

NCSX Fabrication Project
Work Breakdown Structure (WBS) Dictionary
Auxiliary Systems (WBS 2)
NCSX-WBS2-01
Revision 1

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**NCSX WBS Dictionary
Auxiliary Systems (WBS 2)**

Record of Revisions

Revision	Date	Author	Description
0	9/8/2003	Simmons	Initial issue
1	1/21/2004	Simmons	Updated WBS dictionary to delete technical requirements and reflect updated CD-2 scope.

NCSX WBS Dictionary Auxiliary Systems (WBS 2)

WBS Element: 2		WBS Level: 2
WBS Title:	Auxiliary Systems	
Description:	<p>The Auxiliary Systems scope includes several subsystems, which are critical to plasma performance. The NCSX Fabrication Project includes gas fueling, torus vacuum pumping, and neutral beam injection heating subsystems. Future upgrades that can be accommodated include glow discharge cleaning, pellet injection, boronization, lithiumization, and radio frequency wave heating subsystems, as well as an augmented neutral beam system.</p> <p>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. Integrated systems testing of the entire NCSX device is covered in Integrated Testing (WBS 85).</p> <p>Auxiliary Systems include all the systems and related elements that directly provide fueling, vacuum pumping, and heating to the plasma and plasma chamber. Auxiliary Systems include:</p> <ul style="list-style-type: none"> • Fueling Systems (WBS 21); • Vacuum Pumping Systems (WBS 22); • Wall Conditioning Systems (WBS 23); • ICH System (WBS 24); • Neutral Beams (WBS 25); and • ECH Systems (WBS 26) 	

WBS Element: 21		WBS Level: 3
WBS Title:	Fueling Systems	
Description:	This WBS element consists of all the effort and systems to provide operational gas and pellet injection fueling systems for the NCSX device.	

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WBS Element: 211		WBS Level: 4
WBS Title:	Gas Fueling Systems	
Description:	<p>NCSX will re-use the existing Gas Fueling System from PBX-M. In its initial configuration, the Gas Fueling System will have 2 to 4 injectors capable of providing a modest level of torr-liter/s of H₂, D₂, or He fueling. This initial configuration will have the flexibility to allow the easy changing of gas plenum volumes, or the adding of additional injectors, at selected vessel locations, as required by the experimental program. This WBS element consists of the effort to provide a gas fueling injectors, the gas delivery line, and associated vacuum system. System control will be partially manual and partially PLC control. An expanded system is planned as a future upgrade.</p> <p>The existing PBX-M Gas Fueling System hardware will be used as much as possible for the configuration needed for NCSX. This hardware consists of fast pulsed valves, control valves, instrumentation, manifolds, miscellaneous vacuum hardware, and an optional hydrogen purification system. The controls, however, will be upgraded with a modern PLC using the proven NSTX design. As in the case of NSTX, this PLC will also control the vacuum vessel pumping system, glow discharge cleaning (GDC) system, and (as a future upgrade) the boronization system.</p> <p>PBX-M hardware will be repaired and refurbished. The NSTX Gas Fueling System drawings and design materials will be reviewed to determine the modifications needed for application to NCSX. Procurement and fabrication records used to implement the operational NSTX Gas Fueling System will be used to expedite a similar system for NCSX. Based on experience on PBX-M and NSTX, the Gas Fueling System should operate reliably and be readily maintainable.</p>	
WBS Element: 212		WBS Level: 4
WBS Title:	Pellet Injection Fueling Systems	
Description:	<p>NCSX will be designed to accommodate a pellet injector as a future upgrade. Guide tubes can be installed to facilitate pellet launch from the inboard (high field) side of the plasma. The PBX-M pellet injector has been saved for future use on NCSX.</p> <p>The only effort in this area for the NCSX Fabrication Project will be to identify where the pellet injector will go, its space requirements, and the placement of guide tubes inside the vessel for pellet injection.</p>	

