

SNS 10000000-BL0002

Spallation Neutron Source Work Breakdown Structure Descriptors

November 2003



A U.S. Department of Energy Multilaboratory Project

SPALLATION NEUTRON SOURCE

Argonne National Laboratory • Brookhaven National Laboratory • Thomas Jefferson National Accelerator Facility • Lawrence Berkeley National Laboratory • Los Alamos National Laboratory • Oak Ridge National Laboratory

WBS Descriptor Form

WBS 1.02 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999

Title Project Support

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Provides overall management, integration, and coordination services to the SNS Project. This includes the services described in the Project Controls Manual for the SNS "Project Office" in the areas of procurement, business/finance, human resources, project controls, information management, environment, safety and health, systems engineering/design integration, and quality assurance.

WBS Descriptor Form

WBS 1.02.01 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999

Title Project Administration

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Provides overall management, integration, and coordination services to the SNS Project. This includes the services described in the Project Controls Manual for the areas of procurement, business/finance, human resources, project controls, and information management.

WBS Descriptor Form

WBS 1.02.01.01 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999

Title Project Administration

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Provides for overall project management and integration functions including the SNS Project Executive Director and staff, the Project Director and staff, and the Division Directors offices for the Accelerator, Experiment, and Facilities divisions. This element also includes the functions of finance, procurement, human relations, and associated administrative support (see following sheets).

WBS Descriptor Form

WBS 1.02.01.02 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999

Title Project Controls

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Provides for overall project controls functions including cost performance reporting, cost estimating, scheduling, change control, and management information systems.

WBS Descriptor Form

WBS 1.02.01.03 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999
Title Information Management

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Provides management and execution of information technology (IT) and information management (IM) for the Project Support staff as well as some centralized project-wide IT and IM functions including top-level web and intranet strategy, integration and dissemination of baseline information archive and establishment of a SNS virtual private network to enable multi-lab collaboration. Procuring desktop computers and network access for SNS staff is not provided in this WBS. Planning for those cost is distributed throughout the SNS teams. However, this WBS does provide consulting and assistance in making purchasing and configuration decisions. The most important functions of this WBS is to provide a project-wide coordination of IT and IM tasks, even though many of those tasks are executed in different WBS's. Another important function is to facilitate project management by the strategic use of advanced collaboration technologies to mitigate the difficulties of managing a geographically diverse project.

WBS Descriptor Form

WBS 1.02.02 **PCR** _____ **Revision** 1 **Revision Date** 10/20/2000

Title Design Integration & Systems Engineering

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Perform project wide integration activities and maintain project baseline. Perform project wide installation planning and coordination. Provides funding for Systems Integrations Manager, Systems Engineer-Accelerator, Systems Engineer-Target, Document Control Manager and a Information Technology Assistant. Also provides part-time support for an Information Management Analyst.

WBS Descriptor Form

WBS 1.02.02.01 **PCR** _____ **Revision** 1 **Revision Date** 10/20/2000
Title Design Engineering & Systems Engineering

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Perform project wide integration activities and maintain project baseline. Perform project wide installation planning and coordination.
Specific Tasks:

- Maintain the SNS Technical Baseline
- Develop and Implement SNS Level Installation Plan
- Resolve Technical Interface Conflicts between Systems and Partners
- Schedule and Conduct Design Reviews to Support SNS Project Milestones
- Support the Configuration Management Process to ensure the CR's reflect all technical impacts
- Represent the Project Office On Site during Construction
- Coordinate Project Office Approval of Acceptance Test Results
- Plan and Coordinate with Operations the Transition from Installation/Testing to Commissioning
- Develop and Implement SNS Project Strategy for adopting and enforcing Standards and Codes
- Develop and Implement SNS Project Strategy for Project Wide Procurement of Common Items

Provides funding support for the Systems Integration Manager, Systems Engineer-Accelerator, and the Systems Engineer-Target.

WBS Descriptor Form

WBS 1.02.02.02 **PCR** PCR PS 00 010 **Revision** 0 **Revision Date** 10/20/2000

Title Document Control Center and Records Management

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Develop, Implement and Operate the SNS Document Control System. Includes the selection, procurement, and implementation of a project wide electronic file management system

Provides funding to support the Document Control Manager and a Information Technology Assistant. Also provides part-time support for an Information Management Analyst.

WBS Descriptor Form

WBS 1.02.02.03 **PCR** _____ **Revision** _____ **Revision Date** _____

Title Electronic File Management

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS Descriptor Form

WBS 1.02.03 **PCR** PCR PS 00 010 **Revision** 0 **Revision Date** 7/13/1999
Title Environmental Safety & Health

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Provide SNS-wide ES&H coordination, integration, review, and oversight of the design, construction, and commissioning of the Project. Integrate the planning of ES&H issues into the design of the facility, including participation in design review. Coordinate SNS Integrated Safety Management System (ISMS) activities. Provide ES&H oversight of construction. Serve as the liaison with external ES&H review groups. Support commissioning, participate in and provide staff support to readiness reviews and readiness assessments, and develop the ES&H portions of the Commissioning Plan. Provide as-required ES&H reviews and training not specified in individual WBS elements. Provide management and direction of the Pre-operational ES&H staff.

WBS Descriptor Form

WBS 1.02.03.01 **PCR** PCR PS 00 035 **Revision** 1 **Revision Date** 10/3/2000
Title Safety Evaluation & Documentation

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Produce the safety documentation that supports the construction and operation of the SNS. Produce a Preliminary and Final Safety Assessment Documents for the facility with the exception of the Target. Develop the Accelerator Safety Envelop, and determine the safety operating characteristics of the SNS. Produce a Preliminary and Final Safety Assessment Report for the Target facility, and other reports as required by the Department of Energy. Develop Technical Safety Requirements for the operation of the Target facility. Provide the technical support, analyses, and acquire the independent reviews required for approval of the SNS safety documents.

WBS Descriptor Form

WBS 1.02.03.02 **PCR** PCR PS 00 035 **Revision** 0 **Revision Date** 7/13/1999
Title Plans & Permits

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Obtain regulatory permits required for construction and operation of the SNS. Develop early studies of appropriate management and treatment of wastes generated by SNS construction and operation. Develop ES&H Plans required by DOE and regulatory agencies, including D&D, Pollution Prevention, and Energy Conservation and Efficiency.

WBS Descriptor Form

WBS 1.02.04 **PCR** PCR PS 00 035 **Revision** 0 **Revision Date** 7/13/1999
Title Quality Assurance

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Quality Assurance system will ensure that the project conforms to requirements. Quality assurance and quality control activities include QA planning, software QA, procedures creation and control, QA orientation training, quality audits and surveillances, vendor quality program evaluations, acceptance criteria list development, inspection planning, procurement quality activities, dimensional inspection and nondestructive evaluations, oversight of configuration control, records, etc. Trained quality professionals and inspectors will guide the creation and operation of the quality system and do a large part of the verification. For the verification role, their objectivity and credibility depends on a degree of independence from the work being examined.

The Project Office will maintain the project-wide QA program, including the project QA Plan, project-wide procedures and controls, QA leadership through workshops and other training means, top-level audit and surveillance activity, the Acceptance Criteria Listing Database, quality tracking and trending, vendor quality history, and centralized reporting on quality aspects of the project. It will perform oversight of records and document controls, configuration control. This office will obtain and maintain inspection and test equipment, standards, and software that are necessary to perform the central project office QA function. Examples include gage blocks, an engineering workstation for CAD model review and markup, borescope, torque standard, etc.

QA professionals for Subprojects located at ORNL will report to the project QA Manager (either by matrix or line authority).

Assumptions about other parts of the Project-Wide Cost Estimate:

Each Subproject should provide a QA professional (part-time to multiple persons, depending on their scope). They will coordinate QA activities for the subproject, provide plans, procedures and controls specific to the subproject, provide subject matter expertise to the design staff, and perform appropriate audit and surveillance activities to ensure project requirements are met. They will review quality aspects of drawings, specifications, data sheets, procurement documents, vendor submittals, etc. They will be responsible for creation of acceptance criteria lists, oversight of the configuration control process, for deviation and nonconformance controls, and for quality statistics and reports. They will do evaluation of vendor QA programs by means of questionnaires, QA manual reviews, and onsite evaluations or audits when needed, and participate in resolution of quality problems when they arise.

Each Subproject 1.3-1.9 total budget estimate should include the costs of quality control inspection, nondestructive evaluations, vendor on-site inspection and acceptance inspections, etc. for fabricated or procured items in their scope. It is expected that inspectors may be drawn from laboratory or subcontractor pools on an as-needed basis, coordinated by the QA professional(s).

Quality Assurance should not be confused with Title III support. Title III support is a part of ED&I costs and covers engineering support for vendor evaluations, witnessing tests and inspections at vendor plants, approving test reports, performing tests and inspections at the site, etc. Engineering staff generally performs these activities. Quality assurance and quality control activities begin at the start of the project and continue in phase with design, fabrication/procurement, installation and commissioning.

In this strategy, most of the QA/QC costs will be built into the Subproject 1.3-1.9 estimates. 1.2.4 will only retain enough for a few quality professionals and clerical support.

Records management and operating support for the configuration control process are being picked up in Project Support.

WBS Descriptor Form

WBS 1.02.04.01 **PCR** _____ **Revision** _____ **Revision Date** _____

Title Quality Assurance

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS Descriptor Form

WBS 1.03 **PCR** PCR PS 00 035 **Revision** 1 **Revision Date** 10/25/2000
Title Front End Facilities

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Front End Systems WBS categories include all necessary equipment and apparatus to produce an appropriate beam of H- ions and inject it at the 2.5 MeV into the following linear accelerator (linac) chain for further acceleration to approximately 1 GeV. The four principal front end beam components include the H- ion source, a low energy beam transport system (LEBT), a radio-frequency quadrupole linac (RFQ), and a medium beam energy beam transport line (MEBT). Supporting technical components included also comprise the necessary diagnostics and instrumentation apparatus, temperature stabilization and control systems, vacuum subsystems, and support and alignment devices. Beam chopper systems are incorporated into the front end design to establish a gap in the beam for the extraction kicker in the accumulator ring. Chopping will be done in both the LEBT and MEBT. The MEBT chopper system, as well as the rf klystron and power systems for the RFQ, are not included within this scope, but are instead included in the work scope for WBS 1.4 (LINAC) since they are planned to designed and procured by LANL.

The Front End System requirements are established by the 2-MW overall specification for the SNS and are based on a peak H- current provided by the ion source of 70 mA with a projected MEBT output current of 56mA. The duty factor is 5.84% and the repetition rate is 60Hz.

R0 Title: Front End Facilities. Title changed to reflect current cost and schedule title. No PCR.

WBS Descriptor Form

WBS 1.03.01 **PCR** PCR PS 00 035 **Revision** 0 **Revision Date** 7/13/1999
Title Ion Source and LEBT

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Ion Source & Low Energy Beam Transport (LEBT) deliver a 65keV beam of H⁻ particles to the RFQ for the next stage of acceleration to 2.5 MeV. The ion source is a rf-driven multicusp system with a design current of 70mA of H⁻ beam. The ion beam is pulsed at a repetition rate of 60Hz with a duty factor of 5.84% (1-ms pulse length). The LEBT shapes the beam extracted from the source, accelerates it to 65 keV, and matches it into the RFQ. The LEBT consists of an electrostatic extraction gap followed by two einzel lenses. Unwanted electrons are suppressed/deflected from the beam by permanent magnets contained in the source outlet plate. A first stage of beam chopping is also carried out in the LEBT. Some diagnostic elements are provided as well as a compact gate valve isolating the Source/LEBT from the RFQ. The source gas flux will be pumped by a combination of turbo and cryo-pumps.

A total of 3 ion sources will be provided to ensure adequate operational periods can be maintained with a minimum of switchover time when sources are changed out during routine maintenance shifts. Only one LEBT is required.

WBS Descriptor Form

WBS 1.03.01.01 **PCR** PCR PS 00 035 **Revision** 0 **Revision Date** 7/13/1999

Title Mechanical Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Ion Source & LEPT Mechanical Systems contain the source and LEPT mechanical structures and housings, the mechanical subsystems (vacuum system, support structures, diagnostics, and the isolation gate valve) as well as the mechanical engineering and design activities.

WBS Descriptor Form

WBS 1.03.01.02 **PCR** PCR PS 00 035 **Revision** 0 **Revision Date** 7/13/1999

Title Electronic Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Ion Source & LEPT Electronic Systems contain the source and LEPT electronic support systems (Plasma start system, source and LEPT power supplies and chopping systems, diagnostic electronics, and safety system), as well as the electrical and electronic engineering and design activities.

WBS Descriptor Form

WBS 1.03.01.03 **PCR** PCR PS 00 035 **Revision** 0 **Revision Date** 7/13/1999

Title Systems Integration

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Ion Source & LEPT System Integration contains the source and LEPT mechanical and electronic assembly and testing activities. This includes the integrated testing program at LBNL, packing and shipping to ORNL, and installation and testing at ORNL prior to the start of commissioning with beam.
This WBS element also contains the 70mA source and LEPT upgrade activities.

