QPS Preliminary Hazard Assessment

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Prepared by: _____

L. A. Berry, Deputy QPS Project Manager

Approved by: _____

J. F. Lyon, QPS Project Manager

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Work practices, requirements, and procedures are governed by the ORNL Standards Based Management System (SBMS). Formally, the ORNL Research Hazard Analysis provides a systematic approach to identifying issues through the Research Safety Summary process. This Summary then links to applicable Federal, State, and contractual requirements and the procedures and systems for hazard mitigation and regulation compliance. In some cases, additional SBMS management and subject areas will be relevant to a particular hazard. In addition, the QPS General Requirements Document (ORNL/CF-03/30) specifies in greater detail those hazard-mitigation elements that are part of the QPS project. This assessment is preliminary and will be superceded by a formal Research Safety Summary.

Hazard	Assessment/Mitigation
Radiation	• Runaway electrons produced during ramp up of the magnetic field are the principal radiation hazard. The use of a mechanical paddle and/or controlled error fields will be employed to prevent significant x-ray generation. The use of gas puffs during ramp down will also be considered. Both public and occupational exposures will be substantially below exposure limits. • Neutron and tritium generation as a result of DD reactions will be at a very low level because deuterium neutral beam heating will not be employed. Levels are substantially below either occupational or public exposure limits. • Radiation work practices will be governed by the policies and procedures contained in the SBMS subject area Radiological Protection Management.
Electrical	• Magnet and heating power supplies constitute the major electrical hazards. • Electrical isolation will be utilized on instrumentation systems to restrict the hazard to the Test Cell. • A safety interlock system will be used to control access to test cell and power systems areas and prohibit access when these systems are energized. • Work practices will be governed by the policies and procedures contained in the SBMS subject area Electrical Work.

Hazard	Assessment/Mitigation
Fire	• Personnel, the QPS facility, and related equipment will be protected by appropriate fire detection and sprinkling systems. (SMBS subject area Fire Prevention, Detection and Control).
Earthquake	• QPS machine supports and structures will be designed to remain functional under the overall loads due to an earthquake in accordance with applicable Federal and State requirements.
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 and, for windows larger than 6 inches in diameter, installation of protective covers.
Magnetic Fields	• The magnetic field strength that personnel would be exposed to near the test cell during operation shall not exceed the threshold limit value, BTLV, for routine occupational exposure. SBMS subject area Working with Nonionizing Radiation.
Radio Frequency 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. SBMS subject area Working with Nonionizing Radiation.
Mechanical	• The QPS Test Cell wall and the QPS vacuum vessel will provide protection against hazards from failure of magnets or other equipment with the potential for mechanical hazards upon failure.
Hot Fluids/Surfaces	• During bakeout operation, 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.

Hazard	Assessment/Mitigation
Gases	• Trimethylboron (TMB) may be used in a boronization process for plasma impurity control. 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 (e.g., ≤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 QPS vent line during TMB injection. • The QPS vacuum vessel and pit have the potential for oxygen-depleted atmospheres. Oxygen levels will be monitored and appropriate confined-space procedures followed. SBMS subject area Confined Space. • Gas cylinders will be stored/installed in accordance with safety procedures. SBMS subject area Gas Cylinders and Related Systems.
Lasers	• Lasers with hazardous power/energy levels will be employed for QPS plasma diagnostics. Interlocks, enclosures, eye protection, etc. will be utilized in accordance with the procedures in SBMS subject area Lasers.
Device assembly	• The QPS device will be assembled using approved assembly procedures. All cranes will be certified for their rated loading, and all slings, fixtures, and rigging will be designed and tested to 5 times the working load.

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 QPS Test Cell when hazards exist by the use of hardwired interlocks, procedures, and training.