NCSX

Work Breakdown Structure (WBS) Dictionary

Electrical Power Systems (WBS 4)
NCSX-WBS4-02

March 29 2006

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NCSX WBS Dictionary
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Record of Revisions

Revision	Date	Author	Description
0	**8/27/2003**	**Simmons**	**Initial issue**
1	**1/21/2004**	**Simmons**	**Updated WBS dictionary to delete technical requirements, and updated to PBR scope.**
2	**03/29/06**		**Updated WBS Dictionary to reflect the most recent Project scope.**

NCSX WBS Dictionary
Electrical Power Systems (WBS 4)

WBS Element: 4	**WBS Level: 2**
WBS Title:	**Electrical Power Systems**
Description:	The Electrical Power Systems WBS Element covers the supply and delivery of all AC and DC electrical power to all equipment associated with the NCSX experiment. The NCSX Project includes all Electrical Power System capabilities required for initial operation as defined in the GRD. All equipment in the NCSX Fabrication Project will be installed prior to first plasma. All upgrades will be implemented after the first plasma. Included in the NCSX Project are all the engineering and physics design efforts starting with the preliminary design phase (Title I) and ending with completion of the NCSX 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 Pre-Operational and Integrated Systems Testing (WBS 85). Suitable provisions will be made for transition to the upgrades defined in the GRD. This summary-level WBS element consists of the electrical power systems needed by the NCSX device and facility. Electrical Power Systems (WBS 4) includes the following elements: • AC Power Systems (WBS 41); • AC/DC Convertors (WBS 42); • DC Systems (WBS 43); • Control and Protection Systems (WBS 44); • Power System Design and Integration (WBS 45); and • FCPC Building Modifications (WBS 46) Electrical Power Systems (WBS 4) includes the power delivery work up to the bus stubs in the floor. Power supplies for plasma heating systems are not included in Electrical Power Systems (WBS 4), but rather in Auxiliary Systems (WBS 2). This dictionary only includes the work required to support initial operation of the NCSX device, not future upgrades..

NCSX WBS Dictionary
Electrical Power Systems (WBS 4)

WBS Element: 41	**WBS Level: 3**
WBS Title:	**AC Power Systems**
Description:	This WBS element consists of the following subsystems: • Auxiliary AC Power Systems (WBS 411); and • Experimental AC Power Systems (WBS 412).
WBS Element: 411	WBS Level: 4
WBS Title:	Auxiliary AC Power Systems
Description:	This WBS element consists of the effort to design and reconfigure existing auxiliary AC power systems. The existing AC power infrastructure at C-site will be re-used to the maximum practical extent, except for that in the Test Cell that will be stripped. A new AC distribution system, up to and including power panels, is provided in the NCSX test cell. Activities associated with the reactivation of AC power systems at C-site are included. Grounding in the NCSX test cell is provided. Appropriate measures shall be taken by other WBS elements to isolate the a) Vessel and b) PFCs from one another and ground. Isolation shall be tested. All diagnostics components mounted on the vessel/PFC shall also be isolated or float with vessel/PFC.
WBS Element: 412	**WBS Level: 4**
WBS Title:	**Experimental AC Power Systems**
Description:	This WBS element consists of the effort to design and reconfigure existing experimental AC power systems. For initial operation, the C-Site Rectifiers will be used to power the NCSX PF and modular coils. Power supplies for the trim coils will also be provided. WBS 5 is to provide interface for Lockout and E-Stop features.

WBS Element: 42	**WBS Level: 3**
WBS Title:	**AC/DC Convertors**
Description:	This WBS element consists of the AC/DC Convertors required for initial operation.
WBS Element: 421	**WBS Level: 4**
WBS Title:	**C-Site AC/DC Convertors**
Description:	The C-Site AC/DC convertors will be used for initial operation. Six existing Robicon Rectifiers and the PEI Rectifier will be brought into service for NCSX. Required modifications to interface with the NCSX real time controls will be implemented. Additional convertors will be provided as required to power trim coils for initial operations.
WBS Element: 422	**WBS Level: 4**
WBS Title:	**D-Site AC/DC Convertors**
Description:	**Not used**

WBS Element: 43	**WBS Level: 3**
WBS Title:	**DC Systems**
Description:	This WBS element consists of the following subsystems: • C-Site DC Systems (WBS 431); • D-to-C- Site DC Systems (WBS 432); and • D-Site DC Systems (WBS 433).