WBS Descriptor Form

WBS 1.03.02 **PCR** PCR PS 00 035 **Revision** 0 **Revision Date** 7/13/1999
Title RFQ

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Radio Frequency Quadrupole (RFQ) accelerator bunches and accelerates the 65 keV H- beam and delivers a 2.5 MeV beam with minimum emittance increase to the MEBT. The focusing action for the RFQ is purely electrical, rather than magnetic. A 1.2 MW klystron will power the RFQ which is designed to operate at a 402.5 MHz rf frequency and a beam duty-factor of 5.84%; the peak power supplied by the rf system is approximately 0.8 MW under 56 mA beam-loading conditions. The overall RFQ structure is approximately 3.7 meters long, and is constructed in four nearly equal 0.9-1.0 meter long sections. The WBS 1.3.2 scope of work includes all necessary apparatus and equipment required for the complete RFQ (including all costs for engineering and design, construction, test, and installation at ORNL) with the exception of the rf klystron and power system which has been included in WBS 1.4 and is planned to be designed and procured by LANL (along with their identical DTL rf system). Vacuum systems, support and alignment systems, and the temperature controlled closed loop water systems are all included in this work.

WBS Descriptor Form

WBS 1.03.02.01 **PCR** PCR PS 00 035 **Revision** 0 **Revision Date** 7/13/1999

Title Mechanical Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

RFQ Mechanical Systems contain mechanical structures and housings, the mechanical subsystems (vacuum system, support structures, diagnostics) as well as the mechanical engineering and design activities.

WBS Descriptor Form

WBS 1.03.02.02 **PCR** PCR PS 00 035 **Revision** 0 **Revision Date** 7/13/1999

Title Electronic Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The RFQ Electronic Systems contain the electrical systems (waveguide system and rf windows, support structure, and safety systems), as well as the electrical and electronic engineering and design activities.

WBS Descriptor Form

WBS 1.03.02.03 **PCR** PCR PS 00 035 **Revision** 0 **Revision Date** 7/13/1999

Title Systems Integration

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The RFQ System Integration contains the mechanical and electronic assembly and testing activities. This includes the integrated testing program at LBNL, packing and shipping to ORNL, and installation and testing at ORNL prior to the start of commissioning with beam.

WBS Descriptor Form

WBS 1.03.03 **PCR** PCR PS 00 035 **Revision** 0 **Revision Date** 7/13/1999
Title MEBT

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Medium Energy Beam Transport (MEBT) comprises those components and systems necessary to transport the 2.5 MeV, 402.5 MHz rf-bunched and 1.188 MHz chopped beam from the RFQ to the Drift Tube Linac (DTL) structure in WBS element 1.4. The MEBT includes both transverse (14 electromagnet quadrupole magnets and their power supplies), and longitudinal focusing elements to match the beam from the RFQ into the DTL; further diagnostics and instrumentation apparatus, beam scrapers and monitors, vacuum equipment, and the support and alignment apparatus. Four rebunching cavities and their rf supplies are included to focus the beam longitudinally and provide the proper phase/energy-spread ratio to fulfill the requirements of the DTL. The MEBT chopper and anti-chopper apparatus are included in WBS 1.4 and are planned to be provided by LANL in their work scope. The vacuum enclosures and supports for the choppers are included in this WBS, 1.3.3, as well as the chopper target apparatus.

WBS Descriptor Form

WBS 1.03.03.01 **PCR** PCR PS 00 035 **Revision** 0 **Revision Date** 7/13/1999

Title Mechanical Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The MEBT Mechanical Systems contain the mechanical structures and housings, the transport systems (quadrupoles, rebunchers, chopper target), the mechanical subsystems (vacuum system, support structures, diagnostics, and cooling) as well as the mechanical engineering and design activities.

WBS Descriptor Form

WBS 1.03.03.02 **PCR** PCR PS 00 035 **Revision** 0 **Revision Date** 7/13/1999

Title Electronic Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The MEBT Electronic Systems contain the rf systems (for the rebunchers), power supplies (quadrupole and steering magnets), and beam diagnostic electronics, as well as the electrical and electronic engineering and design activities.

WBS Descriptor Form

WBS 1.03.03.03 **PCR** PCR PS 00 035 **Revision** 0 **Revision Date** 7/13/1999

Title Systems Integration

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The MEFT System Integration contains the mechanical and electronic assembly and testing activities. This includes the integrated testing program at LBNL, packing and shipping to ORNL, and installation and testing at ORNL prior to the start of commissioning with beam.

WBS Descriptor Form

WBS 1.03.04 **PCR** PCR PS 00 035 **Revision** 0 **Revision Date** 7/13/1999
Title Technical Support

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS 1.3.4, Technical Support, includes the Front End Systems project management costs, the engineering technical support and systems integration, QA, EH&S, the scheduling, budgeting, and reporting functions, accelerator physics support, administrative and clerical support, and the technical-support-related supplies and expenses (vehicles, space, electricity, telephones, computer recharges, etc.), and travel expenses. This work covers all these functions from their onset in FY1999 through the time of commissioning startup at ORNL at the end of FY2002

WBS Descriptor Form

WBS 1.03.04.01 **PCR** PCR PS 00 035 **Revision** 0 **Revision Date** 7/13/1999

Title Management

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Technical Support, Management, covers the time for the Front End Systems Sr. Team Leader and a small fraction of the LBNL IBT Program Head.

WBS Descriptor Form

WBS 1.03.04.02 **PCR** PCR PS 00 035 **Revision** 0 **Revision Date** 7/13/1999

Title Engineering

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Technical Support, Engineering Support, covers the time for the Front End Systems Project Manager, the Chief Engineer, Systems Integration Engineering, EH&S and QA, and the cost for the Budget and Reporting Manager.

WBS Descriptor Form

WBS 1.03.04.03 **PCR** PCR PS 00 035 **Revision** 0 **Revision Date** 7/13/1999

Title Physics

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Technical Support, Physics Support, covers the time for the Front End Systems Accelerator Physicist and Ion Source Physicist; necessary support from these individuals is covered here for R&D oversight, construction direction and oversight, and commissioning.

WBS Descriptor Form

WBS 1.03.04.04 **PCR** PCR PS 00 035 **Revision** 0 **Revision Date** 7/13/1999

Title Administrative

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Technical Support, Administrative Support, covers the time for the Front End Systems Administrative and Clerical Support

WBS Descriptor Form

WBS 1.03.04.05 **PCR** PCR PS 00 035 **Revision** 0 **Revision Date** 7/13/1999

Title Travel and S&E Support

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Technical Support, Travel and S&E Support, covers the cost for the Front End Systems travel and the supplies and expenses in support of the project (space, electricity, vehicles, phones, etc.).

WBS Descriptor Form

WBS 1.03.05 **PCR** PCR OP 01 008 **Revision** 1 **Revision Date** 10/12/2001

Title FE Field Coordination

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS account contains additional ORNL field coordination and technician labor required to achieve an efficient installation, pre-acceptance testing and commissioning of the Front End.

This activity is in addition to normal Title II supervision as it covers the transition to ORNL of the responsibility for these activities.

WBS Descriptor Form

WBS 1.03.05.01 **PCR** PCR OP 01 008 **Revision** 1 **Revision Date** 10/12/2001

Title FE Field Coordination

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS account contains additional ORNL field coordination and technician labor required to achieve an efficient installation, pre-acceptance testing and commissioning of the Front End. This activity is in addition to normal Title II supervision as it covers the transition to ORNL of the responsibility for these activities.

WBS Descriptor Form

WBS 1.03.05.02 **PCR** PCR OP 01 008 **Revision** 0 **Revision Date** 10/12/2001

Title FE Spares

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Spare parts and components for testing and commissioning the front-end system on the SNS site.

WBS Descriptor Form

WBS 1.03.06 **PCR** PCR OP 01 008 **Revision** 0 **Revision Date** 10/12/2001

Title FE Installation

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Labor and M&S to install and test the front -end system on the SNS site.

WBS Descriptor Form

WBS 1.04 **PCR** PCR SN 01 006 **Revision** 3 **Revision Date** 12/21/2001
Title Linac Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Linac system is responsible for providing the necessary equipment to accelerate the beam from the output of the front end systems (WBS 1.3) at 2.5 MeV to the final energy of approximately 1 GeV for insertion into the ring system (WBS 1.5). The other major interfaces of the Linac system are with the facility (structural support, electrical power, HVAC, water for component cooling) and with the control system (WBS 1.9). WBS 1.4 includes Title 1 and Title 2 design, pre-production articles (where appropriate), fabrication, assembly, installation, component/subsystem tests, and some beam commissioning support. Also included in WBS 1.4 are the MEBT chopper, the RF system for the RFQ, two special RF HEBT cavities and their RF system, and the diagnostics for the Linac dump beam line.

Selected Linac Parameters

Energy & average current	1 GeV; 2.1 mA
Macropulse repetition rate	60 Hz
Macropulse length	0.97 ms
Beam-gate duty factor	6.0%
Chopper transmission & period	65%; 945 ns
Chopper rise time	10 ns
Beam loss	< 1 W/m
Transverse emittance (pi-mm-mrad)	0.26 @ 2.5 MeV; 0.045 @ 1 GeV
Long. emittance (deg-MeV @ 402 MHz)	0.126 @ 2.5 MeV; 0.26 @ 1 GeV
Peak 805-MHz RF power demand	56 MW from 14 5-MW klystrons 12 for Linac; 2 for HEBT cavities
RF frequency	402.5 MHz (<86.8 MeV); 805 MHz
Front-end and Linac length	332m

WBS Descriptor Form

WBS 1.04.01 **PCR** PCR SN 01 006 **Revision** 3 **Revision Date** 12/21/2001
Title RF Power Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS 1.4.1 provides complete RF power systems for the RFQ, DTL, CCL, SRF, HEBT cavities, and RF lab at SNS. For the accelerator there are seven 402.5 MHz, 2.5 MW klystrons, and 6 805 MHz, 5-MW klystrons, and 81 550KW klystrons. There are 27 transmitter systems and 17 IGBT-based high-voltage power systems for the accelerator, including one for the RF lab. Some installation spares are provided.

There is one RF control system for each klystron in the normal-conducting and super-conducting linac. This WBS includes waveguide runs (including as necessary splitters, loads, phase shifters, and circulators between the klystron and the RF structure. The RF reference and distribution systems are in this WBS. All components are assumed to be commercially fabricated, with assembly/test/installation/conditioning done by laboratory or Davis-Bacon labor, as appropriate. The klystrons will be developed by industry. The converter/modulator, transmitter controls, and low-level RF will be developed by the lab and procured on a best value basis.

WBS Descriptor Form

WBS 1.04.01.01 **PCR** PCR SN 01 006 **Revision** 3 **Revision Date** 12/21/2001
Title RF Power Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Provides for the 402.5 MHz and 805 MHz high power RF systems, including transmitter (klystron tube and oil tank), transmitter controls, and rf transport (waveguide, splitters, phase shifters, and circulator).

For the 402.5 MHz klystrons, activities include: preparing specification, bidding and drawing package for 402.5 MHz Klystrons; buying and testing the 402.5 MHz klystrons for the RFQ RF System; procuring 402.5 MHz klystrons for the DTL System, conducting random reviews and factory tests, and installing the two 402.5 MHz Klystrons at SNS.

For the 805 MHz klystrons, activities include: writing the final specification for the 550KW and 5MW 805 MHz Klystrons; performing final design of the klystrons, including tank lids and socket details with information from vendors; purchasing 88 550KW and 9 5MW klystrons and travel labor in support of vendors; and installing and testing the first 550KW and 5MW 805 MHz Klystrons at SNS.

This WBS also includes design, procurement, and installation of the transmitter oil tank and cooling system. For the transmitter controls, activities include preliminary and final design of the 402.5/805 MHz transmitter controls, and PLC computer (software) design within the transmitter rack. Also includes fabrication, installation and testing of racks for :

- 14 each LINAC (SRF)
- 4 each LINAC (CCL)
- 7 for DTL/Front-end
- 2 each for HEBT Cavities
- 2 each for Electronics Labs

The RF Transport System is responsible for delivering the RF power generated by each main amplifier to the accelerating cavities. The basic architecture for each transport line is:

- optical arc detectors
- harmonic filter
- directional couplers
- wave guide switch and dummy load (for amplifier tune-up)
- circulator and circulator load
- splitter
- window (Normal-conducting only)
- wave guide sections, supports, flanges, elbows, & bends

This WBS provides for the design of the 402.5 MHz RF transport, final waveguide layouts, purchase of prototype RF windows, and specification/purchase of water loads and all 402.5 waveguide components, including 6 windows and 7 circulators. It also includes installation of the first two 402.5 MHz RF transport systems and circulators at SNS. WBS 1.3 includes a circulator for the RFQ klystron.

For the 805 MHz systems, the WBS encompasses design and layout of the waveguide system, ordering and testing prototype windows high power (normal-conducting only), finalizing the layout of wave guide, specifying individual components, purchasing all RF transport components, installing the first of each 805 MHz RF Transport systems at SNS, and training SNS personnel to gradually take over.

WBS Descriptor Form

WBS 1.04.01.02 **PCR** PCR SN 01 006 **Revision** 3 **Revision Date** 12/21/2001
Title High Voltage Power Conditioning

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Provides for the design, fabrication, and installation of the high voltage converter/modulator. The high voltage converter/modulator provides precise feedback controlled modulation of klystron cathode voltage. Each system:

- Operates directly from 13.8KV utility grid
- Contains power factor correction and line harmonic filters
- Generates 80 KV (super conducting) or 140 KV (normal conducting), 1.25 ms klystron pulses

The system has 1.1 MVA ratings (7.5% duty).

