National Spherical Torus Experiment

NSTX UPGRADE PROJECT

PRELIMINARY HAZARDS ANALYSIS

Revision 0

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NSTX Upgrade Project Preliminary Hazard Analysis

Hazard	**Barrier**
Radiation:	_ 2nd NBI Only: Estimate maximum of 0.0097 Ci/yr of tritium produced (based on 2.0E17 DD neutrons/yr projected generation rate). If released, dose at nearest business would be <3E-5 mrem/yr. 40CFR61 Subpart H limit is 10 mrem/yr, and EPA approval to construct is required at 0.1 mrem/yr. New CS Only: Estimate maximum of 0.0969 Ci/yr of tritium produced (based on 2.0E18 DD neutrons/yr projected generation rate). If released, dose at nearest business would be <3E-4 mrem/yr. 40CFR61 Subpart H limit is 10 mrem/yr, and EPA approval to construct is required at 0.1 mrem/yr. New CS + 2nd NBI: Estimate maximum of 0.1938 Ci/yr of tritium produced (based on 4.0E18 DD neutrons/yr projected generation rate). If released, dose at nearest business would be ~5E-4 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 NTC and other areas deemed necessary by Health Physics will be excluded during plasma operation and neutral beam conditioning. _ Maximum offsite dose from operations will be (scaled based on NSTX SAD Table 3): 3E-4 mrem/yr for 2nd NBI Only; 3E-3 mrem/yr for New CS Only; and 6E-3 mrem/yr for New CS + 2nd NBI (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 complies with national codes and standards wherever possible. Access to hazardous areas is controlled by the NSTX Safety System. _ To prevent electrical hazards from being transmitted outside the NSTX Test Cell (NTC) boundary all instrumentation is isolated via optical and/or magnetic (magnetic transformer) means prior to exiting the NTC boundary. _ Electrical work practices conform with the requirements of ES&HD 5008, Section 2 (“Electrical Safety”).
Fire	_ The NTC fire detection system consists of ionization smoke detectors and rate of rise heat detectors located at the ceiling and aspirated smoke detection (VESDA) under the platforms. _ The NTC fire suppression is a pre-action type automatic water sprinkler system similarly located.

Hazard	Barrier
Earthquake	_ The NTC along with the rest of the D-Site experimental complex structures, has been determined to have adequate capacity to remain functional under the overall loads due to an earthquake with a horizontal ground acceleration of 0.13g. _ The NSTX platform has been designed for 0.09g, the seismic requirements of the NSTX torus structure. Equipment associated with the NSTX Upgrades will designed and built consistent with these requirements.
Vacuum Windows	_ Personnel injury due to flying debris from failed windows, or from an individual being drawn to, or into, the opening is addressed via window design features and/or installation of protective covers, See ES&HD 5008, Section 9, Chapter 14.
Magnetic Fields	_ Personnel are prevented from entering the NTC during plasma operations by an access control system. _ During a hot access (access while coils are energized but plasma formation is prevented), the magnetic field strength that personnel are 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 have been designed with leakage levels that comply with IEEE Standard C95.1-1991 (outside the test cell) and are routinely checked for leakage. In addition, RF transmission into the NTC is prevented whenever personnel have access to the NTC.
Mechanical	_ During a hot access into the NTC, personnel are 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 are 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 Low Temperature Bakeout Heating/Cooling System, which is run with water at temperatures up to 150°C, was hydrostatically tested to at least 1.5 times its operating pressure prior to operations. The High Temperature Bakeout Heating/Cooling System, which uses pressurized helium at temperatures up to 420°C, was pneumatically tested to 1.3 times its operating pressure prior to operations. _ Precautions are 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.

Hazard	Barrier
Gases/Cryogenics /Lithium	_ The content of the largest gas cylinder (311 cubic ft.) constitutes less than 0.1% of the volume of the NTC (approximately 354,000 cubic ft.). Thus, oxygen concentrations in the NTC would remain at safe levels for personnel even if a gas cylinder's entire contents were released to the room. _ Since SF_6 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. Personnel protection is provided by strategic location of SF_6 detection in the NTC to provide local evacuation alarms. _ Trimethylboron (TMB) used in the boronization process is toxic (7ppm TLV, based upon the TLV of the reaction product B_2O_3) and pyrophoric in air. Protective measures 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 NTC 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 stack vent line during TMB injection. _ Cryogenic system subsections which may be isolated by valves or other means are provided with pressure relief devices. Appropriate personal protective equipment is used by personnel engaged in handling cryogenic fluids. Pressure relief devices have been installed to preclude rupture of sections of the system by excessive internal pressure. All piping has been designed for maximum operating pressure and tested in accordance with applicable ANSI codes. Only materials suitable for cryogenic service are used if in contact with cryogenic fluids or subject to cryogenic temperatures. - Lithium hazards include fire or explosion hazards due to the high reactivity of lithium, and health hazards due to the corrosive and toxic nature of the stable end products of lithium reactions. Safety precautions include avoiding contact with sources of moisture, conducting fabrication and transport of pellet material under an argon atmosphere, receipt and disposal of lithium material in sealed containers, presence of special (LITH-X) fire extinguishers during lithium loading activities and transport to the NTC, venting & cleaning of the vacuum vessel prior to allowing worker entry after lithium experiments, and performing work activities according to approved procedures and using proper PPE.

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 NSTX Test Cell (NTC), the NSTX bus tunnel in the Test Cell Basement and other relevant areas when hazards exist, by the use of hardwired interlocks, procedures, signage, indicator lights and training.