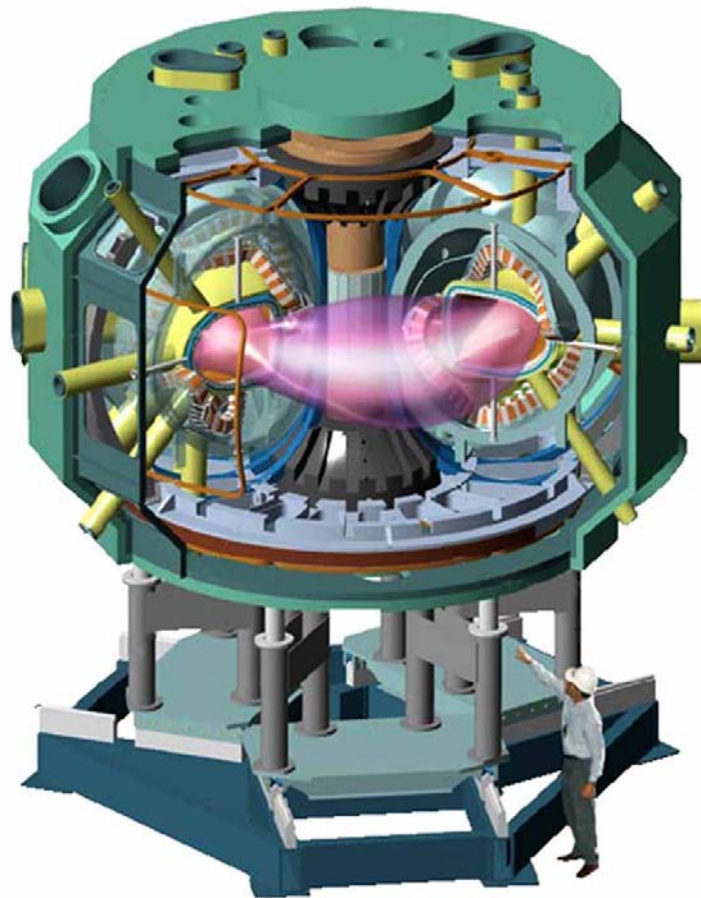


NCSX Start Up Plan

Tasks / Cost / Schedule



Princeton Plasma Physics Laboratory Procedure			
Procedure Title: NCSX Start Up Plan			
Number: C-NCSX-OP-001	Revision: 0	Effective Date: <i>(Ref. OP-AD-97)</i> Expiration Date: <i>(3 yr. unless otherwise stipulated)</i>	
Procedure Approvals			
Author C.A. Gentile			Date
ATI:			Date
RLM:			Date
Responsible Division: NCSX			
Procedure Requirements designated by RLM			
	Work Planning Form # ___ (ENG-032)		Lockout/Tagout (ESH-016)
	Confined Space Permit (5008, Sec. 8, Chap 5)		Lift Procedure (ENG-021)
	Master Equip. List Mod (GEN-005)		ES&H Review (NEPA, IH, etc.)
	RWP (HP-OP-20)		Independent Review
	ATI Walkdown		Pre-job Brief
	Post-job Brief		Hazard Analysis
D-Site Specific			
	D-Site Work Permit (OP-AD-09)		Door Permit (OP-G-93)
	Tritium Work Permit (OP-AD-49)		USQD (OP-AD-63)
	Pre-job brief (OP-AD-79)		T-MOD (OP-AD-03)
	** DCA/DCN (OP-AD-104) # _____		

** OP-AD-104 was voided by procedure ENG-032. However, DCAs that were open at the time of adoption of ENG-032 are still considered valid for work approval purposes.

1.0 PURPOSE

The purpose of this procedure is to list those tasks, documents, actions, reviews required to start up NCSX in a safe, efficient, and compliant manner in accordance with PPPL policies, directives, procedures and DOE orders. It is expected that many of the items required to successfully start up NCSX will occur in parallel with NCSX construction. These tasks include development of NCSX specific procedures and documents including the development of PTP's and configuration of existing C-Site and D-site sub systems in support of NCSX operation.

2.0 SCOPE

This procedure details those sub-systems, documents, reviews (post FDR) which require completion prior to the commencement of the NCSX ISTP and subsequent first plasma and plasma operations.