For the high voltage converter/modulator system, preliminary and final design activities include design of 1. Model, 2. Utility Conversion, 3. Modulator Enclosure, 4. DC Energy Storage & Conditioning, 5. high voltage converter/modulator Network Design/FAB, and 6. Output Network; and developing a contract for an industrial partner. WBS also includes assembly, and vendor oversight and QA costs for all high voltage converter/modulator subassemblies and main assembly, based on the following quantities:

DTL/Front-End - 3 each
 CCL - 4
 SRF- 8
 HEBT - 2
 Electronics Lab - 1

WBS also includes leading the installation and testing of the RFQ/DTL1, DTL 2, and the first superconducting systems. WBS provides for mentoring with the installation and testing of the first CCL system system and consulting support on the installation and testing of all remaining systems.

Specific high voltage converter/modulator subassemblies are: the substation transformer, a 20 KHz poly-phase transformer sub-assembly, high voltage filter network, and mechanical assemblies.

R0 WBS Title: 805 MHz RF Systems

WBS Descriptor Form

WBS 1.04.01.03 **PCR** PCR SN 01 006 **Revision** 3 **Revision Date** 12/21/2001
Title RF Controls

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

LLRF Requirements are: - Goal of $\pm 0.5\%$, $\pm 0.5^\circ$ Cavity Field Control Steady State (The trip point at which the beam is disabled will be about $\pm 0.75\%$, $\pm 0.75^\circ$) - Maintain control during transients (e.g. beam turn-on) - Handle fault situations -loss of beam -arcing in accelerator cavity -arcing in RF transport -etc. - Resonance control. This WBS provides for designing and original testing, and fabricating of the seven RF control system hardware for the 402.5 MHz, four 5 MW 805 MHz normal conducting systems and 81 550 KW 805 MHz superconducting systems. This includes design and prototyping of individual modules, designated as the Clock Distribution Module (CDM), the Field & Resonance Control Module (FRCM), and the HPRF Protect Module (HP). These modules are to be housed in a VXibus chassis with intrasystem cabling. Testing individual modules is included. Also included is the specification of all of the system cables necessary including the reference line. This includes field pickup cables, HPRF Protect power monitors, klystron drive, etc. The High Frequency RF Reference Distribution system, which runs the length of the tunnel, will provide: - 755 MHz, 0.1° phase stability (@755MHz), 332 m long - Multiple, variable coupling taps - Line type: 3.125" rigid copper coax; insulated and temperature controlled (to within 1°C) - Line length: 20' sections with slip joints. This WBS provides for the design and original prototype testing of the RF reference and its distribution system. It also includes purchasing the RF Reference System components.

WBS Descriptor Form

WBS 1.04.01.04 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001

Title System Design & Interface

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The system design and interface WBS element is intended to cover the integration of the preceding WBS elements. In the RF WBS architecture, all oversight (RF Group Leader) and integration resources (labor and materials) are contained here.

R0 WBS Title: RF Transport System
R0 WBS information merged into revised 1.4.1.1.

WBS Descriptor Form

WBS 1.04.01.05 **PCR** PCR LI 00 003 **Revision** 0 **Revision Date** 2/24/2000
Title Bunch Rotator RF Power

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Provides for the design of two HEFT RF Systems; and the procurement and installation of 2 1-MW 805 MHz klystron and wave guide components for the HEFT system. Wave guide components are the same type of 805 MHz run in WBS 1.4.1.4 (less splitter and load) with phase shifter, plus approximately 100 feet more wave guide to get to the HEFT Cavities

WBS Descriptor Form

WBS 1.04.02 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001

Title DTL Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Drift Tube Linac system accelerates the beam from the output of WBS 1.3 Front end systems (2.5 MeV) up to an energy of 86.8 MeV. It is a six-tank, 36.5 meters long, 402.5 MHz structure, and provides an accelerating gradient of 1.13-3.77 MV/m. The 216 drift tubes either contain a permanent magnet quadrupole to provide focusing or a diagnostic/steering device (diagnostics are part of WBS 1.4.5.2). The associated cooling water and vacuum systems and support stands are included.

WBS Descriptor Form

WBS 1.04.02.01 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001
Title DTL Subsystem Integration

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Drift Tube Linac system accelerates the beam from the output of WBS 1.3 Front end systems (2.5 MeV) up to an energy of 86.8 MeV. The contents (function, interface resource requirements) of the level four elements will be discussed individually. The integration WBS element is intended to cover the integration of the subsequent WBS elements. In the DTL WBS architecture, all oversight (DTL lead engineer) and integration resources (labor and materials) are contained here.

The resources contained in this WBS cover the tasks in the programmatic period between the start of the construction project and the beginning of commissioning with beam (WBS 1.10). This includes mechanical checkout through RF conditioning without beam.

WBS Descriptor Form

WBS 1.04.02.03 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001
Title DTL Drift Tube Assemblies

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS contains the resources necessary to design, analyze, fabricate, and test the DTL drift tube assemblies. DTL drift tube assemblies include a drift tube body, a stem assembly, a permanent magnet quadrupole (where applicable), a electromagnet dipole (where applicable), mounting assemblies, Rf/vacuum seals, and fasteners.

The DTL Drift Tube assembly WBS is responsible for providing the permanent magnet quadrupoles (PMQ) and the electromagnet dipoles which fit inside the drift tubes and endwalls providing beam focusing and steering. A total of 149 PMQ's and 12 dipoles are required by the DTL. The WBS 1.4.2.2 Rf Structure provides the interfaces and supports required for each drift tube assembly and endwall PMQ.

This WBS is responsible for the design, fabrication, and testing of drift tube prototypes and mount assemblies to be used to create and validate a manufacturing process plan to aid the design and fabrication of the production drift tube assemblies.

This WBS is responsible for measuring the magnetic harmonics of the magnet assemblies and develop processes that ensure that the PMQ magnetic harmonics are not disturbed during the fabrication process. Also, required is a magnetic center mapping test of each PMQ drift tube assembly prior to assembly into WBS 1.4.2.7 DTL Assembly, this will facilitate the drift tube to drift tube longitudinal and transverse alignment. Drift tube alignment is covered in WBS 1.4.2.7 DTL Assembly.

WBS Descriptor Form

WBS 1.04.02.04 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001
Title DTL Vacuum System

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS provides for the design, analysis, fabrication, assembly, installation, and testing of the DTL vacuum system (pumps, hardware, instrumentation, controls, etc.). The system must provide a sufficient vacuum for the RF environment and minimize beam stripping and associated activation.

Technical Specifications include:

Parameters	Description
Base Pressure	2.0E-7 Torr
Gas Load (pre-conditioned)	2.5E-9 Torr L/s/cm ²
Gas Load (conditioned)	<1E-10 Torr L/s/cm ²

The Drift Tube Linac Vacuum WBS is responsible for providing adequate pumping of the drift tube tanks to minimize beam interaction with foreign particles which can, over the long term, lead to activation of the accelerator and degradation of the focusing permanent magnet quadrupoles. The DTL tanks have major vacuum subassemblies attached directly to mating flanges on the exterior of the DTL tanks shell. Each major subassembly is comprised of an ion pump, which provides the vacuum during operation. Each vacuum sub assembly will be structurally supported by elements from WBS 1.4.2.6 and connected to the Linac control system by cables between the vacuum pumps, gauges and valve controllers and the cards in the control system.

WBS Descriptor Form

WBS 1.04.02.05 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001
Title DTL Water System

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS provides for the design, analysis, fabrication, assembly, installation, and testing of the DTL water-cooling system that removes waste heat from the RF structures and magnets, and provides active resonance control of the Linac.

The technical specifications are:

Water Design Parameters	Description
Heat Load (total for drift tubes, post coupler, slug tuner, tank)	240 kW (40 kW per tank)
Flow Rate (total for drift tubes, drive loop, wall)	360 gpm
Water Delivery Temperature/Stability	TBD

The Drift Tube Linac Water System WBS is responsible for providing controlled thermal cooling de-ionized water for resonance control of the DTL structure (including end walls and drift tubes). The subsystem is comprised of an input manifold system, an equivalent return system, a circulation pump & distribution system, a heat exchanger with the facility system, and a series of flow meters, pressure gauges, and thermocouples.

Water cooling system features include:

- Closed-loop, modular water-cooling and resonance control system
- Loops for DTL RF structure and magnets/drift tubes (6 cooling carts total)
- Loops interface with RF structures at flow ports and with the facility at the chilled water main
- Loops remove waste heat from RF structures (cavity walls, drift tubes, etc.)
- Loops control Linac resonance through temperature control of RF structure (via water temperature control).

WBS Descriptor Form

WBS 1.04.02.06 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001
Title DTL Mechanical Support & Alignment

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Drift Tube Linac Mechanical Support & Alignment System WBS is responsible for providing structural connection between the tunnel and the accelerating structure including the vacuum and water cooling systems. In providing this support the system is also responsible to ensure proper location adjustably and alignment of the DTL with respect to other beam line components within the LINAC tunnel.

The support structure shall provide restraint due to seismic and static loads and meet stability requirements. Seismic analysis to meet SRD-1999-00008-R3. WBS 1.4.2.2 DTL Rf structures is responsible for providing adequate space and interfaces for the structural support connections in this WBS. This WBS is responsible for providing adequate support and interfaces for WBS 1.4.2.4 Vacuum systems and WBS 1.4.2.5 Water System that are not connected or supported by WBS 1.4.2.2 DTL Rf structures. This WBS will provide a rigid connection to the LINAC tunnel floor. WBS 1.8 will be responsible for providing the appropriate interface (i.e. embedment plates, studs etc...) to the mechanical support legs.

WBS Descriptor Form

WBS 1.04.02.07 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001
Title DTL System Assembly

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS will assemble all DTL components from WBS 1.4.2.2 Rf structure, WBS 1.4.2.3 Drift tube assemblies, WBS 1.4.2.6 Mechanical systems, and portions of WBS 1.4.2.5 Water systems and WBS 1.1.2.2 DTL cold model into 6 DTL tank assemblies.

This WBS will be responsible for providing longitudinal and transverse drift tube and endwall alignment required for proper beam acceleration.

This WBS is responsible for the low power tuning of each DTL.

This WBS is responsible for design and fabrication of shipping containers including packaging and shipping completed DTL assemblies to ORNL.

WBS Descriptor Form

WBS 1.04.02.08 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001
Title DTL Installation

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS contains the resources necessary to assemble, transport to tunnel, install, and align 6 DTL tank assemblies into the LINAC tunnel.

This WBS will assemble all remaining DTL components from WBS 1.4.2.6 Mechanical systems, WBS 1.4.2.5 Water systems, and WBS 1.4.2.4 DTL Vacuum systems.

This WBS will be responsible for installing and locating all 6 DTL tank assemblies from WBS 1.4.2.7 into the LINAC tunnel including providing longitudinal and transverse alignment, with respect to a global coordinate system or to the appropriate component(s).

WBS Descriptor Form

WBS 1.04.02.09 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title DTL Cold Model

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS contains the resources necessary to assemble, install, and align the DTL Cold Model.

WBS Descriptor Form

WBS 1.04.03 **PCR** PCR LI 00 003 **Revision** 0 **Revision Date** 2/24/2000
Title CCDTL Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Cavity Coupled Drift Tube Linac (CCDTL) system accelerates the beam from the output of WBS 1.4.2 DTL Systems at 20 MeV to a final energy of 79 MeV. It operates at 805 MHz and has a focusing lattice of 6 beta-lambda. Focusing is done by a total of 85 electromagnetic quadrupoles. The RF structure is comprised of two modules containing 84 segments, each being two-cavity, 3 beta-lambda units, with 3-beta-lambda intersegment spaces. The CCDTL aperture radius is 1.5 cm. The associated vacuum system, cooling water system, magnets (quads and steering dipoles), and support stands are included.

WBS Descriptor Form

WBS 1.04.03.01 **PCR** PCR LI 00 003 **Revision** 0 **Revision Date** 2/24/2000
Title CCDTL Systems Integration

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Coupled Cavity Drift Tube Linac (CCDTL) system accelerates the beam from the output of WBS 1.4.2 DTL Systems at 20 MeV to a final energy of 79 MeV. The contents (function, interfaces, resource requirements) of these level four elements will be discussed individually later. In the CCDTL WBS architecture, all oversight (CCDTL lead engineer) and integration resources (labor and materials) are contained in this WBS element.

The resources included in this WBS cover the tasks up to the point the CCDTL is properly assembled and installed in the tunnel at ORNL, checked out (mechanically, structurally, electrically, hydraulically, pneumatically) including support of RF conditioning, but stopping before any subsystem commissioning with beam begins.

WBS Descriptor Form

WBS 1.04.03.02 **PCR** PCR LI 00 003 **Revision** 0 **Revision Date** 2/24/2000
Title CCDTL Linac Structure

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Coupled Cavity Drift Tube Linac Structure WBS contains the resources necessary to design, fabricate, install, and functionally checkout the portion of the CCDTL structure that will see RF fields (accelerating cells, coupling cells, drift tubes and their support structure).

