NCSX Fabrication Project

Work Breakdown Structure (WBS) Dictionary

Facility Systems (WBS 6)

Revision 1

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Record of Changes

Revision	Date	Author	Description
0	9/9/2003	Simmons	Initial issue
1	11/13/2003	Simmons	Corrected WBS 615, updated WBS 62 & WBS 64, and deleted WBS 66.

Work Breakdown Structure (WBS) Dictionary
Facility Systems (WBS 6)

WBS Element: 6	WBS Level: 2
WBS Title:	**Site and Facilities**
Description:	NCSX operations are divided into six phases: 1. Initial Operation 2. Field Line Mapping 3. Initial Ohmic 4. Initial Auxiliary Heating 5. Confinement and Beta Push 6. Long Pulse The NCSX Fabrication Project includes Site and Facilities equipment required through the Initial Ohmic Phase of operation (that is, Phases 1, 2, and 3). All equipment in the Fabrication Project will be installed prior to first plasma (that is, the start of Phase 1 – Initial Operation). Included in the Fabrication Project are all the engineering and physics design efforts starting with the preliminary design phase (Title I) and ending with completion of the Fabrication 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. Also included in the Fabrication Project is the removal and storage of legacy equipment from PBX-M that will be re-used on NCSX. Integrated systems testing of the entire NCSX device is covered in Pre-Operational and Integrated Systems Testing (WBS 92). This summary-level WBS element consists of the site and facilities needed to support the NCSX experimental program. The NCSX device will make maximum use of existing PPPL systems and facilities. This WBS element includes: • Water Cooling Systems (WBS 61); • Cryogenic Systems (WBS 62); • Utility Systems (WBS 63); • PFC/VV Heating and Cooling Systems (WBS 64); and • Facility Integration (WBS 65) – no longer in use)

WBS Element: 61	WBS Level: 3
WBS Title:	**Water Cooling Systems**
Description:	This WBS element includes all the effort required to add cooling loops to the existing C-site (CS) and HVAC Water Systems as required for NCSX subsystems. This WBS element consists of the following sub-elements: • C-Site Water Cooling (WBS 611) • Neutral Beam Water Cooling (WBS 612); • Vacuum Pumping Water Cooling (WBS 613); • Bakeout Water Cooling (WBS 614); and • Diagnostics Water Cooling (WBS 615)
WBS Element: 611	**WBS Level: 4**
WBS Title:	**C-Site Water Cooling System**
Description:	This WBS element consists of the effort to refurbish and decommission the existing C-Site water-cooling systems. The systems used on PBX-M will be reused where practical. These systems are required to operate 24 hours/day 365 days/year.

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WBS Element: 612	WBS Level: 4
WBS Title:	**Neutral Beam Water Cooling Systems**
Description:	This WBS element consists of the effort to provide cooling water capability for the neutral beams. This work has been deferred until after first plasma, however, a small facilty integration effort will remain in the Fabrication Project to ensure that system requirements are kept current. Electrical connections to motorized valves are provided by the Neutral Beam WBS. Initially, this WBS will provide a 375 gpm cooling water capability for the NCSX neutral beams for day one operations. The NB Accel Rectifiers will require cooling water (they are located in the MG room). The old cooling system for the rectifiers was a closed one with it's own chiller and demineralizer. That chiller has been removed. The old cooling system will be plumbed into the CS water system to provide necessary cooling.
WBS Element: 613	**WBS Level: 4**
WBS Title:	**Vacuum Pumping Water Cooling System**
Description:	This WBS element consists of the effort to provide a cooling water loop to reject heat produced by the vacuum vessel vacuum pumping system. Also included is a small amount of facility integration effort. The system used on PBX-M will be reused where practical. The cooling loop will be connected to the HVAC water system. This WBS will Provide a small < 20 gpm cooling water loop to reject heat produced by the vacuum vessel and neutral beam vacuum pumping systems. The existing HVAC chilled water system will be used as the ultimate heat sink. This system is required to operate 24 hours/day 365 days/year.
WBS Element: 614	**WBS Level: 4**
WBS Title:	**Bakeout Water System**
Description:	The WBS element consists of the effort to provide a cooling water loop to reject waste heat from the PFC/VV Heating and Cooling System (WBS 64). Also included is a small amount of facility integration effort The cooling loop will be connected to the CS cooling water system.
WBS Element: 615	**WBS Level: 4**
WBS Title:	**Diagnostic Water Cooling System**
Description:	The WBS element consists of the effort to provide a manifold around the machine which supplies de-ionized (DI) cooling water facility for the diagnostics systems. The work includes design, fabrication and installation. Also included is a small amount of facility integration effort The cooling loop will be connected to the CS cooling water system. The design and fabrication of any new systems and/or re-commissioning of existing legacy systems has been deferred as a **future upgrade.**

