

**NCSX Fabrication Project**  
**Work Breakdown Structure (WBS) Dictionary**  
**Facility Systems (WBS 6)**  
**NCSX-WBS6-01**

**Revision 3**

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**NCSX WBS Dictionary  
Facility Systems (WBS 6)**

**Record of Changes**

<b>Revision</b>	<b>Date</b>	<b>Author</b>	<b>Description</b>
<b>0</b>	<b>9/9/2003</b>	<b>Simmons</b>	<b>Initial issue</b>
<b>1</b>	<b>12/1/2003</b>	<b>Simmons</b>	<b>Deleted WBS 66.</b>
<b>2</b>	<b>1/21/2004</b>	<b>Simmons</b>	<b>Updated WBS dictionary to remove correct WBS 615, updated WBS 62 &amp; 64, deleted WBS 66 and technical requirements, and updated to CD-2 scope.</b>
<b>3</b>	<b>3/30/2004</b>	<b>Simmons</b>	<b>Updated to correct references to partial installation of cryostat in WBS 623.</b>

## NCSX WBS Dictionary Facility Systems (WBS 6)

<b>WBS Element: 6</b>		<b>WBS Level: 2</b>
<b>WBS Title:</b>	<b>Site and Facilities</b>	
<b>Description:</b>	<p>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:</p> <ul style="list-style-type: none"> <li>• Water Cooling Systems (WBS 61) ;</li> <li>• Cryogenic Systems (WBS 62);</li> <li>• Utility Systems (WBS 63);</li> <li>• PFC &amp; Vacuum Vessel Heating and Cooling Systems (WBS 64) Systems; and</li> <li>• Facility Integration (WBS 65) – no longer in use)</li> </ul> <p>The NCSX Fabrication Project includes Site and Facilities equipment required support first plasma and field mapping. All equipment in the Fabrication Project will be installed prior to first plasma.</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&amp;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 85).</p>	

<b>WBS Element: 61</b>		<b>WBS Level: 3</b>
<b>WBS Title:</b>	<b>Water Cooling Systems</b>	
<b>Description:</b>	<p>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:</p> <ul style="list-style-type: none"> <li>• C-Site Water Cooling (WBS 611)</li> <li>• Neutral Beam Water Cooling (WBS 612);</li> <li>• Vacuum Pumping Water Cooling (WBS 613);</li> <li>• Bakeout Water Cooling (WBS 614); and</li> <li>• Diagnostics Water Cooling (WBS 615).</li> </ul>	

<b>WBS Element: 611</b>		<b>WBS Level: 4</b>
<b>WBS Title:</b>	<b>C-Site Water Cooling System</b>	
<b>Description:</b>	<p>The CS Water System is a demineralized water cooling system that originally supplied the cooling water for the PBX and PLT experiments. The system currently is inactive and will be refurbished and recommissioned by WBS 611 prior to the start of NCSX operation. This system removes heat from the NCSX water cooling subsystems and transfers it to the atmospheric cooling tower via the flat plate heat exchanger in the C-Site pump room basement.</p>	

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<b>WBS Element: 612</b>		<b>WBS Level: 4</b>
<b>WBS Title:</b>	<b>Neutral Beam Water Cooling Systems</b>	
<b>Description:</b>	<p>This WBS element consists of the effort to provide cooling water capability for the neutral beams. This system transfers heat from the internal beamline enclosure components, Accell power supplies, and Accell rectifiers to the CS Water System. The Decell power supplies are connected to the CS Water System and need to be refurbished and recommissioned. The NB modulators are cooled by the RF water system and are operational. This system was operational for PBX.</p> <p>This majority of the refurbishment and recommissioning work has been deferred until after first plasma, however, a small facility integration and assessment effort will remain in the Fabrication Project to ensure that system requirements are kept current and the scope of the refurbishment and recommissioning activities defined and understood.</p>	
<b>WBS Element: 613</b>		<b>WBS Level: 4</b>
<b>WBS Title:</b>	<b>Vacuum Pumping Water Cooling System</b>	
<b>Description:</b>	<p>The Vacuum Pumping Water Cooling System (VPWCS) provides a cooling water loop to reject heat produced by the Torus Vacuum Pumping System (TVPS) and the NB Vacuum Pumping System to the HVAC Water System. The system used on PBX-M will be re-used where practical. The equipment to be cooled includes the turbomolecular pumps (TMPs) and backing pumps for the TVPS and NB enclosures. Also included is a small amount of facility integration effort. The existing HVAC chilled water system will be used as the ultimate heat sink.</p>	
<b>WBS Element: 614</b>		<b>WBS Level: 4</b>
<b>WBS Title:</b>	<b>Bakeout Water System</b>	
<b>Description:</b>	<p>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.</p>	
<b>WBS Element: 615</b>		<b>WBS Level: 4</b>
<b>WBS Title:</b>	<b>Diagnostic Water Cooling System</b>	
<b>Description:</b>	<p>The Diagnostics Water Cooling System (DWCS) will provide a cooling manifold around NCSX to cool various diagnostics components to be installed on or near the vacuum vessel. The manifold shall be installed far enough away from the machine to avoid space impacts to diagnostics and other equipment occupying real estate close in to the vacuum vessel. 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.</p> <p>The design and fabrication of any new systems and/or re-commissioning of existing legacy systems has been deferred as a <b>future upgrade</b>.</p>	
<b>WBS Element: 62</b>		<b>WBS Level: 3</b>
<b>WBS Title:</b>	<b>Cryogenic Systems</b>	
<b>Description:</b>	<p>This WBS element consists of the following subsystems:</p> <ul style="list-style-type: none"> <li>• LN<sub>2</sub>-LHe Supply System (WBS 621);</li> <li>• LN<sub>2</sub> Coil Cooling (WBS 622); and</li> <li>• GN<sub>2</sub> Cryostat Cooling System (WBS 623).</li> </ul>	