The CCDTL system captures and accelerates the beam from 20 MeV to 79 MeV in an 805 MHz resonant structure. Design features include:

- two modules, 82 segments, 83 quadrupole magnets (includes quad at 20 MeV between DTL and CCDTL)
- Segments are 2-Cavity, 3beta-lambda, units with 3 beta-lambda intersegment spacing.
- Linac bore radius : 1.5cm
- Total Length – 52.7 meters
- Copper material stock ~ 72,000 lbs.
- Cavity Water System thermal load – 0.401 MW continuous

Each segment is approximately one meter long and consists of accelerating cells, coupling cells, drift tube assemblies, and inter-segment beam hardware. The inter-segment beam hardware will include beam diagnostics and be installed during the build up of a module, but the interface will be purely structural. The diagnostics WBS will be responsible for all resources to develop the design for these beam diagnostics, as well as resources to provide the interface between the diagnostics and the control system. The resources to cover the design and installation of thermocouples in the structure are included.

WBS 1.4.3.6 Mechanical Support & Alignment provides structural attachment between the segments and the tunnel floor. The interface with this other WBS element is at the hard points on the external surface of the segment (owned by the CCDTL structures). WBS 1.4.3.5 Water System provides thermal control water to the CCDTL structure and drift tubes to maintain cavity resonance control. The interface between these two subsystems is at the external flanges on the sidewalls of the segments and at the input couplings of each drift tube-cooling loop. The water system WBS is responsible for all equipment (i.e., circulation pumps, distribution piping, flow control & monitoring) from the facility water system to the tank and drift tubes. Similarly, the interface with WBS 1.4.3.3 Vacuum System is at the conflat flanges on the exterior of the segment (owned by the structure WBS) and the mating flange and vacuum pump system (pumps, roughing ports, isolation valves, controllers, etc.) whose resources are kept in the vacuum system WBS. The next interfacing system is the RF transport system. WBS 1.4.1.4 RF Transport System contains equipment to interface with a stub RF section which is part of the CCDTL structures WBS (the stub section is comprised of a tapered transition from waveguide to input iris on the side of an accelerating cell in a segment). Two of these stub sections are required per RF module. In addition to the stub drive sections, the RF power system also has two cavity field sensors per module. Like the other diagnostics, the structure simply provides a place for these sensors in the structure, with all subsequent resources to design and install the sensors costed in the RF power WBS.

Other interfaces include the inter-segment focusing magnets. These magnets will be installed around the inter-segment beam pipe and aligned. The main structural support will come from WBS 1.4.3.6 Mechanical Support & Alignment. During design and fabrication, close coordination between efforts will be required to ensure proper integration between all the CCDTL level four WBS accounts. The structures account will provide support and alignment of these items with the diagnostics account responsible for subsequent interfaces with other systems (i.e., instrumentation & control systems). Resources to oversee this integration effort (lead engineer for the CCDTL) are book kept in the integration account.

The remaining interfacing systems deliver beam to, and transport it from, the CCDTL structure. Delivering beam to the CCDTL structure is WBS 1.4.2 DTL Systems, with an interface at the external beam pipe flange of the last DTL tank. All necessary connection hardware for this junction is in the DTL structures WBS 1.4.2.2. Transporting the accelerated beam from the last CCDTL segment to the next accelerating component, WBS 1.4.4 Coupled Cavity Linac (CCL) Systems, is an inter-segment section which is part of the CCL structures WBS. The CCDTL structures account is responsible to provide a mating flange on the end wall of the last segment and all connection hardware to connect to the CCL system.

WBS Descriptor Form

WBS 1.04.03.03 **PCR** PCR LI 00 003 **Revision** 0 **Revision Date** 2/24/2000
Title CCDTL Magnet System

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS provides for the design, analysis, fabrication, assembly, installation, and testing of the CCDTL the Electro-magnetic quadrupoles (EMQ's) and associated power supplies which provide the required beam focusing between segments. Like the segments themselves, there are 82 EMQ's to provide focusing after exiting an accelerating segment. The quadrupoles straddle the RF coupling cavities. Also included in this WBS are steering dipoles and associated power supplies.

The magnets will have to be properly aligned during the integration of the CCDTL segments. WBS 1.4.3.6, which contains the necessary resources to properly anchor, provides the proper structural support for the EMQ's the magnets to the same structural support system as the accelerating segments. Other interfaces include the electrical connection between the power supply control system and the Linac control system (WBS1.9.4) and the interface with Diagnostics (WBS 1.4.5.2). As with other connections to the control system, the magnet system is responsible for all resources necessary (cables and connectors) up to the back of the control system cards. The last interface is with the facility electrical system. This interface is at the power supply electrical power input with the facility system responsible for providing the resources to ensure a proper connection.

WBS Descriptor Form

WBS 1.04.03.04 **PCR** PCR LI 00 003 **Revision** 0 **Revision Date** 2/24/2000
Title CCDTL Vacuum System

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS provides for the design, analysis, fabrication, assembly, installation, and testing of the CCDTL vacuum system (pumps, hardware, instrumentation, controls, etc.) that provides a sufficient vacuum for the RF environment and minimizes beam stripping and associated activation.

Technical Specifications include:

Parameters	Description
Base Pressure	1.0E-7 Torr
Gas Load (pre-conditioned)	2.5E-9 Torr* L/s/cm ²
Gas Load (conditioned)	<1E-10 Torr L/s/cm ²

The vacuum system is responsible for providing adequate pumping of the CCDTL segments to minimize beam interaction with foreign particles, which can, over the long term, lead to activation of the accelerator and degradation of the focusing electromagnet quadrupoles. The pumping is accomplished through a plenum that spans one complete RF module of accelerating segments. Attached to this plenum, at roughly 3-meter intervals, are vacuum pump subassemblies. Each major subassembly is comprised of an ion pump, which provides the vacuum during operation. Each vacuum sub assembly will be structurally supported by elements from WBS 1.4.3.6 and connected to the Linac control system by cables between the vacuum pumps, gauges and valve controllers and the cards in the control system.

WBS Descriptor Form

WBS 1.04.03.05 **PCR** PCR LI 00 003 **Revision** 0 **Revision Date** 2/24/2000
Title CCDTL Water System

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS provides for the design, analysis, fabrication, assembly, installation, and testing of the CCDTL water cooling system that removes waste heat from the RF structures and magnets, and provides active resonance control of the Linac.

Technical specifications are:

Water Design Parameters	Description
Heat Load (total per module)	~250 kW
Flow Rate (total per module)	~408 gpm
Water Delivery Temperature/Stability	24.9 C (76.7°F)/0.38 C

The CCDTL Water System WBS is responsible for providing controlled thermal cooling for resonance control of the CCDTL structure (accelerating cells and drift tubes). The subsystem is comprised of an input manifold system, an equivalent return system, a circulation pump & distribution system, a heat exchanger with the facility system, and a series of flow meters, pressure gauges, and thermocouples.

The input and return interfaces are at the fittings on the external surface of the CCDTL structure, with this WBS account responsible for all interface hardware between the structure and the water system. Interfaces with facility water for the heat exchanger, and for water system makeup, are at the input flanges on the specific CCDTL water system components (similarly, all interface hardware is included in this WBS account). The control system interface mirrors the other CCDTL WBS elements in that the water system is responsible for providing cables from the various gauges, meters and pumps back to standard interface cards (owned by the controls WBS). The last major interface is with the facility itself which is required to provide suitable mounting hard points to allow the water system equipment to be properly installed and supported (including end walls and drift tubes). The subsystem is comprised of an input manifold system, an equivalent return system, a circulation pump & distribution system, a heat exchanger with the facility system, and a series of flow meters, pressure gauges, and thermocouples.

Water cooling system features include:

- Closed-loop, modular water-cooling and resonance control system
- 4 loops for CCDTL RF structure
- Magnets cooled by separate deionized water cart
- Loops control Linac resonance through temperature control of RF structure (via water temperature control).

WBS Descriptor Form

WBS 1.04.03.06 **PCR** PCR LI 00 003 **Revision** 0 **Revision Date** 2/24/2000
Title CCDTL Mech. Support & Alignment System

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS provides for the design, procurement, fabrication, and integration of the mechanical support & alignment system with the balance of the CCDTL system. The system is responsible for providing structural connection between the tunnel and the accelerating structure and its auxiliary systems (vacuum, & thermal control). In providing this support the system is also responsible to ensure proper alignment of the CCDTL segments.

The resources included in this WBS cover the tasks up to the point the CCDTL is properly assembled, installed in the tunnel at ORNL and checked out (mechanically and structurally) including support of RF conditioning, but stopping before any subsystem commissioning with beam begins.

WBS Descriptor Form

WBS 1.04.04 **PCR** PCR SN 01 006 **Revision** 3 **Revision Date** 12/21/2001
Title CCL Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Cavity Coupled Linac (CCL) system operates at 805 MHz and accelerates the beam from the output of WBS 1.4.2 DTL Systems at 86.8 MeV to an energy of 185.6 MeV, as input to WBS 1.4.10 Medium-Beta Cryomodule. It is approximately 57 meters long and consists of four modules. Each module is composed of twelve, 8-cavity segments. There are 768 half-cells in the 8-cavity system. The focusing lattice is 13 beta-lambda throughout, with intersegment spacing of 2 beta-lambda. The electromagnetic quadrupoles provide focusing. The bore radius is 2.0 cm. The vacuum systems, water-cooling systems, magnets, and mechanical support structure are included as subsystems.

WBS Descriptor Form

WBS 1.04.04.01 **PCR** PCR SN 01 006 **Revision** 3 **Revision Date** 12/21/2001
Title CCL Subsystem Integration

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Coupled Cavity Linac (CCL) system accelerates the beam from the output of WBS 1.4.2 DTL Systems at 86.8 MeV to an energy of 185.6 MeV, as input to WBS 1.4.10 Medium-Beta Cryomodule. In the CCL WBS architecture, all oversight (CCL lead engineer) and integration resources (labor and materials) are contained in this element.

The resources included in this WBS cover the tasks up to the point of handout to ORNL ASD as defined in the official hand-off document. Typically this handoff follows the lead, mentor, consult model where LANL leads the initial activity in each subsystem area and gradually turns ownership to their counterparts at ORNL as feasible.

WBS Descriptor Form

WBS 1.04.04.02 **PCR** PCR SN 01 006 **Revision** 3 **Revision Date** 12/21/2001
Title CCL Linac Structure

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Coupled Cavity Linac Structure WBS contains the resources necessary to design, fabricate handoff the assembly and installation of the RF Structure. The RF structure is defined as that portion of the CCL structure that will see RF fields (accelerating cells, coupling cells, and their support structure).

The CCL captures and accelerates beam from 86.8 MeV to 185 MeV. Design features include:

4 Modules, 48 segments, 44 bridge couplers, and 48 EMQ's

8-Cell Cavity Segments of 4 beta-lambda each with 2.5 beta-lambda intersegment spaces containing the bridge couplers and various diagnostics and EMQ's.

Powered bridge couplers between the segments allowing two rf feeds per module

Beam Aperture: 2.0 cm

Thermal load: 0.8 MW continuous

The CCL structure is comprised of 48 segments arranged in four modules of twelve. Each segment and modules interfaces with the five other WBS level four elements under the WBS 1.4.4 CCL System. Each segment is approximately .6 to .8 meters long and consists of accelerating cells and intra-segment power coupling cells. Between the segments are the inter-segment regions that contain the bridge couplers and inter-segment beam pipe assemblies. The inter-segment beam pipe will contain beam diagnostics and be installed during the final assembly of a module. WBS 1.4.4.6 Mechanical Support & Alignment provides structural attachment between the segments and the tunnel. The interface with this other WBS element is at the hard points on the external surface of the segment (owned by the CCL structures). WBS 1.4.4.5 Water System provides thermal control water to the CCL structure to maintain cavity resonance. The interface between these two subsystems is at the external flanges on the side walls of the segments, with the water system WBS responsible for all equipment (i.e., circulation pumps, distribution piping, flow control & monitoring) between the facility water system and the CCL. Similarly, the interface with WBS 1.4.4.3 Vacuum System is at the conflat flanges on the exterior of the segment (owned by the structure WBS) and the mating flange and vacuum pump system (pumps, roughing ports isolation valves, controllers, etc.) whose resources are kept in the vacuum system WBS. The next interfacing system is the RF transport system. WBS 1.4.1.4 RF Transport System contains equipment up to the interface with a stub RF section (waveguide transition section) which is part of the CCL structures WBS (the stub section is comprised of a special tapered transition from waveguide to input iris on the side of an accelerating cell in a segment). Two of these stub sections is required per RF module (8 in total). The direct interface to the waveguide transition section is the rf window in the RF WBS. In addition to the stub drive sections, the RF power system has two cavity field sensors per module. Like the other diagnostics, the structure simply provides a place for these sensors, with all subsequent resources to design, and install the sensors accounted for in the RF power WBS.

Other interfaces include the inter-segment focusing magnets. These magnets will be installed around the inter-segment beam pipe and aligned. During design and fabrication close coordination between efforts will be required to ensure proper integration between all the CCL level four WBS activities. The remaining interfacing systems deliver beam to and transport it from, the CCL structure. Delivering beam to the CCL structure is WBS 1.4.2 DTL Systems, with an interface at the downstream surface to the beam isolation valve on the exit end of tank 6. All necessary connection hardware for this junction including the beamtube and bellows elements is part of the CCL structures (WBS 1.4.4.2). Transporting the accelerated beam from the output of the CCL is WBS 1.4.10 Medium-Beta Cryomodule.

