QPS Fabrication Project
Work Breakdown Structure (WBS) Dictionary
Central I&C and Data Acquisition (WBS 5)

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QPS WBS Dictionary
Central I&C and Data Acquisition (WBS 5)

WBS Element: 5	**WBS Level: 2**
WBS Title:	**Central I&C and Data Acquisition**
Description:	The Central Instrumentation and Control and Data Acquisition (WBS 5) will provide the remote and local control and monitoring, diagnostic data acquisition and data management for the various subsystems on QPS. The QPS Fabrication Project includes Central I&C capabilities required through the Field Line Mapping Phase and ECH First Plasma of operation. All equipment in the Fabrication Project will be installed prior to first plasma. Included in the QPS Fabrication Project are all the engineering and physics design efforts starting with the preliminary design phase (Title I) and ending with completion of the Construction 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 QPS device is covered in Integrated Systems Testing (WBS 73). This summary-level WBS element consists of the central instrumentation and control (I&C) systems that provide the central supervisory control and data handling systems for QPS. These systems interface with the subsystem local I&C systems and allow for control and monitoring of QPS experiments from the control room (local or remote) and the analysis of the results. The central I&C systems covered under this WBS elements include: • TCP/IP Network Infrastructure (WBS 51); • Central Instrumentation and Control (WBS 52); • Data Acquisition and Facility Computing (WBS 53); • Facility Timing and Synchronization (WBS 54); • Real Time Plasma and Power Supply Control (WBS 55); • Central Safety Interlock System (WBS 56); and • Control Room Facility (WBS 57).

WBS Element: 51	**WBS Level: 3**
WBS Title:	**TCP/IP Network Infrastructure**
Description:	The TCP/IP network infrastructure will provide the common backbone for all data acquisition, and I&C communications. This system shall be designed to meet the following basic requirements: • Network Communications for critical subsystems must be protected from intrusion from both the local ORNL and the wide area networks. • The network is required to operate in a high noise environment close to the machine and its power sources. • Isolation of diagnostic data acquisition network traffic and the facility subsystems network traffic is required to insure that high data load will not impact facility control and monitoring. • Fiber optic cables should be used when possible to reduce ground loops. The TCP/IP network Infrastructure will provide a minimum of 100 Mbps Ethernet connectivity to all facilities and users of QPS. Backbone bandwidth of Gigabit Ethernet or faster will be deployed. The network will consist of three distinct branches: ORNL, QPS and PLC networks. The ORNL network will be for general use. The QPS Network will support all users and diagnostic control. The PLC network will support facility subsystems and low level PLC communications. The ORNL network is already behind a secure firewall. The QPS and PLC networks will be behind a second, local firewall for additional security.

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WBS Element: 52		**WBS Level: 3**
WBS Title:	**Central Instrumentation and Control**	
Description:	The central process control system will provide supervisory control and a common user interface to all engineering subsystems and high-energy systems. It will support current and historical trending, alarm logging, mimic displays, machine state archival, and process control and monitoring functions for QPS. It will be designed using the Experimental Physics and Industrial Control System (EPICS). • The central process control system (CPCS) will be based on a similar PC and Labview system provided by ORNL for use by Theragenics Corporation. The system presents a user interface to the PLC system described in WBS55, providing the ability to control and monitor the PLC. The PLC will provide audible alarms when signals fall below or rise above preset set points, while the CPCS will provide visual alarms and identify which signal(s) are out of range. PLC data will be stored in the MDSplus system to provide machine state archival. The CPCS will cover the following subsystems: • WBS 21 Fueling Systems • WBS 22 Vacuum Pumping Systems • WBS 23 First Wall Conditioning Thermocouples for Bakeout, GDC • WBS 24 RF Heating Systems • WBS 42 Magnet Power Systems • WBS 61 Water Systems	