WBS Element: 431	WBS Level: 4
WBS Title:	**C-Site DC Systems**
Description:	As part of the NCSX initial operations phase, the coils will be fed from the C-Site Rectifiers located in the ESAT Building. This will include reuse and refurbishment, as needed of the following existing C-Site components: • Cabling from the ESAT Building to the Test Cell Basement • Circuit Disconnect Switches • Bus stubs with the associated Disconnect switches coming into the Test Cell
WBS Element: 432	**WBS Level: 4**
WBS Title:	**D-to-C-Site DC Systems**
Description:	**Not used**
WBS Element: 433	**WBS Level: 4**
WBS Title:	**D-Site DC Systems**
Description:	**Not used**

WBS Element: 44	WBS Level: 3
WBS Title:	**Control and Protection Systems**
Description:	This WBS element consists of the following subsystems: • Electrical Interlocks (WBS 441); • Kirk Key Interlocks (WBS 442); • Real Time Control Systems (WBS 443); • Instrumentation Systems (WBS 444); • Coil Protection Systems (WBS 445); and • Ground Fault Monitoring System (WBS 446).
WBS Element: 441	**WBS Level: 4**
WBS Title:	**Electrical Interlock System**
Description:	This WBS element consists of the effort to design, fabricate, and install an electrical interlock system for NCSX. An electrical interlock system is designed and installed which ensures the proper configuration of the power system in accordance with the commanded state from the NCSX control room and access control systems, and which provides coordinated fast fault response of the power supplies when faults are detected. The system is implemented by Programmable Logic Controllers (PLCs) at various C-site and D-site locations interconnected through a fiber optic network.
WBS Element: 442	**WBS Level: 4**
WBS Title:	**Kirk Key Interlocks**
Description:	This WBS element consists of the effort to design, procure, fabricate, and install kirk key interlocks for NCSX.
WBS Element: 443	**WBS Level: 4**
WBS Title:	**Real Time Control Systems**
Description:	This WBS element consists of the effort to develop the specification of the hardware requirements and software algorithms to be provided by WBS 5 (Central I&C) for the real time digital feedback control of the power supply system, including the high-speed digital input and output links.

WBS Element: 444	WBS Level: 4
WBS Title:	**Instrumentation Systems**
Description:	This WBS element consists of the effort to design, specify, procure, install, and implement current and voltage measurements for the NCSX coil systems. For initial operation, optically isolated shunts will be provided for each circuit. Voltage measurements will also be provided using voltage transducers. Included in this WBS element will be the capability to signal condition using devices that are capable to receive the current measurements and buffer, filter, and fan out each signal to multiple destinations.
WBS Element: 445	**WBS Level: 4**
WBS Title:	**Coil Protection Systems**
Description:	This WBS element consists of the effort to design, specify, procure, and implement hardware as required to protect the NCSX coils based on current signatures.
WBS Element: 446	**WBS Level: 4**
WBS Title:	**Ground Fault Monitoring System**
Description:	**Not used**

WBS Element: 45	WBS Level: 3
WBS Title:	**Power System Design and Integration**
Description:	This WBS element consists of the following subsystems: • System Design and Interfaces (WBS 451); • Electrical Systems Support (WBS 452); and • System Testing/PTPs (WBS 453).
WBS Element: 451	**WBS Level: 4**
WBS Title:	**System Design and Interfaces**
Description:	This WBS element consists of the electrical system engineering and design/drafting, which includes the design and analysis of the overall electrical system, its documentation, and the conduct of design reviews.
WBS Element: 452	**WBS Level: 4**
WBS Title:	**Electrical Systems Support**
Description:	This WBS element consists of the effort to ensure overall project coordination of electrical systems by providing electrical systems support to other systems, including diagnostics, which provides the engineering, design/drafting, and installation of diagnostic cabling.

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WBS Element: 453	WBS Level: 4
WBS Title:	**Systems Testing (PTPs)**
Description:	This WBS element consists of the effort to conduct all systems-related preoperational testing, including: • DC circuit hipots and impedance measurements • Electrical interlocks • Overall systems testing, including: o kirk key interlock testing, o instrumentation test & calibration, o real time control system testing, o coil protection system testing, o ground fault monitor testing, and o coil power supply dummy load testing.

WBS Element: 46	WBS Level: 3
WBS Title:	**FCPC Building Modifications**
Description:	**Not used**