WBS Descriptor Form

WBS 1.04.04.03 **PCR** PCR SN 01 006 **Revision** 3 **Revision Date** 12/21/2001
Title CCL Magnet System

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS provides for the design, analysis, fabrication, assembly, installation, and testing of the CCL the Electro-magnetic quadrupoles (EMQ's) and associated power supplies which provide the required beam focusing between segments. Like the segments themselves, there are 48 EMQ's to provide focusing in both x & y between accelerating segments. These magnets will have to be properly aligned during the integration of the CCL segments. The quadrupoles occupy a portion of the intersegment space between the CCL segments. The first and last CCL module will each have four rack-mounted, single magnet power supplies. Multiple magnet, stand-alone power supplies will power the remainder of the magnets.

WBS 1.4.4.6, which contains the necessary resources to properly anchor, provides the structural support for the EMQ's, attaching the magnets to the same structural support system as the accelerating segments. Other interfaces include the electrical connection between the power supply control system and the Linac control system (WBS 1.9.4) and the interface with Diagnostics (WBS 1.4.5.2). As with other connections to the control system, the magnet system is responsible for all resources necessary (cables and connectors) up to the backplane of the control system cards. The last interface is with the facility electrical supply system. This interface is at the power supply electrical input, with the facility system responsible for providing the resources to ensure a proper connection.

WBS Descriptor Form

WBS 1.04.04.04 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001
Title CCL Vacuum System

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS provides for the design, analysis, fabrication, assembly, installation, and testing of the CCL vacuum system (pumps, hardware, instrumentation, controls, etc.) that provides a sufficient vacuum for the RF environment and minimizes beam stripping and associated activation.

Technical Specifications include:

Parameters	Description
Base Pressure (CCL)	5E-8 Torr
Gas Load (pre-conditioned)	2.5E-9 Torr L/s/cm ²
Gas Load (conditioned)	<1E-10 Torr L/s/cm ²

The Vacuum WBS is responsible for providing adequate pumping of the CCL segments to minimize beam interaction with foreign particles which can, over the long term, lead to activation of the accelerator and degradation of the focusing electromagnet quadrupoles. The pumping is accomplished through a plenum that spans one complete RF module of accelerating segments. Attached to this plenum, at roughly 3meter intervals, are vacuum pump subassemblies. Each major subassembly is comprised of an ion pump, which provides the vacuum during operation. Each vacuum sub assembly will be structurally supported by elements from WBS 1.4.4.6 and connected to the Linac control system by cables between the vacuum pumps, gauges and valve controllers and the cards in the control system.

WBS Descriptor Form

WBS 1.04.04.05 **PCR** PCR SN 01 006 **Revision** 3 **Revision Date** 12/21/2001
Title CCL Water System

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS provides for the design, analysis, fabrication, assembly, installation, and testing of the CCL water-cooling system that removes waste heat from the RF structures and magnets, and provides active resonance control of the CCL.

Technical specifications are:

Water Design Parameters	Description
CCL (8 Cavity Segments)	
Heat Load (total per module)	~200 kW
Flow Rate (total per module)	~326 gpm
Water Delivery Temperature/Stability	24.9 °C (76.8°F)/0.38°C

The CCL Water System WBS is responsible for providing controlled thermal cooling and resonance control of the CCL structure (accelerating cells). The subsystem is comprised of an input manifold system, an equivalent return system, a circulation pump & distribution system, a heat exchanger with the facility system, and a series of flow meters, pressure gauges, and thermocouples.

The input and return interfaces are at the fittings on the external surface of the CCL structure, with this WBS account responsible for all interface hardware between the structure and the water system. Interfaces with facility water for the heat exchanger and for water system makeup are at the input flanges on the specific CCL water system components (similarly, all interface hardware is included in this WBS account).

The control system interface mirrors the other CCL WBS elements in that the water system is responsible for providing cables from the various gauges, meters and pumps back to standard interface cards (owned by the controls WBS). The last major interface is with the facility itself which is required to provide suitable mounting hard points to allow the water system equipment to be properly installed and supported.

The water cooling system features includes;

- Closed-loop, modular water-cooling and resonance control system
- 8 carts for CCL RF structure
- 1 cart for magnets: cooled by separate deionized water loop
- Loops control Linac resonance through temperature control of RF structure via water temperature control

WBS Descriptor Form

WBS 1.04.04.06 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001
Title CCL Mechanical Support & Alignment

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS provides for the design, procurement, fabrication, and integration of the mechanical support & alignment system with the balance of the CCL system. The system is responsible for providing structural connection between the tunnel and the accelerating structure and its auxiliary systems (vacuum, & thermal control). In providing this support the system is also responsible to ensure proper alignment of the CCL segments.

The resources included in this WBS cover the tasks up to the point the CCL is handed of to the ORNL assembly and installation team as defined in the handoff requirements documents.

WBS Descriptor Form

WBS 1.04.04.07 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001

Title CCL System Assembly

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS will provide the labor for insuring the handoff to ORNL is accomplished in accordance with the handoff documents defined for this system.

WBS Descriptor Form

WBS 1.04.04.08 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001
Title CCL Installation

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS contains the resources necessary to assemble, install, and align the CCL assemblies into the LINAC tunnel.

This WBS will assemble all remaining CCL components from WBS 1.4.4.6 Mechanical systems, WBS 1.4.4.5 Water systems, WBS 1.4.4.3 Magnet Assemblies, and WBS 1.4.4.4 CCL Vacuum systems.

This WBS will be responsible for installing and locating all CCL assemblies from WBS 1.4.4.7 into the LINAC tunnel including providing supervision and guidance to the survey and alignment group, for longitudinal and transverse alignment, with respect to a global coordinate system or to the appropriate component(s).

WBS Descriptor Form

WBS 1.04.04.09 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001
Title HEBT System

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The HEBT Cavity (HC) Structures are RF driven cavities designed to reduce the energy spread inside a beam pulse with-in the high energy beam transport (HEBT) subsystem of WBS 1.5 Ring and Transfer Systems. The resources to design, fabricate, integrate and deliver these cavities are included here.

The HEBT cavities prepare beam for ring injection; features include:

- Energy regulator - ~8-cell CCL cavity with increased bore (2.5 cm). 4-MV integrated field. ~300-kW RF power
- Energy expander- Similar to regulator but driven at 100 kHz higher frequency
- Each structure requires separate RF system using about 300 kW power

The bulk of the interfaces are with other WBS 1.5 subsystems. The HC system will rely on the Ring and Transfer System to provide structural support and alignment with other beamline components. The interface will be at hard points on the external shell of the HC system (with the mounting hardware provided by the Ring and Transfer WBS). Similarly, the Ring and Transfer System will provide vacuum pumping at the input flanges on the exterior of the tank shell and ports on the RF power system. This HC WBS does not include any resources for pumps of any type, it depends on sharing the loads in this area with other Ring & Transfer Systems. WBS 1.4.1.1 provides RF power for the HEBT cavities.

WBS Descriptor Form

WBS 1.04.05 **PCR** PCR SN 01 006 **Revision** 3 **Revision Date** 12/21/2001
Title Physics, Diagnostics & Commissioning

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Provides for physics support during design and commissioning; design, fabrication, installation and testing of beam diagnostics devices; and design, fabrication, and testing of the chopper/anti-chopper structure. Diagnostics devices are located in intersegment spaces, and also in the beam line to the Linac dump (provided by target systems). The diagnostics scope includes pulsed beam current monitors, bunched beam current monitors, position & angle measuring devices, central phase and energy devices, 3 low-power actuated beam stops (for tuning), a video fluorescence profile monitors, slow wire scanners, beam-loss monitors, phase spread monitors, emittance monitors, target harps, and one beam-in-gap monitor. The chopper will be installed in the MEBT by LBL.

WBS Descriptor Form

WBS 1.04.05.01 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001
Title Chopper Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Provides for the design, fabrication and procurement of the final chopper and anti-chopper structures, specification and procurement of the chopper pulser power supplies, specification and procurement of the high-power 50-ohm load assemblies and delivery of all hardware to LBNL. Each chopper structure consists of opposing slow-wave meander line circuits, which must operate at +/- 2350 volts nominally with a risetime of less than 10 ns (1%-95%). The structures include beam scrapers on each end and thermocouples for measuring temperatures where useful. Also included are all of the electrical vacuum feedthroughs and the water-cooling feedthroughs required for operation. Not included are the vacuum vessels, vessel lids, meander line support structures or position adjustment hardware. A complete set of (4) spare, bare meander-line, assemblies are included. At least six spare high-voltage vacuum feedthroughs will be included. Four high-voltage pulsers are to be procured and delivered for driving the chopper and anti-chopper structures at a nominal +/- 2530 volts, risetimes and falltimes of 10 ns or less and designed for driving 50 ohm loads. LANL is responsible for the pulser units only, without control system interfacing hardware, software or pattern generation hardware. No spare pulsers are included. LANL will procure and deliver the four high-power 50-ohm loads required for the chopper and anti-chopper pulsers as well as two spare load units. LANL will procure and deliver a four-channel, 500-MHz, rackmountable, monitor oscilloscope, suitable for permanent mounting near the pulser units. The oscilloscope brand shall be agreed upon by the responsible LBNL engineers.

The chopper interfaces with the MEBT system of WBS 1.3.

WBS Descriptor Form

WBS 1.04.05.02 PCR PCR SN 01 006 Revision 3 Revision Date 12/21/2001

Title Diagnostics

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Provides for preliminary and final design, test fixtures, fabrication, and portions of testing and installation of diagnostic devices and electronics for the Linac and for commissioning purposes. The following diagnostics are planned:

Accelerator area	D-Plate	DTL	CCL	SRF	HEBT
Current toroid	1	6	2	3	1
BPM & Phase detector	2	12	16	30	2
Wire scanner (X & Y)	1	6	8	29	-
Faraday Cup	1	6	1	1	-
Harp (X & Y)	1	2	-	-	4
Beam-in-Gap	-	-	-	-	1
Emittance	1	-	-	-	-
Vu-screen/ TV	1	-	-	-	-
Loss Monitors	-	-	24	58	-

BPM & phase detector, cables, and electronics; current monitor toroids and cables (no electronics); wire scanner actuators, cables, and electronics; harp for spallation target, cables up through to the top of the the bulk shielding, and electronics; D-plate mechanical and electronics (except for emittance electronics); MEBT slit and collector (actuators and heads only); energy absorbers / Faraday Cups actuators and electronics. These systems provide beam information to the accelerator commissioners and facility operators for proper beam tuning. They also monitor the beam parameters during normal facility operations to determine beam delivery effectiveness, monitor beam parameters for off-normal events, and provide sufficient beam parameter information to facility operators to recover from off-normal events. Important interfaces include the electrical connection between diagnostics and the Linac control system (WBS 1.9.4) and the interface with Linac magnets (WBS and 1.4.4.3).

WBS Descriptor Form

WBS 1.04.05.03 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001

Title Physics Support

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS provides accelerator physics support for Linac. Support will include physics studies, supporting calculations for engineering development, developing steering and matching requirements, developing commissioning plans, complete studies of halo reduction mechanisms, fabrication support and tuning. Collaborate with ORNL/partner labs for Beam Commissioning and tuning of activities. Provide physics design, specifications for construction and fabrication, and machine tuning, control and commissioning.

WBS Descriptor Form

WBS 1.04.05.04 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Commissioning

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS was Closed per PCR LI-01-077

This WBS provides accelerator physics support for Linac commissioning. Support will include development of steering, phase & amplitude tuning, and modeling algorithms; and developing commissioning plans/procedures. This activity also directs and supports the initial Linac beam commissioning.

WBS Descriptor Form

WBS 1.04.06 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001
Title Technical Support

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Provide project management of the SNS Linac project, responsible for scope, schedule, and budget, interface with SNS project office and DOE. The scope covers the project management overall engineering supervision, cost and schedule management, financial and procurement management, reporting and budgeting, systems integration, quality assurance, records management and engineering, and administrative costs.

Provides for project control support using Primavera scheduling software and Microframe Project Manager project resource management software. Activities include baseline management, work package generation, funds allocation, schedule reporting and control, financial systems management and management of procurement activities. Provide high level administrative and staff support to the SNS Linac Division Director. Provide administrative/secretarial functions of the project office. Serve as the primary administrative contact and resource, interfacing extensively with all levels of staff management within the SNS Linac Project and the overall SNS project office at ORNL, BNL, ANL, LBNL, DOE HQ and LAAO. Provides for systems engineering, interface control, systems integration, technical baseline development and maintenance, information systems management, document control, configuration management, records management and web page development and maintenance. Provide financial analysis, cost collection and maintenance, and financial planning. Provide procurement planning and management of procurements. Provides ES&H and Quality Assurance oversight for WBS 1.1.2 R&D, 1.4.1 RF Power Systems, 1.4.2 DTL Systems, 1.4.4 CCL Systems, 1.4.5 Physics and Diagnostics, 1.4.6 Project Services.

WBS Descriptor Form

WBS 1.04.06.01 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Project Management

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Provides for overall project management (STL)

WBS Descriptor Form

WBS 1.04.06.02 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Project Office

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Provides for project controls support and financial and procurement support.