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<b>WBS Element: 621</b>		<b>WBS Level: 4</b>
<b>WBS Title:</b>	<b>LN<sub>2</sub>-LHe Supply System</b>	
<b>Description:</b>	<p>The Liquid Nitrogen (LN<sub>2</sub>) and Liquid Helium (LHe) Supply System (WBS 621) will be used to receive, store, and deliver cryogenics to the LN<sub>2</sub> Coil Cooling System (WBS 622), to the GN<sub>2</sub> Cryostat Cooling System (WBS 623), and to the Neutral Beam Injection System (WBS 25). This WBS element also includes connection to the existing LN<sub>2</sub> storage tank. The scope of the NCSX Fabrication Project is limited to satisfying only liquid nitrogen supply requirements in WBS 62.</p> <p>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 <b>future upgrade</b>) a LHe transfer line between the helium dewar in the C-site Helium Dewar Storage Shed and the beamlines. A helium supply line will be installed (as a future upgrade) prior to the start of experiments requiring significant neutral beam heating (about 1 year or more after first plasma). It will connect the beamlines to a helium dewar in the C-site helium dewar storage shed located in the courtyard outside the NCSX Test Cell.</p>	
<b>WBS Element: 622</b>		<b>WBS Level: 4</b>
<b>WBS Title:</b>	<b>LN<sub>2</sub> Coil Cooling Supply System</b>	
<b>Description:</b>	<p>This WBS element consists of the effort to provide a closed loop LN<sub>2</sub> system for the cooling of the modular coils (WBS 14), and conventional coils (WBS 13). This system will:</p> <ul style="list-style-type: none"> <li>• Distribute liquid nitrogen to the stellarator core with a supply/return differential sufficient to move fluid through the field coils at an acceptable rate; and</li> <li>• Remove the energy gained by the recirculating loop from the field coils in a manner that results in a stable supply temperature to the coils.</li> </ul> <p>The distribution system within the cryostat for cooling the coil systems is the responsibility of WBS 1.</p>	
<b>WBS Element: 623</b>		<b>WBS Level: 4</b>
<b>WBS Title:</b>	<b>GN<sub>2</sub> Cryostat Cooling System</b>	
<b>Description:</b>	<p>The GN<sub>2</sub> Cryostat Cooling System (WBS 623) will be used to circulate nitrogen gas of a controlled temperature through the NCSX cryostat and, consequently, around the exposed surfaces of the structures within the cryostat 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.</p>	

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<b>WBS Element: 63</b>		<b>WBS Level: 3</b>
<b>WBS Title:</b>	<b>Utility Systems</b>	
<b>Description:</b>	<p>The Utility Systems (WBS 63) are required to provide service manifolds around the NCSX stellarator for compressed air, vacuum pump venting and gaseous nitrogen. Utility Systems are comprised of three (3) service manifolds around the NCSX vacuum vessel: one for vacuum venting; one for GN2 service; and one for compressed air. 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.</p> <p>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.</p>	

<b>WBS Element: 64</b>		<b>WBS Level: 3</b>
<b>WBS Title:</b>	<b>PFC/VV Heating and Cooling</b>	
<b>Description:</b>	<p>The WBS element consists of the effort to provide heating and cooling to the vacuum vessel and plasma facing components (PFCs). Prior to the initial auxiliary heating phase, there will be only minimal coverage of the interior with carbon tiles so bakeout capability of the PFCs is not required for the NCSX Fabrication Project.</p> <p>However, accommodating bakeout of the PFCs, as well as the design and fabrication of any new systems and/or re-commissioning of existing legacy systems, is required as a <b>future upgrade</b>.</p>	

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