline 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.

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

The Subcontractor shall maintain an effective Quality Assurance Program to assure that the Subcontractor's work meets the required quality 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.



#### **4.6 Inspection and Tests**

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.

#### **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 5.4.2. Such objective evidence may include "travelers"; and material test, certification, inspection, examination, test and nonconformance reports; which shall be complete, legible, and validated by responsible personnel and shall be traceable to subject items.

#### **4.8 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.

#### **4.9 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.

#### **4.10 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, 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 five working days prior to performance of the work.

#### **4.11 PPPL Receiving and Inspection**

PPPL will perform Receiving Inspection on items supplied by Subcontractor.

### **5 DELIVERABLES**

#### **5.1 Prior to Fabrication Release**

##### **5.1.1 Segmentation Scheme**

The Subcontractor shall provide the segmentation scheme as required in the Vacuum Vessel Subassembly product Specification (NCSX-CSPEC-121-02) section 3.3.3 Fabrication.

##### **5.1.2 Fiducials**

The Subcontractor shall provide the fiducials as required in the Vacuum Vessel Subassembly product Specification (NCSX-CSPEC-121-02) section 3.3.4.2 Fiducials.

##### **5.1.3 Processing Outline and Associated Procedures**

The Supplier shall provide their Processing Outline and all associated procedures to PPPL for approval prior to beginning fabrication.

#### **5.2 Weekly Reports**

Brief weekly status reports covering technical, administrative, and quality activities and notable problems/issues and progress photographs. Periodically, when requested by the Princeton Technical Representative, the report will include the percent completion of the work for the next milestone deliverable.

### **5.3 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.

### **5.4 Vacuum Vessel subassemblies**

Provide three (3) completed VVSA's per the requirements contained in the product specification (NCSX-CSPEC-121-02).

#### **5.4.1 Shipping Release Form**

Prior to shipment of VVSA components, the Subcontractor must have submitted 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 5.4.2), and received from PPPL written acceptance to ship.

### 5.4.2 **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
- Welding procedures and procedure qualification test records
- Completed nonconformance reports
- Validated inspection and test reports, including radiographs, inspection grid, point cloud files of each VVSA (PRO-E and IGES format)
- Completed shop travelers or process sheets
- Personnel qualifications for Special Processes (Non Destructive Examination, welding, etc.)
- Signed Shipping Release

### 5.5 **Tooling**

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

# ATTACHMENT 1

## PRINCETON UNIVERSITY PLASMA PHYSIC LABORATORY—PPPL

PRODUCT QUALITY CERTIFICATION AND SHIPPING RELEASE					
PROJECT	ITEM DESCRIPTION			SHIPMENT NUMBER	
PPPL Subcontract / Order No.	REV.	ITEM NO.	SUBCONTRACTOR REFERENCE NO.	REV.	QUANTITY SHIPPED
<p><b>SUBCONTRACTOR'S CERTIFICATION</b></p> <p>This is to certify that the products and services identified herein have been produced under a controlled quality assurance program and are in conformance with the procurement requirements including applicable codes, standards and specifications as identified in the above-referenced documents unless noted below. Any supporting documentation will be retained in accordance with the procurement requirements.</p> <p>SIGNED: _____ DATE: _____</p> <p>TITLE: _____ COMPANY: _____</p>					
<p><b>PPPL (AUTHORIZED REPRESENTATIVE) SHIPPING RELEASE</b></p> <p>This is to certify that evidence supporting the above Subcontractor'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 Subcontractor of any and all responsibility or obligation imposed by the purchase contract. It does not waive any rights the Purchaser may have under the purchase contract, including the Purchaser's right to reject the above described material upon discovery of any deviations from requirements of the purchase contract, drawings and specifications.</p>					
<p><b>NONCONFORMANCES FROM PROCUREMENT QUALITY REQUIREMENTS:</b></p> 					
<p><b>REMARKS/PRODUCT SERIAL NUMBERS:</b></p> 					
<p>BY PPPL QA REPRESENTATIVE (OR DESIGNEE)</p>				<p>DATE</p>	

## ATTACHMENT 2

### Processing Outline Form

<b>Spec. Ref.</b>	<b>Activity</b>	<b>Visual manf. Reference</b>	<b>Reference Procedure(s)</b>	<b>Witness/Hold point</b>	<b>Reporting / Documentation Req.</b>
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