3.0 RERERENCES

- 3.1 NCSX-ISTP-001 " NCSX Coil Energization ISTP"
- 3.2 C-NCSX-OP-002 " Start Up of NCSX"
- 3.3 NCSX Safety Assessment Document
- 3.4 ESHD-5008 "Environmental, Safety, and Health Manual"

4.0 DEFINITIONS

- 4.1 End of construction: That physical condition when the NCSX reactor is fully assembled. All sub-systems required for first plasma are installed and interfaced with NCSX. All field coils have successfully passed Hi-Pot. The NCSX vacuum vessel is vacuum tight to 5×10^{-6} cc / sec.
- 4.2 Start-up: That condition where the NCSX (Startup) Test Director has assumed control of NCSX from the NCSX construction manager and has configured the device in a startup and operational configuration. Such configuration should include access control in accordance with sub-system safing procedures.

5.0 Duration Of Startup / Cost

5.1 It is expected that it will take ~ 3 months from end of construction to NCSX first plasma. This assumes that prior to the transfer of NCSX from the Construction Manager to the NCSX (startup) Test Director that those required sub-systems listed in section 6.0 of this procedure are available and configured for operation. In addition those required documents (section 8 of this document) have been completed .

5.2 The cost associated with those activities commencing at the completion of NCSX construction to first plasma is ~ **\$ 1,063 K** (cost detailed in 7.5 & 8.1 of this document).

These cost include the Startup Staff, Sub-System Staff (section 7.5 of this document) and cost associated with preparation of required documentation.

(section 8 of this document) for first plasma.

6.0 NCSX Sub-systems

6.1 The following are NCSX sub-systems.

Those sub-systems in **bold** are required to be operational to support first plasma.

NCSX Vacuum Pumping System (TVPS)

Coil systems and associated hardware

AC Power Systems

Motor Generator Sets

Water Systems

Fluorinert System

Cryo System

Bake-out System

Computer Control Systems

NCSX Test Cell Safety Interlock Systems

Energy Conversion Systems (ECS)

Diagnostic Systems

Glow Discharge Cleaning (GDC) System

Vessel Boronization Systems

RF Systems (HHFW & ECH)

Neutral Beam Injection Systems

NCSX Test Cell Fire Protection Systems

Test Cell Boundary Radiation Detection Instrumentation

NCSX Test Cell HVAC System (dew point control)

7.0 TECHNICAL ELEMENTS OF STARTUP

7.1 Documents, Procedures

NCSX Safety Assessment Document (SAD)

ESHD-5008	Environmental, Safety, and Health Manual
ESH-014	NEPA Review System
ESH-016	Control of Hazardous Energy Sources via Lockout Tagout of Energy Isolation Devices
ENG-030	PPPL Technical Procedures for Experimental Facilities
ENG-032	PPPL Work Planning Procedure
ENG-033	PPPL Engineering Design Verification
NCSX-XX	Administrative Control of Procedures
OP-AD-39	Conduct of Operations
OP-AD-56	Control of Equipment and System Status (chain of command)
OP-AD-24	Control of Workplace Cleanliness Around D-Site Experimental
OP-AD-31	D- Site Fire Watch Requirements