WBS Descriptor Form

WBS 1.04.06.03 **PCR** _____ **Revision** _____ **Revision Date** _____

Title Physics Support

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS Descriptor Form

WBS 1.04.06.04 **PCR** _____ **Revision** _____ **Revision Date** _____

Title System Engineering

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS Descriptor Form

WBS 1.04.06.05 **PCR** _____ **Revision** _____ **Revision Date** _____

Title QA/QC Support

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS Descriptor Form

WBS 1.04.06.06 **PCR** _____ **Revision** _____ **Revision Date** _____

Title Physics/Engineering Management

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS Descriptor Form

WBS 1.04.06.07 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title SNS Division Management

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Provides for Division Management, that is management not previously funded via 1.4.6.1, Quality Assurance, Safety, Systems Integration, records management and administrative support. Space, infrastructure and software costs also are funded in this WBS.

WBS Descriptor Form

WBS 1.04.06.08 **PCR** PCR LI 01 004 **Revision** 0 **Revision Date** 10/30/2001

Title Conventional Facilities Interface

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The conventional facilities interface for the Linac has required the committment of two engineers and one designer full time for the period from October 1, 2000 to September 30, 2001. This level of effort was ever budgeted in the Linac WBS 1.4. The increased demand has resulted from the need to continously address changes to the conventional facility design to attempt to reduce costs. The additional cost incurred from October 1, 2000 through March 30, 2001 have been \$160k. \$140k of the cost has been included in this PCR as agreed to with the ORNL project office.

WBS Descriptor Form

WBS 1.04.06.09 **PCR** _____ **Revision** _____ **Revision Date** _____

Title Replanning Effort

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS Descriptor Form

WBS 1.04.07 **PCR** PCR OP 01 008 **Revision** 2 **Revision Date** 10/12/2001

Title Linac Field Coordination

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS account contains additional ORNL field coordination required to achieve an efficient installation, pre-acceptance testing and commissioning of the Linac.

This activity is in addition to normal Title III supervision as it covers the transition to ORNL of the responsibility for these activities.

WBS Descriptor Form

WBS 1.04.07.00 **PCR** _____ **Revision** _____ **Revision Date** _____

Title ORNL Field Coordination

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS Descriptor Form

WBS 1.04.07.01 **PCR** PCR OP 01 008 **Revision** 1 **Revision Date** 10/12/2001

Title Linac Field Coordination

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS account contains additional ORNL field coordination required to achieve an efficient installation, pre-acceptance testing and commissioning of the Linac. This activity is in addition to normal Title III supervision as it covers the transition to ORNL of the responsibility for these activities.

WBS Descriptor Form

WBS 1.04.07.02 **PCR** PCR OP 01 008 **Revision** 1 **Revision Date** 10/12/2001

Title Design Confirmation Studies (Closed)

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Labor to make the ORNL independent cost estimate for the warm linac.

WBS Descriptor Form

WBS 1.04.07.03 **PCR** PCR OP 01 008 **Revision** 1 **Revision Date** 10/12/2001

Title Preliminary SC Activities (Closed)

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Labor for the preliminary activities including the CDR for the scope change from a warm linac to a superconducting linac.

WBS Descriptor Form

WBS 1.04.07.04 **PCR** PCR OP 01 008 **Revision** 1 **Revision Date** 10/12/2001

Title Linac Installation Services

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Lease, utilities and property taxes for the RATS building. Supervision and organizing labor, equipment and M&S for accelerator component installation.

WBS Descriptor Form

WBS 1.04.07.05 **PCR** PCR OP 01 008 **Revision** 0 **Revision Date** 10/12/2001

Title Linac FC Power Supplies

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Field coordination activities connected to the linac power supplies.

WBS Descriptor Form

WBS 1.04.07.06 **PCR** PCR OP 01 008 **Revision** 0 **Revision Date** 10/12/2001

Title Linac FC Diagnostics

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Field coordination activities connected to the linac diagnostics.

WBS Descriptor Form

WBS 1.04.07.07 **PCR** PCR OP 01 008 **Revision** 0 **Revision Date** 10/12/2001

Title Linac FC Cryomodules and Cyrogenic

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Field coordination activities connected to the linac cryomodules and cryogenics systems.

WBS Descriptor Form

WBS 1.04.07.08 **PCR** PCR OP 01 008 **Revision** 0 **Revision Date** 10/12/2001

Title Linac Spares

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Spare parts and components for testing and commissioning the linac on the SNS site.

WBS Descriptor Form

WBS 1.04.07.10 **PCR** PCR OP 01 008 **Revision** 0 **Revision Date** 10/12/2001

Title Linac RF

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Field coordination activities connected to the linac RF system.

WBS Descriptor Form

WBS 1.04.07.11 **PCR** PCR SN 01 006 **Revision** 0 **Revision Date** 12/21/2001

Title Linac Field Coordination - Vacuum

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Field Coordination activities for Linac Vacuum Systems

WBS Descriptor Form

WBS 1.04.07.14 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Linac FC Mechanical

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Field coordination activities connected to the linac mechanical system.

WBS Descriptor Form

WBS 1.04.07.15 **PCR** PCR AS 03 011 **Revision** 0 **Revision Date** _____

Title Linac Survey and Alignment Field Coordination

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Provide labor and materials for survey and alignment of linac components.

WBS Descriptor Form

WBS 1.04.07.18 **PCR** PCR OP 01 008 **Revision** 0 **Revision Date** 10/12/2001

Title Linac Installation Services HIST

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Installation Planning Support for FY01

WBS Descriptor Form

WBS 1.04.08 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001
Title Project Services

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS element covers all aspects of Project Services activities required in support of the construction of the Superconducting Linac. At Level 4, this WBS consists of:

- 1.04.08.01 Project Management
- 1.04.08.02 Project Controls/Business Office Support
- 1.04.08.03 Systems Engineering
- 1.04.08.04 ES&H & QA/QC Support
- 1.04.08.05 Physics & Engineering Management

WBS Descriptor Form

WBS 1.04.08.01 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Project Management

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the provision of project management services to the Superconducting Linac construction project.

FY02 Deliverables: This is a level of effort activity, and therefore has no specific deliverables.

WBS Descriptor Form

WBS 1.04.08.02 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Project Controls/Business/Office Support

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the provision of project controls and business office support to the Superconducting Linac construction project.

FY02 Deliverables: This is a level of effort activity, and therefore has no specific deliverables.

WBS Descriptor Form

WBS 1.04.08.03 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001
Title System Engineering

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the provision of systems engineering services to the Superconducting Linac construction project.

FY02 Deliverables: This is a level of effort activity, and therefore has no specific deliverables.

WBS Descriptor Form

WBS 1.04.08.04 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001
Title ES&H & QA/QC Support

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the provision of Environment, Health and Safety and Quality Assurance/Control support to the Superconducting Linac construction project.

FY02 Deliverables: This is a level of effort activity, and therefore has no specific deliverables.

WBS Descriptor Form

WBS 1.04.08.05 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Physics & Engineering Management

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the provision of physics and engineering management services to the Superconducting Linac construction project.

FY02 Deliverables: This is a level of effort activity, and therefore has no specific deliverables.

WBS Descriptor Form

WBS 1.04.09 **PCR** PCR SN 02 002 **Revision** 1 **Revision Date** 11/2/2001
Title SCL Magnets and Cooling

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS provides for the design, analysis, fabrication, assembly, installation, and testing of the SCL the Electro-magnetic quadrupoles (EMQ's) and associated power supplies which provide the required beam focusing between segments. There are 30 EMQ doublets to provide focusing in both x & y after exiting an accelerating segment. These magnets will have to be properly aligned during the integration of the SCL segments. Also included in this WBS are steering dipole windings and associated power supplies. Also provides for the design, analysis, and fabrication of the quadrupole magnet water cooling system (pumps, hardware, instrumentation, controls, etc.) in the superconducting linac. The system must provide for the removal of waste heat and provide temperature control. Water cooling system features include closed-loop, modular water-cooling system Loops interface with magnets at flow ports and with the facility at the chilled water main Loops remove waste heat from magnets

WBS Descriptor Form

WBS 1.04.09.01 **PCR** PCR LI 02 018 **Revision** 1 **Revision Date** 3/25/2002
Title SCL Transition Region

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS provides for the design and partial procurement of components for the CCL/SCL Transition region. Components include two EMQ magnets, EMQ mounts, cabling, power supplies, cooling piping, wire scanner, BPM, beam stop, beam boxes, diagnostics mounts and miscellaneous materials. Beam pipe, bellows, flanges, NEG pumps, ion pumps, controllers and precipitator will be by others. Assembly, cleaning, bakeout and installation will be by others.

WBS Descriptor Form

WBS 1.04.09.02 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001
Title SCL Magnet Hardware

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS provides for the design, analysis, fabrication, assembly, installation, and testing of the SCL the Electro-magnetic quadrupoles (EMQ's) and associated power supplies which provide the required beam focusing between segments. There are 30 EMQ doublets to provide focusing in both x & y after exiting an accelerating segment. These magnets will have to be properly aligned during the integration of the SCL segments. Also included in this WBS are steering dipole windings and associated power supplies.

WBS Descriptor Form

WBS 1.04.09.03 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001
Title SCL Magnet Cooling

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS provides for the design, analysis, fabrication, assembly, installation, and testing of the SRF Electro-magnetic quadrupole (EMQ) doublets and associated power supplies which provide the required beam focusing between cryomodules. Like the cryomodules themselves, there are 32 doublets to provide focusing in both x & y after exiting an accelerating segment. These magnets will have to be properly aligned during the integration of the cryomodules. The quadrupoles are located on the warm beam pipe.

Steel length (cm)	35.0
Bore Radius (cm)	8.0
Pole Tip Field (gauss)	4195
Current (A)	500
Gradient (gauss/cm)	620
L _{eff} (cm)	39.0
GL (T)	2.41
Power/Quad (Kw)	6.59
Weight (lbs)	778
Quantity	64

This WBS also contains the necessary resources to properly anchor/align and provide the structural support for the magnets, and provide water cooling. Interfaces include the electrical connection between the power supply control system and the Linac control system (WBS 1.9.4) and the interface with Diagnostics (WBS 1.4.5.2). As with other connections to the control system, the magnet system is responsible for all resources necessary (cables and connectors) up to the back of the control system cards. The last interface is with the facility electrical supply system. This interface is at the power supply electrical input, with the facility system responsible for providing the resources to ensure a proper connection.

WBS Descriptor Form

WBS 1.04.10 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001
Title Medium Beta Cryomodule

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS element covers all aspects of specification, design, fabrication, procurement, assembly, and testing of the medium-beta cryomodules at JLAB for the Superconducting Linac. It also covers some of the installation, pre-operational testing and commissioning of the cryomodules after they are delivered to SNS. At Level 4, this WBS consists of

:

- 1.04.10.01 Cavity String Assembly
- 1.04.10.02 Space Frame Assembly
- 1.04.10.03 Cryomodule Assembly
- 1.04.10.04 Cavity/Cryomodule Assembly Labor
- 1.04.10.05 Cavity Test
- 1.04.10.06 Cryomodule Installation
- 1.04.10.07 Electrical

WBS Descriptor Form

WBS 1.04.10.01 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001
Title Cavity String Assembly Procurements

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the design, fabrication and clean-room assembly of the medium-beta cavities, including the input power coupler, the higher order mode coupler and the helium vessel into a single integrated vacuum system, ready to be installed in the cryomodule.

FY02 Deliverables: Complete fabrication of the medium- β cavities, with HOM couplers.

- Receive, inspect and process all medium- β cavities.

- Begin testing of medium- β cavities.

- Award contract for production of Fundamental Power Couplers

- Begin assembly and conditioning of Fundamental Power Couplers

- Complete fabrication and procurement of bellows, seals and miscellaneous components for the medium- β cavities string.

- Complete fabrication and procurement of medium- β cavities field probes.

- Fabricate/procure all medium- β cavity helium vessels.

- Complete fabrication/procurement of medium- β cryomodule wiring.

- Complete fabrication/procurement of medium- β cryomodule feedthroughs.

WBS Descriptor Form

WBS 1.04.10.02 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001
Title Space Frame Assembly Procurements

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the design, fabrication and assembly of the space frame for the medium-beta cavities, including the cavity tuner, helium supply and return headers, magnetic and thermal shields, and the space frame, itself.

FY02 Deliverables: Deliver first 24 medium- β tuner mechanical assemblies.

Award contract for procurement of medium- β tuner motors and harmonic drives.

Complete procurement of medium- β cryomodule header assemblies.

Complete fabrication/delivery of medium- β cryomodule magnetic shields.

Fabricate/deliver first 8 medium- β cryomodule thermal shields.

Award contract for procurement of medium- β cryomodule seals and miscellaneous components.

Fabricate/deliver first 8 medium- β cryomodule space frame.

WBS Descriptor Form

WBS 1.04.10.03 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001
Title Cryomodule Assembly Procurements

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the assembly of the medium-beta cryomodules, including the stands, end can, vacuum tank, internal beam line assemblies and alignment fiducials.

FY02 Deliverables: Complete fabrication/delivery of medium- β alignment fiducials.
Complete fabrication/delivery of first 7 medium- β cryomodule vacuum tanks.
Fabricate/deliver first 9 sets of medium- β end cans.
Complete procurement of medium- β cryomodule beam line components.
Complete fabrication/delivery of medium- β cryomodule stands.

WBS Descriptor Form

WBS 1.04.10.04 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Cavity/Cryomodule Assembly Labor

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the labor for the assembly of cryomodules.

FY02 Deliverables: Begin assembly of medium- β cryomodules.

WBS Descriptor Form

WBS 1.04.10.05 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Cavity Test

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the testing of cavities prior to assembly into cavity strings or cryomodules.