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WBS Element: 62	WBS Level: 3
WBS Title:	**Cryogenic Systems**
Description:	This WBS element consists of the following subsystems: • LN_2-LHe Supply System (WBS 621); • LN_2 Coil Cooling (WBS 622); and • GN_2 Cryostat Cooling System (WBS 623).
WBS Element: 621	**WBS Level: 4**
WBS Title:	**LN_2-LHe Supply System**
Description:	This WBS element consists of the effort to design and install a system to supply liquid nitrogen and liquid helium to the NCSX facility. End users include the LN_2 coil cooling supply system (WBS 622), the GN_2 cryostat cooling supply system (WBS 623), and the NB system (WBS 25). This WBS element also includes connection to the existing LN_2 storage tank. This WBS will support two beamlines with provisions for a total of four beams and a pellet injector. Initially, the neutral beamline will be tested using an individual LHe dewar, which is not part of this work package. The facility is required to accommodate (as a future upgrade) a LHe transfer line between the helium dewar in the C-site Helium Dewar Storage Shed and the beamlines.
WBS Element: 622	**WBS Level: 4**
WBS Title:	**LN_2 Coil Cooling Supply System**
Description:	This WBS element consists of the effort to provide a closed loop LN_2 system for the cooling of the modular coils (WBS 14), and conventional coils (WBS 13). The distribution system within the cryostat for cooling the coil systems is the responsibility of WBS 1.
WBS Element: 623	**WBS Level: 4**
WBS Title:	**GN_2 Cryostat Cooling System**
Description:	This WBS element consists of the effort to circulate GN_2 through the cryostat to provide heat removal during cooldown from room temperature and also during operation. This WBS element provides heating to bring the equipment within the cryostat up from the operating temperature of 80K back to room temperature. The cryostat cooling system is vented to the outside environment through a stack that is also part of this WBS element.

WBS Element: 63	WBS Level: 3
WBS Title:	**Utility Systems**
Description:	The WBS element only consists of the effort to provide the design, fabrication and installation of a manifold system around the NCSX stellarator for compressed air, vacuum pump venting and gaseous nitrogen. The vacuum pump venting system shall provide a system to vent the vacuum pumps in the CS basement and the diagnostic vacuum pumps in the NCSX test cell to the outside. Construction of the system shall be such that the system can be upgraded to TMB use at a later date.

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WBS Element: 64		WBS Level: 3
WBS Title:	**Helium Bakeout System**	
Description:	The WBS element consists of the effort to provide heating and cooling to the vacuum vessel and plasma facing components (PFCs). Prior to Initial Auxiliary Heating (Phase 4), there will be only minimal coverage of the interior with carbon tiles so bakeout capability of the PFCs is not required for the Fabrication Project. However, accommodating bakeout of the PFCs is required as a future upgrade. The capability to bakeout the vessel will be provided for by WBS 64 in the Fabrication Project.	
WBS Element: 64		**WBS Level: 3**
WBS Title:	**PFC/VV Heating and Cooling**	
Description:	This WBS element consists of the effort to provide heating and cooling to the Vacuum Vessel (WBS 12) and Plasma Facing Components (WBS 11). The design and fabrication of any new systems and/or re-commissioning of existing legacy systems has been deferred as a **future upgrade.**	

WBS Element: 65		WBS Level: 3
WBS Title:	**Facility Systems Integration**	
Description:	This WBS element has been deleted since the CDR and the facility integration costs collapsed into the individual WBS 6 elements.	