OP-AD-03	Control Of Temporary Modifications
OP-AD-117	Operation of the NCSX Access System
NCSX-OP-XX	Preparations of Experimental Areas for Machine Operations
NCSX-OP-XX	Operation of the NCSX TVPS
NCSX-OP-XX	Testing the NCSX HIS with Areas Safe for Access
NCSX-OP-XX	GDC Operations
NCSX-OP-XX	Testing the NCSX Emergency Stop System
NCSX-OP-XX	Safety Lockout Device Test Procedure
NCSX-OP-XX	Hot Access Requirements
NCSX-OP-XX	Testing of the Hot Access and HIS Systems with SLD Pressurized
NCSX-OP-XX	NCSX Training Matrix
NCSX-OP-XX	NCSX Operations Guide for Startup and Shutdown
NCSX-OP-XX	HPP Daily Operations
NCSX-OP-XX	Changing the Trip Control Settings of the RIS Protective Circuit for the NCSX Field Coils
NCSX-OP-XX	ACP & PDP Trip Control Settings
NCSX-OP-XX	Startup, Operation, and Shutdown of the NCSX Bakeout System
NCSX-OP-XX	Verification of Interlock Readiness for Operation of the NB Injection System
NCSX-OP-G-XX	Preparation for NCSX pumpdown
NCSX-OP-XX	Helium Heating and Cooling System Operations Procedure
NCSX-OP-G-XX	Daily Hi-Pot Test of the NCSX Inner/Outer Vacuum Vessel
NCSX-OP-G-XX	NCSX Boronization using TMB
ISTP-NCSX-01	Coil Energization Tests
OP-KK-24	MG Reactor Kirk Key Test
OP-KK-27	MG CO2 Kirk Key Test
OP-KK-28	NCSX SLD Kirk Key Test
OP-KK-90	ICRF System 3&4 Kirk Key and Local E-Stop Test
OP-KK-266	ICRF System 5&6 Kirk Key and Local E-Stop Test
OP-KK-267	ICRF System 1 & 2 Kirk Key and Local E-Stop Test
NCSX-OP-G-XX	MPTS Personnel <u>Safety Interlock Test Procedure</u>
NCSX-OP-G-XX	Neutral Beam Kirk Interlock Testing
OP-MG-07	D-Site MG Operation in support of NCSX
OP-PC-44	ECS HCS Input/Output Interface Testing
OP-PC-45	ECS Interlock and Level 1 Display Testing
OP-PC-46	SDS Preoperational Testing
OP-PC-48	ECS Critical Interlocks
OP-PC-49	ECS Ground Fault Testing
OP-PC-735	Rectifier Settings
OP-ECS-245	FCPC Daily Startup/Shutdown Procedure
NCSX-XX	Leak Checking of NCSX

OP-NB-64	Pumpdown of a NB enclosure
OP-NB-66	Cooldown of a NB enclosure
OP-NB-79	NB Long Pulse Operation Source Accel Startup & Daily Operations using local control
OP-NB-97	Preparations of NB Areas and Equipment for daily operations
OP-NB-229	Startup/operations of the 1070W helium refrigerator
OP-NB-230	Beamline liquid helium operations
OP-NB-710	Startup and Shutdown of the beamline water systems
NCSX-PTP-XX	Preop testing of the NB Power Systems
NCSX-PTP-XX	NB Long Pulse Ion Source Startup Procedures
NCSX-PTP-XX	HiPot of NCSX Coil Sys from SDS in FCPC
NCSX-PTP-XX	HiPot test of CHI Metal Oxide Varistors
PTP-ECS-XX	ECS Continuity, Resistance, Inductance, & Meggar
PTP-ECS-XX	Halmar (DCCT) & Shunt System Pre-op testing
PTP-ECS-XX	RIS Tests
PTP-ECS-XX	ACP Tests
PTP-ECS-XX	PSRTC Simulation Tests
PTP-ECS-XX	PSRTC I/O Tests
PTP-ECS-XX	Pulse Duration Period Timer Tests
PTP-ECS-XX	FCPC Dummy load tests
PTP-ECS-XX	ECS HiPot Tests
PTP-NCSX-XX	NCSX ECH-PI Pre-Operations Testing
PTP-NCSX-XX	NCSX De-Ionized Water/System Testing
PTP-NCSX-XX	NCSX Coil System Preoperational Tests
PTP-NCSX-XX	ECS to NCSX Machine Coil Link Installation

7.2 SAFETY DOCUMENT (SAD)

At the conclusion of Final Design Review (FDR) A Safety Assessment Document (SAD) needs to be developed specifically for NCSX. Approval of the NCSX SAD by the PPPL Safety Review Committee (SRC) is required prior to first plasma.

7.3 REVIEWS / APPROVAL

The following reviews (post FDR) will need to occur prior to first plasma;

- SRC review and approval of NCSX SAD.
- Review and approval of technical documents in section 8.0 of this procedure.
- ACC review / and walk-down of NCSX and (first plasma) sub-systems.
- Approval of ES&H Executive Safety Board for issuance of Safety Certificate.
- Concurrence from the Test Director, NCSX Chief Operating Engineer, and ACC that all sub-system PTP's (for first plasma) have been successfully completed.
- Approval by the NCSX Project Manager to commence First Plasma.