FY02 Deliverables: Production cryomodule testing is not scheduled to begin until FY03. This WBS has no deliverables in FY02.

WBS Descriptor Form

WBS 1.04.10.06 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001
Title Cryomodule Installation

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the shipment, receiving inspection and installation of the medium beta cryomodules in the SNS linac tunnel.

FY02 Deliverables: Shipment of medium-beta cryomodules to SNS is not scheduled to begin until FY03. This WBS has no deliverables in FY02.

WBS Descriptor Form

WBS 1.04.10.07 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Electrical

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the specification, design, fabrication and procurement of instrumentation and interlocks for the medium-beta cryomodules.

FY02 Deliverables: Complete fabrication/delivery of medium-β instrumentation and interlocks components.

WBS Descriptor Form

WBS 1.04.11 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001
Title High Beta Cryomodule

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS element covers all aspects of specification, design, fabrication, procurement, assembly and testing at JLAB of the high-beta cryomodules for the Superconducting Linac. It also covers some of the installation, pre-operational testing and commissioning of the cryomodules after they are delivered to SNS. At Level 4, this WBS consists of

:

- 1.04.11.01 Cavity String Assembly
- 1.04.11.02 Space Frame Assembly
- 1.04.11.03 Cryomodule Assembly
- 1.04.11.04 Cavity/Cryomodule Assembly Labor
- 1.04.11.05 Cavity Test
- 1.04.11.06 Cryomodule Installation
- 1.04.11.07 Electrical

WBS Descriptor Form

WBS 1.04.11.01 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001
Title Cavity String Assembly Procurements

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the design, fabrication and clean-room assembly of the high-beta cavities, including the input power coupler, the higher order mode coupler and the helium vessel.

FY02 Deliverables: Begin fabrication of high- β cavities and HOM couplers.

- Completion of the fabrication/delivery of the sheet niobium metal for the high-beta cavities.

- Completion of eddy currnt testing of high- β cavity niobium.

- Completion of the fabrication/delivery of the niobium-titanium alloy for cavity-to-helium vessel joints.

- Complete fabricion/delivery of bellows, seals and miscellaneous components for the high- β cavity string.

- Complete delivery of the high- β cavity field probes.

- Award of the contract for input power coupler fabrication.

- Complete fabrication/delivery of the first 16 high- β helium vessels.

- Complete fabrication/delivery of the high- β cavity feedthroughs and wiring.

WBS Descriptor Form

WBS 1.04.11.02 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001
Title Space Frame Assembly Procurements

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the design, fabrication and assembly of the space frame for the high-beta cavities, including the cavity tuner, helium supply and return headers, magnetic and thermal shields, and the space frame, itself.

FY02 Deliverables: Complete fabrication/delivery of high- β cryomodule header assemblies.
Complete fabrication/delivery of first high- β cryomodule magnetic shield.
Complete fabrication/delivery of high- β cryomodule support rods.

WBS Descriptor Form

WBS 1.04.11.03 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001
Title Cryomodule Assembly Procurements

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the assembly of the high-beta cryomodules, including the stands, end can, vacuum tank, internal beam lines and alignment fiducials.

FY02 Deliverables: Complete fabrication/delivery of first high- β cryomodule alignment fiducials.
Complete fabrication/delivery of high- β cryomodule beam line components.
Award contract for production of high- β cryomodule stands.

WBS Descriptor Form

WBS 1.04.11.04 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Cavity/Cryomodule Assembly Labor

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the labor for the assembly of cryomodules.

WBS Descriptor Form

WBS 1.04.11.05 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Cavity Test

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the testing of cavities prior to assembly into cavity strings or cryomodules.

FY02 Deliverables: Cavity testing is not scheduled to begin until FY03. This WBS has no deliverables in FY02.

WBS Descriptor Form

WBS 1.04.11.06 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Cryomodule Installation

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the shipment, receiving inspection and installation of the high beta cryomodules in the SNS linac tunnel.

FY02 Deliverables: Shipment of high-beta cryomodules to SNS is not scheduled to begin until FY04. This WBS has no deliverables in FY02.

WBS Descriptor Form

WBS 1.04.11.07 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001
Title Electrical

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the specification, design, fabrication and procurement of instrumentation and interlocks for the high-beta cryomodules.

FY02 Deliverables: Complete fabrication and delivery of high-β cryomodule instrumentation and interlock components.

WBS Descriptor Form

WBS 1.04.12 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001
Title Cryogenics System

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS element covers all aspects of specification, design, fabrication, procurement, assembly and pre-commissioning checkout of the cryogenic system for the Superconducting Linac. It also covers some of the installation, pre-operational testing and commissioning of the refrigerator and transfer lines after they are delivered to SNS. At Level 4, this WBS consists of

:

- 1.04.12.01 CHL Labor
- 1.04.12.02 Refrigeration System
- 1.04.12.03 Controls, Refrigerator/Cryomodule
- 1.04.12.04 Ancillary Equipment
- 1.04.12.05 Transfer Lines, Linac/Distribution

WBS Descriptor Form

WBS 1.04.12.01 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title CHL Labor, Design, Checkout, Commissioning

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the labor associated with the design, specification, procurement oversight, fabrication, installation and commissioning of the cryogenic system.

FY02 Deliverables: This level of effort activity has no specific deliverables in FY02.

WBS Descriptor Form

WBS 1.04.12.02 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001
Title Refrigeration System

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the specification, design, fabrication and assembly of the refrigeration system, including the warm compressor, oil removal systems, 4.5 K coldbox and 2.1 K coldbox.

FY02 Deliverables: Completion of fabrication/delivery of the warm compressors.
 Completion of fabrication/delivery of the oil removal system.
 Completion of fabrication/delivery of the 4.5 K cold box and cold box spares.
 Completion of fabrication/delivery of the 2.1 K cold box and cold compressors.

WBS Descriptor Form

WBS 1.04.12.03 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Controls, Refrigerator & Cryomodule

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the specification, design, procurement, fabrication, assembly, installation, pre-operational testing and commissioning of the controls for the refrigerator and cryomodule.

FY02 Deliverables: Delivery of operational refrigerator control system.

WBS Descriptor Form

WBS 1.04.12.04 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001
Title Ancillary Equipment

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the specification, design, fabrication, procurement, assembly, pre-operational testing and commissioning of ancillary equipment for the cryogenic system, including the liquid helium and liquid nitrogen dewars, the external 80 K purifiers, gaseous helium storage, instrument air systems, contamination removal equipment and external piping.

FY02 Deliverables: Completion of the repair and delivery of the liquid helium dewar to ORNL.

- Delivery of 80 K purifiers to ORNL.

- Install gaseous helium tanks on site.

- Complete procurement and installation of instrument air system on site.

- Complete procurement and installation of contamination equipment on site.

- Complete delivery and begin installation of external piping.

WBS Descriptor Form

WBS 1.04.12.05 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001

Title Transfer Lines, Linac/Distribution

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the specification, design, fabrication, procurement, assembly, installation, pre-operational testing and commissioning of the transfer lines for the cryogenic system, including expansion/anchor boxes, warm gas pipelines and transfer lines.

FY02 Deliverables: Complete assembly of bayonet/valve assemblies at JLab.
Begin assembly of U-tubes at JLab.

WBS Descriptor Form

WBS 1.04.13 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001
Title Five CM Production/Repair Assembly Facility

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS element covered all aspects of specification, design, fabrication, procurement, assembly, and JLAB involvement in the installation, pre-operational testing and commissioning of the cryomodule production/repair/assembly facility at SNS. This activity has been substantially descoped and about half the budget was returned to contingency. The remaining scope will be done at JLab, and the remaining budget is being used to provide essential capability to JLab facilities. At Level 4, this WBS consists of

:

- 1.04.13.1 ORNL 1500 W Refrigerator (Move)
- 1.04.13.2 Transfer Lines
- 1.04.13.3 Vertical Dewar
- 1.04.13.4 RF
- 1.04.13.5 Chemistry
- 1.04.13.6 Hot Water Heater
- 1.04.13.7 Waste Water Neutralization
- 1.04.13.8 Tooling
- 1.04.13.9 Shielding, Vertical Test Area
- 1.04.13.10 EDIA
- 1.04.13.11 SRF Building

WBS Descriptor Form

WBS 1.04.13.01 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title ORNL 1500W Refrigerator (Move)

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the labor and procurements associated with the relocation of the ORNL 1500 W refrigerator.

FY02 Deliverables: Complete the upgrade of the cryogenic supply to the CTF to support extended testing.

WBS Descriptor Form

WBS 1.04.13.02 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001
Title Transfer Lines

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the specification, design, fabrication, procurement, assembly, installation, pre-operational testing and commissioning of the transfer lines for the cryogenic system for the SRF facility.

FY02 Deliverables: This WBS has been totally descope, in line with the decision to cancel the SRF facility as a cost reduction measure, and has no deliverables in FY02.

WBS Descriptor Form

WBS 1.04.13.03 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Vertical Dewars

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the specification, design, procurement, fabrication, assembly, installation, pre-operational testing and commissioning of the vertical dewar for the SRF facility.

FY02 Deliverables: This WBS has no deliverables in FY02.

WBS Descriptor Form

WBS 1.04.13.04 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001
Title RF Systems/Equipment

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the specification, design, fabrication, procurement, assembly, pre-operational testing and commissioning of the RF test stand for the SRF facility, which will initially be used at JLab in support of cavity and cryomodule testing and fundamental power coupler processing.

FY02 Deliverables: Complete delivery and installation of rf test equipment.

WBS Descriptor Form

WBS 1.04.13.05 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Chemistry

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the specification, design, fabrication, procurement, assembly, installation, pre-operational testing and commissioning of the chemical processing cabinets and equipment for the SRF facility, including the cabinets, high pressure rinse equipment, cavity storage equipment, cleaning/handling/ultrasonic equipment, an electron beam welder, and inspection equipment.

FY02 Deliverables: This activity is complete. It has no deliverables in FY02.

WBS Descriptor Form

WBS 1.04.13.06 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001

Title DI Water

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the specification, design, fabrication, procurement, assembly, installation, pre-operational testing and commissioning of the deionized water system for the SRF facility.

FY02 Deliverables: This WBS has been totally descope, in line with the decision to cancel the SRF facility as a cost reduction measure, and has no deliverables in FY02.

WBS Descriptor Form

WBS 1.04.13.07 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001

Title Waste Water Neutralization

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the specification, design, fabrication, procurement, assembly, installation, pre-operational testing and commissioning of the waste water neutralization system for the SRF facility.

FY02 Deliverables: This WBS has been totally descope, in line with the decision to cancel the SRF facility as a cost reduction measure, and has no deliverables in FY02.

WBS Descriptor Form

WBS 1.04.13.08 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Tooling

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the specification, design, fabrication, procurement, assembly, installation, pre-operational testing and commissioning of the cavity and cryomodule assembly tooling and equipment for the SRF facility.

FY02 Deliverables: Complete delivery of tooling to JLAB.

WBS Descriptor Form

WBS 1.04.13.09 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001
Title Shielding, Vertical Test Area

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the specification, design, fabrication, procurement, assembly, installation, pre-operational testing and commissioning of the shielding for the vertical test area of the SRF facility.

FY02 Deliverables: This WBS has been totally descope, in line with the decision to cancel the SRF facility as a cost reduction measure, and has no deliverables in FY02.

WBS Descriptor Form

WBS 1.04.13.10 **PCR** PCR SN 01 006 **Revision** 3 **Revision Date** 12/21/2001

Title EDIA

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers all engineering design, inspection and acceptance activities for the SRF facility with the exception of the SRF building.

FY02 Deliverables: This is a level of effort activity and has no significant deliverables in FY02.

WBS Descriptor Form

WBS 1.04.13.11 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title SRF Building

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the specification, design, fabrication, procurement, assembly, installation, pre-operational testing and commissioning of the building for the SRF facility.

FY02 Deliverables: Delivery of the ultra pure water system and cabinets.

WBS Descriptor Form

WBS 1.04.14 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001
Title Warm Beam Pipe Vacuum

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS element covers all aspects of specification, design, fabrication, procurement, assembly, and JLAB involvement in the installation, pre-operational testing and commissioning of the warm beam pipe vacuum systems at SNS. At Level 4, this WBS consists of

:

- 1.04.14.01 Manifolds/Pumpdrops
- 1.04.14.02 Valves
- 1.04.14.03 Ion Pumps w/Power Supply
- 1.04.14.04 Vacuum Fittings
- 1.04.14.05 Roughing Pump Cart
- 1.04.14.06 Vacuum System Installation
- 1.04.14.07 Beamline Assembly Components

WBS Descriptor Form

WBS 1.04.14.01 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001
Title Dummy Cryomodules

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the specification, design, fabrication, procurement and assembly of the dummy cryomodules needed to balance the cryogenic loads for the central helium liquifier of the superconducting linac.

FY02 Deliverables: Award contract for production of dummy cryomodules.

WBS Descriptor Form

WBS 1.04.14.02 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Valves

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the specification, design, fabrication, procurement and assembly of the valves for the warm beam pipe vacuum system for the superconducting linac.

FY02 Deliverables: Delivery of 23 valves.

WBS Descriptor Form

WBS 1.04.14.03 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Ion Pumps w/o Power Supply

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the specification, procurement and assembly of the ion pumps and power supplies for the warm beam pipe vacuum system for the superconducting linac.