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WBS Element: 22		WBS Level: 3
WBS Title:	Torus Vacuum Pumping System	
Description:	<p>NCSX requires a Torus Vacuum Pumping System in order to achieve the base pressure requirements. The NCSX Torus Vacuum Pumping System will use as much as possible of the existing PBX-M vacuum pumping system hardware. The PBX-M Torus Vacuum Pumping System consists of:</p> <ul style="list-style-type: none"> • Four (4) Leybold Heraeus TMP 1500 turbo-molecular pumps (TMPs) • Four (4) Model 1398 belt driven backing pumps • One (1) Kinney KT 500 belt driven roughing pump • Gate valves, flanges, and instrumentation <p>Initially, only two of the four available TMPs will be installed.</p> <p>A new Residual Gas Analyzer (RGA) will be provided. In addition, the existing pumping system controls will be replaced with a PLC based system, which will also control the gas fueling GDC (a future upgrade), and a future boronization system. The design will adopt as much as possible of the recently engineered, proven and operational NSTX Torus Vacuum Pumping System.</p> <p>Work will be performed to repair, refurbish as necessary, and test the PBX-M hardware. The Torus Vacuum Pumping System will be assembled and tested off-line prior to first operation on NCSX in order to eliminate uncertainties associated with re-using the existing hardware.</p> <p>Two additional TMPs and backing pumps may be added to NCSX as a future upgrade.</p> <p>The Torus Vacuum Pumping System (WBS 22) will be connected to Utility Systems (WBS 63) for venting to the outside environment.</p>	

WBS Element: 23		WBS Level: 3
WBS Title:	Wall Conditioning Systems	
Description:	<p>This WBS element consists of the effort and systems to provide wall conditioning and impurity control. All these systems will be installed as future upgrades. For the NCSX Fabrication Project, the effort is limited to only the necessary design effort to assure that these systems can be accommodate at a later time.</p> <p>Included are the Glow Discharge Cleaning (WBS 231), Boronization Systems (WBS 232) and Lithiumization Systems (WBS 233).</p>	

WBS Element: 231		WBS Level: 4
WBS Title:	Glow Discharge Cleaning System	
Description:	<p>For the NCSX Fabrication Project, this WBS element consists of the design effort to assure that a glow discharge cleaning (GDC) system can be accommodated on NCSX as a future upgrade.</p>	

WBS Element: 232		WBS Level: 4
WBS Title:	Boronization System	
Description:	<p>For the NCSX Fabrication Project, this WBS element consists of the design effort to assure that a boronization system can be accommodated on NCSX as a future upgrade.</p>	

WBS Element: 233		WBS Level: 4
WBS Title:	Lithiumization System	
Description:	<p>For the NCSX Fabrication Project, this WBS element consists of the design effort to assure that a lithiumization system can be accommodated as a future upgrade.</p>	

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WBS Element: 24		WBS Level: 3
WBS Title:	ICH System	
Description:	The addition of up to 6MW of ICH may be required as a future upgrade . For the NCSX Fabrication Project, the effort is limited to only the necessary design effort to assure that an ICH system can be accommodate at a later time. The design effort shall include developing a design concept, locating the equipment, and defining space requirements.	

WBS Element: 25		WBS Level: 3
WBS Title:	NB System	
Description:	<p>The NCSX Neutral Beam Injection system will re-use the C-site NBI system in its entirety. The NCSX system will initially consist of one beamline with one ion source and associated internal components to condition and inject a neutral beam into the vessel proper through an interconnecting duct. The NCSX NBI system will be installed at the time of first plasma but will not be operational. Subsystems will be tested to a pre-operational level. System testing, integrated systems tests, and commissioning will occur during operations phase after first plasma and in parallel with NCSX initial machine operations.</p> <p>The NCSX Fabrication Project only includes the evaluation of legacy equipment including one beamline, power systems, ac power, and controls.</p> <p>The beamlines will be connected to the torus through the Auxiliary Systems Duct.</p> <p><i>Refurbishment and eventual re-installation of the additional beams will be an upgrade.</i></p>	

WBS Element: 26		WBS Level: 3
WBS Title:	ECH System	
Description:	The addition of up to 3MW of ECH may be required as a future upgrade . For the NCSX Fabrication Project, the effort is limited to only the necessary design effort to assure that this can indeed be accommodated.	