NCSX Preliminary Hazard Analysis
Revision 1

Hazard	Barrier
Radiation:	_ Estimate maximum of 0.0011 Ci/yr of tritium produced (based on 2.3E16 DD neutrons/yr projected maximum generation rate). If released, dose at nearest business would be <2E-5 mrem/yr. 40CFR61 Subpart H limit is 10 mrem/yr, and EPA approval to construct is required at 0.1 mrem/yr. _ Personnel occupancy of the NCSX Test Cell and other areas deemed necessary by Health Physics will be excluded during plasma operation. _ Maximum offsite dose will be < 2 mrem/yr (limit is 10 mrem/yr); maximum worker dose will be ≤1000 mrem/yr (limit is 5000 mrem/yr).
Electrical	_ In order to ensure the protection of personnel from electrical hazards, the selection of electrical equipment and the design and construction of electrical distribution systems will comply with national codes and standards wherever possible. Access to electrically hazardous areas will be controlled by the NCSX Safety Interlock System. _ To prevent electrical hazards from being transmitted outside the NCSX Test Cell boundary, instrumentation will be isolated via appropriate means (e.g., optical) prior to exiting the Test Cell boundary. _ Electrical work practices will conform with the requirements of ES&HD 5008, Section 2 (“Electrical Safety”).
Fire	_ The NCSX Test Cell fire detection system will be designed using appropriate components (e.g., ionization smoke detectors at the ceiling and aspirated smoke detection (VESDA) under the platform, pre-action type automatic water sprinkler systems) to protect personnel, the machine and the facility.
Earthquake	_ NCSX machine supports and Test Cell structures will be designed to remain functional under the overall loads due to an earthquake in accordance with the latest DOE required standards.
Vacuum Windows	_ Personnel injury due to flying debris from failed windows, or from an individual being drawn to, or into, the opening will be addressed via window design features and/or installation of protective covers, See ES&HD 5008, Section 9, Chapter 14.

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Magnetic Fields	_ Personnel will be prevented from entering the NCSX Test Cell during plasma operations by an access control system (via the NCSX Safety Interlock System). _ If hot access to the NCSX Test Cell (access while coils are energized but plasma formation is prevented) is required, the magnetic field strength that personnel would be exposed to shall not exceed the threshold limit value, B_{TLV}, for routine occupational exposure. See DOE Standard STD-6003-96.
RF Fields	_ RF systems will be designed with leakage levels that comply with IEEE Standard C95.1 (outside the test cell) and will be routinely checked for leakage.
Mechanical	_ During any hot access into the NCSX Test Cell, personnel will be required to stay in a protective enclosure to protect against magnetically propelled projectiles or possible arc splatter that may attend an electrical bus failure. _ Gas cylinders will be stored/installed in accordance with PPPL safety procedures (ES&HD 5008, Section 9, Chapter 2) to prevent breaking the cylinder heads, which could propel the cylinders due to a rapid release of gas.
Hot Fluids	_ The Bakeout Heating System, which will use pressurized helium at temperatures ≥ 350°C, will be pneumatically tested to a multiple (e.g.,1.3 times) its operating pressure prior to operations. _ Precautions will be taken to prevent personnel contact with hot surfaces, including restricting access to areas where hot pipe or components are present, posting of warning signs, and personnel training.

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Gases/Cryogenics	_ The potential for release of the contents of one or more gas cylinders will be assessed to ensure that oxygen concentrations in the NCSX Test Cell would remain at safe levels for personnel upon release of the contents to the room. _ Since SF_6 (used for electrical insulation in neutral beam injection system power equipment) is heavier than air and can displace oxygen, leakage of the gas could be hazardous to personnel occupying an enclosed area below the leak point. Assessments will be made of the need for personnel protection by strategic location of SF_6 detection in the areas where relevant equipment is situated to provide local evacuation alarms. _ Trimethylboron (TMB) may be used in a boronization process for plasma impurity control in the NCSX vacuum vessel. TMB is toxic (7ppm TLV, based upon the TLV of the reaction product B_2O_3) and pyrophoric in air. Protective measures would include low TMB inventory (≤50 g), prior leak checking of components that will be TMB pressurized above 1 atm, use of portable leak detectors, limiting Test Cell access during boronization to only TMB trained personnel, interlocks that halt TMB injection on loss of plasma discharge or glow discharge current, and nitrogen purging of the NCSX vent line during TMB injection. _ Cryogenic system subsections which may be isolated by valves or other means will be provided with pressure relief devices. Appropriate personal protective equipment will be used by personnel engaged in handling cryogenic fluids. Pressure relief devices will be installed to preclude rupture of sections of the system by excessive internal pressure. All piping will be designed for maximum operating pressure and tested in accordance with applicable ANSI codes. Materials suitable for cryogenic service will be used if in contact with cryogenic fluids or subject to cryogenic temperatures. _ The cryostat will be filled with cold (80K) dry nitrogen gas and maintained at a pressure slightly above atmospheric to prevent moisture from leaking into the cryostat. Excessive leakage of nitrogen gas represents a possible mechanism for oxygen depletion in the vicinity of the cryostat. The air in the Test Cell should be constantly exchanged and oxygen levels monitored to ensure personnel safety. The cryostat will be carefully air purged, monitored, and certified safe before cryostat panels are removed and personnel are allowed to enter.

In general, proper system design, construction and the presence of features that mitigate the effect of failures (e.g. redundancy, energy isolating barriers, etc.) will ensure the safety of personnel. Personnel will be excluded from areas such as the NCSX Test Cell when hazards exist by the use of hardwired interlocks, procedures, and training.