

**NCSX Fabrication Project
Work Breakdown Structure (WBS) Dictionary
Auxiliary Systems (WBS 2)**

Revision 0

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Work Breakdown Structure (WBS) Dictionary

Auxiliary Systems (WBS 2)

WBS Element: 2		WBS Level: 2
WBS Title:	Auxiliary Systems	
Description:	<p>NCSX operations are divided into six phases:</p> <ol style="list-style-type: none"> 1. Initial Operation 2. Field Line Mapping 3. Initial Ohmic 4. Initial Auxiliary Heating 5. Confinement and Beta Push 6. Long Pulse <p>The NCSX Fabrication Project includes all Auxiliary System capabilities required through the Initial Ohmic Phase of operation (that is, Phases 1, 2, and 3).</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 (WS 76).</p> <p>The NCSX Fabrication project includes preliminary evaluation of NBI legacy equipment including localized tests and such maintenance as is necessary to perform those tests to determine fitness for duty on the NCSX project, to improve the preliminary design, and to refine the NBI cost estimate for a future upgrade.</p> <p>All equipment in the Fabrication Project will be installed prior to first plasma (that is, the start of Phase 1 – Initial Operation).</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.	
WBS Element: 211		WBS Level: 4
WBS Title:	Gas Fueling Systems	
Description:	This WBS element consists of the effort to provide a gas fueling system consisting of one-pulse valve based gas injector. It will also be comprised of the of 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.	
WBS Element: 212		WBS Level: 4
WBS Title:	Pellet Injection Fueling Systems	
Description:	This WBS elements consists of the design effort to assure that a pellet injection fueling system can be accommodated on NCSX as a future upgrade and includes identifying where the pellet injector will go, its space requirements, and the placement of guide tubes inside the vessel for pellet injection.	

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WBS Element: 22		WBS Level: 3
WBS Title:	Torus Vacuum Pumping System	
Description:	<p>The Torus Vacuum Pumping System (WBS 22) will re-use the legacy torus vacuum pumping equipment from the PBX-M device. Much of the effort will be to recommission, upgrade (as necessary), install, and test the existing equipment, such that two TMPs and two backing pumps are fully operational in the NCSX facility. The legacy PBX-M torus vacuum pumping equipment for use by WBS 22 consists of:</p> <ul style="list-style-type: none"> • Four (4) Leybold Heraeus TMP 1500 turbo-molecular pumps • Four (4) Model 1398 belt driven backing pumps <p>Two additional TMPs and backing pumps will be added to NCSX as a future upgrade.</p> <p>A new Residual Gas Analyzer (RGA) will be provided. In addition, the legacy Pumping System controls will be replaced with a PLC based system.</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:	This WBS element consists of the effort and systems to provide wall conditioning and impurity control. Included are the Glow Discharge Cleaning (WBS 231), Boronization Systems (WBS 232) and Lithiumization Systems (WBS 233).	

WBS Element: 231		WBS Level: 4
WBS Title:	Glow Discharge Cleaning System	
Description:	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. The WBS element will consist of one fixed wall anode and one pre-ionization filament unit in each of the 3 NCSX periods.	

WBS Element: 232		WBS Level: 4
WBS Title:	Boronization System	
Description:	This WBS element consists of the design effort to assure that a boronization system can be accommodated on NCSX as a future upgrade.	

WBS Element: 233		WBS Level: 4
WBS Title:	Lithiumization System	
Description:	The capability for lithiumization, either by pellet injection, spray, or other techniques, is required as a future upgrade. This WBS element consists of the design effort to assure that a pellet injector can be accommodated as a future upgrade. No R&D and prototyping; fabrication; and assembly, installation, and testing is required for WBS 233.	

WBS Element: 24		WBS Level: 3
WBS Title:	ICH System	
Description:	The addition of up to 6MW of ICH is required as a future upgrade . This WBS element consists of the design effort to assure that this can indeed be accommodated as future upgrade. The design effort shall include developing a design concept, locating the equipment, and defining space requirements. No R&D and prototyping; fabrication; and assembly, installation, and testing is required for WBS 24.	

Work Breakdown Structure (WBS) Dictionary Auxiliary Systems (WBS 2)

WBS Element: 25		WBS Level: 3
WBS Title:	NB System	
Description:	<p>The NCSX Fabrication Project only includes the evaluation of legacy equipment and the refurbishment and installation of one (1) beamline by first plasma.</p> <p><i>Refurbishment and eventual re-installation of additional beams will be an upgrade.</i></p>	

WBS Element: 26		WBS Level: 3
WBS Title:	ECH System	
Description:	<p>The addition of up to 3MW of ECH is required as a future upgrade. This WBS element consists of the design effort to assure that this can indeed be accommodated as future upgrade. The design effort shall include developing a design concept, locating the equipment, and defining space requirements. No R&D and prototyping; fabrication; and assembly, installation, and testing is required for WBS 26.</p>	