NCSX Fabrication Project
Work Breakdown Structure (WBS) Dictionary
Central I&C Systems (WBS 5)
NCSX-WBS5-01
Revision 1

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NCSX WBS Dictionary
Central I&C Systems (WBS 5)

Record of Revisions

Revision	Date	Author	Description
0	**9/2/2003**	**Simmons**	**Initial issue**
1	**2/17/2004**	**Simmons**	**Updated WBS dictionary to delete technical requirements and reflected updated CD-2 scope.**

NCSX WBS Dictionary
Central I&C Systems (WBS 5)

WBS Element: 5	**WBS Level: 2**
WBS Title:	**Central I&C Systems**
Description:	The Central Instrumentation and Control System (WBS 5) will provide the remote and local control and monitoring, diagnostic data acquisition and data management for the various subsystems on NCSX. The NCSX Fabrication Project includes Central I&C capabilities required through the Field Line Mapping Phase of operation. All equipment in the Fabrication Project will be installed prior to first plasma. Included in the NCSX Fabrication Project are all the engineering and physics design efforts starting with the preliminary design phase (Title I) and ending with completion of the Construction Project, all the necessary Research and Development (R&D) to support the design effort, all component fabrication, assembly, and installation activities, and all system level commissioning and testing. Integrated systems testing of the entire NCSX device is covered in Integrated Systems Testing (WBS 85). This summary-level WBS element consists of the central instrumentation and control (I&C) systems that provide the central supervisory control and data handling systems for NCSX. These systems interface with the subsystem local I&C systems and allow for control and monitoring of NCSX experiments from the control room (local or remote) and the analysis of the results. The central I&C systems covered under this WBS elements include: • TCP/IP Infrastructure Systems (WBS 51); • Central Instrumentation and Control Systems (WBS 52); • Data Acquisition & Facility Computing Systems (WBS 53); • Facility Timing and Synchronization Systems (WBS 54); • Real Time Control Systems (WBS 55); • Central Safety Interlock Systems (WBS 56); and • Control Room Facility (WBS 57).

WBS Element: 51	WBS Level: 3
WBS Title:	**TCP/IP Infrastructure Systems**
Description:	The TCP/IP network infrastructure will provide the common backbone for all data acquisition, and I&C communications. This system shall be designed to meet the following basic requirements: • Network Communications for critical and high-energy subsystems are required to be protected from intrusion from the local PPPL network and the wide area. • Network Communications for critical protective systems will be implemented with dual power supply switches fed from house and UPS sources. • The network is required to operate in a high noise environment close to the machine and its power sources. • Isolation of diagnostic data acquisition network traffic and the facility subsystems network traffic is required to insure that high data load will not impact facility control and monitoring. • A fiber optic facility will be required for the Timing and Synchronization System, diagnostic video cameras and real time plasma control system communications. The network will consist of an extension of the NSTX Physics and Engineering networks. The Engineering network is behind a secure firewall. All cable and switch infrastructure will minimally support 10/100Mbps Ethernet and all uplinks will use the existing 1 Gigabit Ethernet infrastructure already in place for NSTX. The Test Cell Ethernet infrastructure will be implemented with fiber optic cable. 12 network drops in the test cell and control room will be deployed for Day One operations. New switch port modules will be deployed in five locations: • D-Site FCPC for Power conversion and Plasma Control; • D-Site MG area; • C-Site S1 for RF connectivity; • C-Site NCSX Control Room for test cell and NBI connectivity; and the • PPLCC area for facility computing. Two fiber optic distribution panels will be located in the Test Cell on each side of the machine. A fiber optic infrastructure consisting of 144 fibers between D-Site and C-Site RF building will be deployed for facility timing and synchronization, and real time data acquisition. 120 fiber optic cables for diagnostic and I&C requirements will be deployed between the control room and the test cell. A wireless Ethernet transceiver will be deployed in the test cell to aid in troubleshooting, and for use by collaborators.

NCSX WBS Dictionary
Central I&C Systems

WBS Element: 52	WBS Level: 3
WBS Title:	**Central Instrumentation and Control Systems**
Description:	The central process control system will provide supervisory control and a common user interface to all engineering subsystems and high-energy systems. It will provide the synchronization between two or more operating machines at PPPL using shared power conversion resources. It will support current and historical trending, alarm logging, mimic displays, machine state archival, and process control and monitoring functions for NCSX. It will be designed using the Experimental Physics and Industrial Control System (EPICS). The EPICS infrastructure for the NCSX Fabrication Project will provide required I/O for control and display pages for the following systems: • WBS 21 Fueling Systems • WBS 22 Vacuum Pumping Systems • WBS 42 AC/DC Converters • WBS 62 Water Systems • WBS 63 Cryogenic Systems As the research program evolves, additional EPICS infrastructure will be added at the appropriate time as upgrades. This will include the following systems: • WBS 23 First Wall Conditioning Thermocouples for Bakeout, GDC; • WBS 24 RF Heating Systems, ICH; • WBS 25 Neutral Beam Heating Systems; and • WBS 42 AC/DC Converters (MG Instrumentation)