7.4 ISSUANCE OF SAFETY CERTIFICATE

Prior to combined NCSX field testing and Startup a Safety Certificate for (limited) operation must be issued. The Safety Certificate is issued after the ACC has made appropriate presentation and recommendation to the PPPL ES&H Executive Safety Board for the safe Startup and Operation of the device.

7.5 STARTUP & OPERATION / STARTUP STAFF

Startup activities include the initiation of combine field test, integration of appropriate sub-systems (section 6.0) available to support first plasma and initial plasma operations, employment of controlling documentation, proper alignment of NCSX safe access and e-stop systems.

Labor Cost For NCSX Startup

<u>Startup Staff Should Include;</u>	<u>Loaded Cost For 3 Month Startup</u>
- 1 Test Director,	\$ 66 K
- 1 Chief Operations Engineer (COE),	\$ 66 K
- 1 Project Engineer,	Cost Currently Budgeted in Project
- 2 Machine Technicians,	\$ 87 K
- 1 Physicist In Charge (PIC)	Cost Currently Budgeted in Project
 <u>Sub System Staff Should Include;</u>	
- 1 Water Systems Technician,	\$ 43 K
- 1 AC Power Engineer,	\$ 66 K
- 1 Computer Engineer,	\$ 66 K
- 2 FCPC Technicians,	\$ 86 K
- 1 MG Operator,	\$ 43 K
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Total Startup Labor Cost =	\$ 523 K

8.0 Technical Documentation Required / Status

LEGEND	
1	Document in development
2	Current document satisfactory for NCSX Startup and Operation
3	Document requires minor revision
4	Document requires major revision
5	Document needs to be developed
6	Need a NCSX Project specific version
*	Required for first plasma

Documents Required for NCSX Startup and Operations		Status	Estimated person-weeks to complete to sign-off (total)
* NCSX Safety Assessment Document (SAD)		6	10
* ESHD-5008	Environmental, Safety, and Health Manual	2	0
* ESH-014	NEPA Review System	2	0
* ESH-016	Control of Hazardous Energy Sources via Lockout Tagout of Energy Isolation Devices	2	0
* ENG-030	PPPL Technical Procedures for Experimental Facilities	2	0
* ENG-032	PPPL Work Planning Procedure	2	0
* ENG-033	PPPL Engineering Design Verification	2	0
* NCSX-XX	Administrative Control of Procedures	5	4
* OP-AD-39	Conduct of Operations	6	1
* OP-AD-56	Control of Equipment and System Status (chain of command)	6	1
* OP-AD-24	Control of Workplace Cleanliness Around D-Site Experimental	6	1
* OP-AD-31	D- Site Fire Watch Requirements	6	1
* OP-AD-03	Control Of Temporary Modifications	6	1
* OP-AD-117	Operation of the NCSX Access System	6	1
* NCSX-OP-XX	Preparations of Experimental Areas for Machine Operations	5	3
* NCSX-OP-XX	Operation of the NCSX TVPS	5	3
* NCSX-OP-XX	Testing the NCSX HIS with Areas Safe for Access	5	3
NCSX-OP-XX	GDC Operations	5	3