QPS WBS Dictionary
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WBS Element: 53	WBS Level: 3
WBS Title:	**Data Acquisition & Facility Computing**
Description:	The Diagnostic Data Acquisition System will provide a data management software structure to catalog and manage experimental results for subsequent retrieval and analysis. • It will be a "shot" mode time system where initialization sequences are started before the experimental discharge, and data archival is completed after the discharge. Access to current machine process control data will be required for diagnostic operations. • All experimental data will be retained for the life of the machine (although not necessarily on-line) and will be accessible for analysis. • Achieve high performance and fault tolerance, all experimental data will be stored on RAID 1 or 5 disk storage. • At least two copies of the raw data will be maintained at all times. The design will use the existing MIT developed MDSplus software for data acquisition, data archiving and display. Individual diagnostic local control and data acquisition hardware will be designed with standard PC architecture or in a Compact PCI or PXI chassis. Diagnostic operator interface units will be configured and deployed for day 1 operations. A QPS Computing Interface Specification will be developed for use at ORNL and for remote collaborators. The standard will be composed of a set of interfaces specifications to MDSplus, Timing Systems, EPICS, and networking which when used will insure a smooth integration of diagnostics into the DAS. For example, the MDSplus specification will include interface specifications for Labview VIs, IDL functions, Visual Basic DLLs, COM objects, VC++ DLLs, Java and Fortran. It is assumed that the MDSplus specification which is to be developed for NCSX will be directly applicable to QPS. The Data Acquisition System will make use of existing FED compute and data storage resources as much as possible. Additional capacity will be added to meet QPS requirements. This includes PC's, PXI and/or CPCI units with I/O channels as specified by WBS3, a facility compute server/cluster, tape system and disk storage subsystem. Due to rapidly changing technology, the software and hardware which will be deployed will be reviewed as the start of operation approaches.

WBS Element: 54	WBS Level: 3
WBS Title:	**Facility Timing and Synchronization**
Description:	The Facility Timing will provide events triggers to define the QPS shot cycle. We plan to use a PC/Labview system to generate the same timing signals that were provided on ATF (-30sec, -5sec, T0 and end-of-shot/abort). Timing signals will be passed over fiber optic cables. This same system will support multiple screens with various "comfort displays". A system from BNL (which is also used for the SNS project at ORNL and is planned for NCSX) is under consideration for future operations. We will investigate whether it's more appropriate to begin with the PC/Labview system or to install the BNL system immediately. The BNL system is a VME-based system which provides: 1. Timing granularity of 100 ns 2. Overall accuracy +/- 1us 3. 256 Event triggers 4. Fiber optic broadcast transmission Because the BNL system is also used for the SNS project at ORNL, we anticipate that the local experience in the system would greatly aid the implementation.

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WBS Element: 55	**WBS Level: 3**
WBS Title:	**Real Time Plasma and Power Supply Control**
Description:	The Plasma and Power Supply Control System (PPSCS) will control the coil currents in all power supplies plus the gas puff. There are 9 separate power supply control points (5 modular coils, 3 vertical coils and the ohmic solenoid current). The 10 subsystems will be controlled in a pre-programmed manner (i.e., no real-time feedback will be involved). The data acquisition system will include 10 digitizers for magnetic sensors. It is expected that this system will be based on the existing system used in the High Power Test Facility (HPTF) at ORNL. This system is a PC-based system using Labview and commercially available analog output boards. It provides an interactive waveform manager with the ability to save and recall selected waveforms for each subsystem. The existing system will be expanded to support the larger number of subsystems used in QPS and to support archiving the waveforms in the MDSplus data system.

WBS Element: 56	**WBS Level: 3**
WBS Title:	**Central Safety Interlock Systems**
Description:	The Central Safety Interlock System will provide system wide coordination of personnel and hardware interlocks and will be designed using fail-safe design techniques. Each QPS subsystem will interface with the Central Safety Interlock System. The subsystem WBS element will be responsible for ensuring the design of its interlocks and safety features are adequate. The Central Safety Interlock System will be a fail-safe, hybrid system. Mechanical components and hardwired devices will provide primary protective functions. To reduce the cost of system maintenance and to support flexible operational scenarios, secondary safety and interlock functions will use a redundant PLC system that will be distributed throughout the QPS facility.

WBS Element: 57	**WBS Level: 3**
WBS Title:	**Control Room Facility**
Description:	The QPS control room area is approximately 1500 sq. ft. This WBS includes the following elements: • Installation of 9 dual workstation tables wired for network and power. • Installation of 10-25 equipment racks wired for network and power. • Expandable closed circuit TV system with 3 cameras • Test Cell and control room PA system