WBS Element: 53	WBS Level: 3
WBS Title:	**Data Acquisition & Facility Computing Systems**
Description:	The Diagnostic Data Acquisition System will provide a data management software structure to catalog and manage experimental results for subsequent retrieval and analysis. The design will use the existing MIT developed MDSplus software for data acquisition, data archiving and display. Individual diagnostic local control and data acquisition hardware will be designed with standard PC architecture or in Compact PCI chassis. This system will: • Be a "shot" mode time system where initialization sequences are started before the experimental discharge, and data archival is completed at some period after the discharge. This period must be shorter than the minimum pulse interval of NCSX. • Provide access to current Engineering process control data to support diagnostic operations. • Provide online access for the life of the machine via fast rotating magnetic storage of all experimental data. • Achieve high performance and fault tolerance by storing all experimental data on state-of-the-art storage units with dual power supplies using battery backup cache controllers. The online spare disks which will be automatically configured into the storage units set after a disk failure. • Provide readily accessible archival information of the raw experimental data: o One nightly backup of the local data acquisition computer; o One nightly backup of the central data server; and o Continuous maintenance of one copy of the raw data for the life of NCSX on the central storage array. The NCSX Fabrication Project work will: • Provide sufficient DAS and facility computing systems to support of Diagnostic Field Line Mapping • Include the design and purchase of two diagnostic operator interface units and two PCs/CPCI units with I/O channels as specified by WBS3. • Design of a standard Computer Interface Specification for use at PPPL and remote collaborators. This specification will insure a smooth integration of diagnostics and facility systems into the DAS and will be composed of a set of interfaces specifications to MDSplus, Timing Systems, Inter-process Communications (IPCS), and networking. Legacy CAMAC will not be used in the design of the NCSX DAS. As a future upgrade, an additional facility compute server/cluster and expandable tape library will be deployed for the data acquisition system.

WBS Element: 54	WBS Level: 3
WBS Title:	**Facility Timing and Synchronization Systems**
Description:	The Facility Timing and Synchronization System will provide up to 256 preprogrammed events triggers to define the NCSX shot cycle. These systems will utilize a new timing and synchronization technology since the old CAMAC-based TFTR Timing System will not be adequate for NCSX. It is anticipated that this new system will include a 10 MHZ time base and an off-the-shelf or existing solution. An internally developed Field Programmable Gate Array (FPGA) PCI design running at 10MHz will be deployed for NCSX. This system will be based on the NSTX design and will factor in NSTX experiences and lessons learned in optimizing the design. This activity will provide the engineering design and test of a PCI clock encoder module and manpower to write driver software.

WBS Element: 55	WBS Level: 3
WBS Title:	**Real Time Plasma and Power Supply Control Systems**
Description:	The real time software is divided into two functions, the power supply real time control system (PSRTC) and the plasma control system (PCS). The PSRTC will calculate the alpha control signal required by the power conversion firing generators. The basic code of the NSTX PSRTC will be modified for use on NCSX. This signal is calculated using coil currents, machine state permissives, and fault conditions. The NCSX Fabrication Project will consist of new/modified software PSRTC to support NCSX requirements. The NCSX Fabrication Project will only provide limited plasma control, however, the system will be capable of expansion to several hundred real time signals as a future upgrade. The NCSX PCS will share that developed for NSTX with a new real time data acquisition system in the NCSX test cell.

WBS Element: 56	WBS Level: 3
WBS Title:	**Central Safety Interlock Systems**
Description:	The Central Safety Interlock System will provide system-wide coordination of personnel and hardware interlocks. Its primary man machine interface will be EPICS. The Central Safety Interlock System will be a fail-safe, hybrid system. Mechanical components and hardwired devices will provide primary protective functions. Each NCSX high-energy subsystem will interface with the Central Safety Interlock System. An access control system will be incorporated to grant access to the Test Cell for only authorized/trained personnel. UPS and Standby power will be used for critical components.

NCSX WBS Dictionary
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WBS Element: 57		WBS Level: 3
WBS Title:	**Control Room Facility**	
Description:	The Control Room Facility will provide a centralized location for researchers (PPPL physicists, engineers and collaborators) to direct and monitor the experimental operation of NCSX. Key features of this facility will include: • Raised flooring to route network, fiber optic, and power cables to the control racks and Operator Interface Units located in this area. • A minimal space of 3200 square feet to support a similar level of activity as presently seen in the NSTX Control Room. Day 0 operations will require considerably less space. • Wireless Ethernet telecommunications and a test cell PA system • Workstation tables and chairs as required.	