* NCSX-OP-XX	Testing the NCSX Emergency Stop System	5	3
* NCSX-OP-XX	Safety Lockout Device Test Procedure	5	2
* NCSX-OP-XX	Hot Access Requirements	5	2
* NCSX-OP-XX	Testing of the Hot Access and HIS Systems with SLD Pressurized	5	2
* NCSX-OP-XX	NCSX Training Matrix	1	3
* NCSX-OP-XX	NCSX Operations Guide for Startup and Shutdown	5	3
NCSX-OP-XX	HPP Daily Operations	5	2
* NCSX-OP-XX	Changing the Trip Control Settings of the RIS Protective Circuit for the NCSX Field Coils	5	2
* NCSX-OP-XX	ACP & PDP Trip Control Settings	5	2
NCSX-OP-XX	Startup, Operation, and Shutdown of the NCSX Bakeout System	5	3
NCSX-OP-XX	Verification of Interlock Readiness for Operation of the NB Injection System	5	3
* NCSX-OP-G-XX	Preparation for NCSX pumpdown	5	3
NCSX-OP-XX	Helium Heating and Cooling System Operations Procedure	5	3
* NCSX-OP-G-XX	Daily Hi-Pot Test of the NCSX Inner/Outer Vacuum Vessel	5	3
NCSX-OP-G-XX	NCSX Boronization using TMB	5	4
* ISTEP-NCSX-01	Coil Energization Tests	1	4
* OP-KK-24	MG Reactor Kirk Key Test	6	3
* OP-KK-27	MG CO2 Kirk Key Test	6	1
* OP-KK-28	NCSX SLD Kirk Key Test	6	1
OP-KK-90	ICRF System 3&4 Kirk Key and Local E-Stop Test	6	2
OP-KK-266	ICRF System 5&6 Kirk Key and Local E-Stop Test	6	2
OP-KK-267	ICRF System 1 & 2 Kirk Key and Local E-Stop Test	6	2
NCSX-OP-G-XX,	MPTS Personnel <u>Safety Interlock Test Procedure</u>	6	3
NCSX-OP-G-XX,	Neutral Beam Kirk Interlock Testing	6	2
* OP-MG-07	D-Site MG Operation in support of NCSX	6	2
OP-PC-44	ECS HCS Input/Output Interface Testing	6	2
* OP-PC-45	ECS Interlock and Level 1 Display Testing	6	2

* OP-PC-46	SDS Preoperational Testing	6	2
* OP-PC-48	ECS Critical Interlocks	6	2
* OP-PC-49	ECS Ground Fault Testing	6	2
* OP-PC-735	Rectifier Settings	6	2
* OP-ECS-245	FCPC Daily Startup/Shutdown Procedure	6	2
* NCSX-XX	Leak Checking of NCSX	5	2
OP-NB-64	Pumpdown of a NB enclosure	5	1
OP-NB-66	Cooldown of a NB enclosure	5	1
OP-NB-79	NB Long Pulse Operation Source Accel Startup & Daily Operations using local control	5	1
OP-NB-97	Preparations of NB Areas and Equipment for daily operations	5	1
OP-NB-229	Startup/operations of the 1070W helium refrigerator	5	1
OP-NB-230	Beamline liquid helium operations	5	1
OP-NB-710	Startup and Shutdown of the beamline water systems	5	1
NCSX-PTP-XX	Preop testing of the NB Power Systems	5	4
NCSX-PTP-XX	NB Long Pulse Ion Source Startup Procedures	5	4
* NCSX-PTP-XX	HiPot of NCSX Coil Sys from SDS in FCPC	5	3
NCSX-PTP-XX	HiPot test of CHI Metal Oxide Varistors	5	3
* PTP-ECS-XX	ECS Continuity, Resistance, Inductance, & Meggar	5	2
* PTP-ECS-XX	Halmar (DCCT) & Shunt System Pre-op testing	5	2
* PTP-ECS-XX	RIS Tests	5	2
* PTP-ECS-XX	ACP Tests	5	2
* PTP-ECS-XX	PSRTC Simulation Tests	5	2
* PTP-ECS-XX	PSRTC I/O Tests	5	2
* PTP-ECS-XX	Pulse Duration Period Timer Tests	5	2
* PTP-ECS-XX	FCPC Dummy load tests	5	2
* PTP-ECS-XX	ECS HiPot Tests	5	2
PTP-NCSX-XX	NCSX ECH-PI Pre-Operations Testing	5	2
* PTP-NCSX-XX	NCSX De-Ionized Water/System Testing	5	2
* PTP-NCSX-XX	NCSX Coil System Preoperational Tests	5	2
* PTP-NCSX-XX	ECS to NCSX Machine Coil Link	5	2

	Installation		
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8.1

Documentation Cost For NCSX Start Up

Staff Requirement

Loaded Cost For 106 Weeks

- 1 EM Engineer

\$ 540 K

Summation and Grand total of Start Up Cost

Total Labor Cost for Startup Activities = \$ 523 K

Total Documentation Cost = \$ 540 K

Grand Total Cost For NCSX Start Up = \$ 1,063 K

NCSX Start Up Flow Chart