FY02 Deliverables: This activity has no deliverables in FY02.

WBS Descriptor Form

WBS 1.04.14.04 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Differential Pump Stations & Warm Girders

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the specification, procurement and assembly of the Differential Pump Stations & Warm Girders of vacuum system of the superconducting linac.

FY02 Deliverables: This activity has no deliverables in FY02.

WBS Descriptor Form

WBS 1.04.14.05 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Roughing Pump Cart

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the specification, design, fabrication, procurement and assembly of the roughing pump cart for the warm beam pipe system of the superconducting linac.

FY02 Deliverables: This activity has no deliverables in FY02.

WBS Descriptor Form

WBS 1.04.14.06 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Vacuum System Installation

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Scope of Work: This WBS covers the installation of the warm beam pipe systems for the superconducting linac in the SNS linac tunnel.

FY02 Deliverables: This activity has no deliverables in FY02.

WBS Descriptor Form

WBS 1.04.14.07 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Beamline Assembly Components

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the specification, design, fabrication, procurement and assembly of the equipment needed to support the assembly of the warm beam pipe vacuum systems for the superconducting linac.

FY02 Deliverables: This activity has no deliverables in FY02.

WBS Descriptor Form

WBS 1.04.15 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001
Title High Gradient

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS element covers all aspects of specification, design, fabrication, procurement, assembly, and JLAB involvement in the installation, pre-operational testing and commissioning of the warm beam pipe vacuum systems at SNS. At Level 4, this WBS consists of

:

- 1.04.15.01 Electropolishing System for 805 MHz Cavities
- 1.04.15.02 Cooling Unit for Electropolishing System
- 1.04.15.03 Facility Upgrade for Electropolishing System
- 1.04.15.04 Tooling for Cavity Manipulation
- 1.04.15.05 Manpower for Implementation & Commissioning
- 1.04.15.06 Process Development
- 1.04.15.07 Set Up Test Cave
- 1.04.15.08 Test of Additional MB CMs
- 1.04.15.09 CM Assy Procedure Development
- 1.04.15.10 Installation High Power RF System

WBS Descriptor Form

WBS 1.04.15.01 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Electropolishing System for 805 Mhz Cavities

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the specification, design, fabrication, procurement and assembly of the components of the electropolish system and elements of the cabinet within which the polishing will take place.

FY02 Deliverables: Delivery of electropolish system elements and cabinet.

WBS Descriptor Form

WBS 1.04.15.02 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Cavity Rotary Components

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the specification, design, fabrication, procurement and assembly of Cavity Rotary Components for the electropolishing cabinet.

FY02 Deliverables: Delivery of Cavity Rotary Components.

WBS Descriptor Form

WBS 1.04.15.03 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Facility Upgrade for Electropolishing System

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the specification, design, fabrication, procurement and assembly of elements of the electropolishing cabinet.

FY02 Deliverables: Delivery of electropolish cabinet components.

WBS Descriptor Form

WBS 1.04.15.04 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Tooling for Cavity Manipulation

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the specification, design, fabrication, procurement and assembly of elements of the electropolishing cabinet.

FY02 Deliverables: Delivery of electropolish cabinet components.

WBS Descriptor Form

WBS 1.04.15.05 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Manpower for Implementation & Commissioning of Electropolishing Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the labor needed to install and commission the electropolishing system.

FY02 Deliverables: Install and commission the electropolishing system.

WBS Descriptor Form

WBS 1.04.15.06 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Process Development

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the development of procedures for electropolishing that will achieve the needed cavity performance.

FY02 Deliverables: Begin the development of high gradient electropolishing procedures.

WBS Descriptor Form

WBS 1.04.15.07 **PCR** PCR SN 02 002 **Revision** 0 **Revision Date** 11/2/2001

Title Set Up Test Cave

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Procure and install hardware and software to speed up installation and testing of cryomodules in the JLab Test Cave, so that the rate of cryomodule testing can be increased from 4 to 12 per year

WBS Descriptor Form

WBS 1.04.15.08 **PCR** PCR LI 01 017 **Revision** 0 **Revision Date** 7/23/2002
Title Test of Additional MB CMs

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS element covers the cryogenic testing of 9 additional medium- β cryomodules, to assist in determining the techniques needed to preserve the gradient performance of high-gradient cavities in the Vertical Test Assembly during assembly into a cryomodule. It specifically covers installation of the cryomodule in the Test Cave, integration of the cryomodule into the Test Cave infrastructure, cooldown, rf testing, data acquisition and analysis, and removal of the cryomodule from the Test Cave.

WBS Descriptor Form

WBS 1.04.15.09 **PCR** PCR LI 01 018 **Revision** 0 **Revision Date** 1/8/2003
Title CM Assy Procedure Development

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS element covers the equipment and manpower needed to carefully characterize assembly procedures, to identify those that have the greatest potential for improvement in the fraction of the gradient performance achieved in the Vertical Test Assembly remaining after the cavity is assembled into a cryomodule.

WBS Descriptor Form

WBS 1.04.15.10 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Installation of High Power RF System

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the specification, design, fabrication, procurement and installation of the equipment (LCW and electrical) needed to provide infrastructure support for the 1 MW RF test stand.

FY02 Deliverables: Complete installation of LCW and electrical infrastructure for the 1 MW RF test stand.

WBS Descriptor Form

WBS 1.04.16 **PCR** PCR OP 01 008 **Revision** 1 **Revision Date** 10/12/2001

Title ORNL Transfer Lines Fab Installation

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS is the ORNL support of WBS 1.04.12 (and 1.04.13.01) Refrigeration installation, and non-beam commissioning and Transfer Line assembly, installation, and non-beam commissioning.

WBS Descriptor Form

WBS 1.04.16.01 **PCR** PCR LI 01 036 **Revision** 0 **Revision Date** 3/14/2001

Title CHL Labor

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

No scope.

WBS Descriptor Form

WBS 1.04.16.02 **PCR** PCR LI 01 036 **Revision** 0 **Revision Date** 3/14/2001

Title Refrigeration System

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

No scope.

WBS Descriptor Form

WBS 1.04.16.03 **PCR** PCR LI 01 036 **Revision** 0 **Revision Date** 3/14/2001

Title Controls, Refrigerator/Cryomodule

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

No scope.

WBS Descriptor Form

WBS 1.04.16.04 **PCR** PCR OP 01 008 **Revision** 1 **Revision Date** 10/12/2001

Title ORNL Ancillary Equipment

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Labor and M&S for ORNL ancillary equipment for the superconducting RF linac.

WBS Descriptor Form

WBS 1.04.16.05 **PCR** PCR OP 01 008 **Revision** 1 **Revision Date** 10/12/2001

Title ORNL Transfer Line/Piping

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

ORNL labor, equipment and M&S needed to fabricate and install the cryogenic transfer lines.

WBS Descriptor Form

WBS 1.04.16.06 **PCR** PCR LI 01 036 **Revision** 0 **Revision Date** 3/14/2001

Title CTF Support

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

No scope.

WBS Descriptor Form

WBS 1.04.17 **PCR** PCR OP 01 008 **Revision** 1 **Revision Date** 10/12/2001

Title ORNL Support for Cryomodule Fabrication

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

ORNL labor and M&S to fabricate linac cryomodules, both medium and high beta, at JLAB

WBS Descriptor Form

WBS 1.04.17.01 **PCR** PCR LI 01 038 **Revision** 0 **Revision Date** 3/14/2001

Title Cavity String Assembly Procurements

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

No scope.

WBS Descriptor Form

WBS 1.04.17.02 **PCR** PCR LI 01 038 **Revision** 0 **Revision Date** 3/14/2001

Title Space Frame Assembly Procurements

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

No scope.

WBS Descriptor Form

WBS 1.04.17.03 **PCR** PCR LI 01 038 **Revision** 0 **Revision Date** 3/14/2001

Title Cryomodule Assembly Procurements

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

No scope.

WBS Descriptor Form

WBS 1.04.17.04 **PCR** PCR OP 01 008 **Revision** 1 **Revision Date** 10/12/2001

Title Cavity/Cryomodule Assembly Labor

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

ORNL labor and M&S to fabricate linac cryomodules, both medium and high beta, at JLAB

WBS Descriptor Form

WBS 1.04.17.05 **PCR** PCR LI 01 038 **Revision** 0 **Revision Date** 3/14/2001

Title Cavity Test

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

No scope.

WBS Descriptor Form

WBS 1.04.17.06 **PCR** PCR LI 01 038 **Revision** 0 **Revision Date** 3/14/2001

Title Cryomodule Installation

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

No scope.

WBS Descriptor Form

WBS 1.04.17.07 **PCR** PCR LI 01 038 **Revision** 0 **Revision Date** 3/14/2001

Title Electrical

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

No scope.

WBS Descriptor Form

WBS 1.04.18 **PCR** PCR OP 01 008 **Revision** 0 **Revision Date** 10/12/2001

Title ORNL Refrigeration System

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

ORNL labor and M&S to fabricate and install the SCL linac refrigeration system on the SNS site.

WBS Descriptor Form

WBS 1.04.19 **PCR** PCR OP 01 008 **Revision** 0 **Revision Date** 10/12/2001

Title ORNL Linac Assembly & Installation

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

ORNL engineering, technician and Davis-bacon labor and M&S to assemble and install the linac on the SNS site.

WBS Descriptor Form

WBS 1.04.19.01 **PCR** PCR OP 01 008 **Revision** 0 **Revision Date** 10/12/2001

Title ORNL RF Assembly and Installation

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

ORNL engineering, technician and Davis-bacon labor and M&S to assemble and install the linac RF system on the SNS site.

WBS Descriptor Form

WBS 1.04.19.02 **PCR** PCR OP 01 008 **Revision** 0 **Revision Date** 10/12/2001

Title ORNL DTL Assembly & Installation

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

ORNL engineering, technician and Davis-bacon labor and M&S to assemble and install the DTL on the SNS site.

WBS Descriptor Form

WBS 1.04.19.03 **PCR** PCR OP 01 008 **Revision** 0 **Revision Date** 10/12/2001

Title ORNL CCL Assembly & Installation

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

ORNL engineering, technician and Davis-bacon labor and M&S to assemble and install theCCL on the SNS site.

WBS Descriptor Form

WBS 1.04.19.04 **PCR** PCR OP 01 008 **Revision** 0 **Revision Date** 10/12/2001

Title ORNL Diagnostics Assembly & Installation

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

ORNL engineering, technician and Davis-bacon labor and M&S to assemble and install the linac beam diagnostics on the SNS site.

WBS Descriptor Form

WBS 1.04.19.05 **PCR** PCR OP 01 008 **Revision** 0 **Revision Date** 10/12/2001

Title ORNL SCL Assembly & Installation

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

ORNL engineering, technician and Davis-bacon labor and M&S to assemble and install the SCL including the warm sections between cryomodules on the SNS site.

WBS Descriptor Form

WBS 1.04.19.06 **PCR** PCR OP 01 008 **Revision** 0 **Revision Date** 10/12/2001

Title AC Distribution, Trays and Cables

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Labor and materials to provide for AC distribution and cables trays for the linac on the SNS site.

WBS Descriptor Form

WBS 1.04.20 **PCR** PCR AS 02 006 **Revision** 0 **Revision Date** 9/30/2002

Title Linac LLRF Support

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

LANL is responsible for the design and fabrication of the low level RF, LLRF, feedback and feed-forward control systems for the linac 402.5-MHz and 805 MHz-RF systems and for the associated software, integration and testing. This WBS provides for ORNL (or LBNL) support for this LLRF work.

WBS Descriptor Form

WBS 1.04.20.01 **PCR** PCR AS 02 006 **Revision** 0 **Revision Date** 9/30/2002

Title LBNL Linac LLRF Support

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS provides for LBNL support for Linac LLRF work.

WBS Descriptor Form

WBS 1.04.20.02 **PCR** PCR AS 02 006 **Revision** 0 **Revision Date** 9/30/2002

Title ORNL Linac LLRF Support

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS provides for ORNL support for Linac LLRF work.

WBS Descriptor Form

WBS 1.05 **PCR** PCR LI 01 038 **Revision** 0 **Revision Date** 7/13/1999
Title Ring and Transfer System

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Ring & Transport System accepts 1.0 GeV H- beam from the Linac and delivers the compressed beam of about 1 micro second to the target for neutron production. The system is divided into three major components: 1) the High Energy Beam Transport (HEBT) System, 2) the Accumulator Ring (AR) and 3) the Ring to Target Beam Transport (RTBT) System.

The function of HEBT is to provide the beam-matching channel for the Linac and to transport the beam to the injection region of the Ring. The beam halos generated in Linac and outside the acceptance of the Ring have to be scraped and collimated away. This will be done with three collimators to cover three-dimensional beam space. Two bunch rotators are provided to match the beam energy and momentum spread into the Ring.

The AR can provide 2 MW beam power by operating at 60 HZ with 2 by 10 E14 ppp. The AR receives 1msec long H- beam bunches of 56 mA at 1.0 GeV from the Linac. About 1200 turns of charge exchange injection is needed to accumulate 2 mA beam in the Ring.

The Ring design takes into consideration space charge tune shift,

RF beam loading, injection painting, coherent instabilities, e-p instabilities, halo formation and collimations. Beam losses will be kept at localized areas to minimize the radiation level around unprotected components.

The RTBT receives the beam from the Ring and transports it to the target. Before reaching the target, the beam has to be enlarged to the size of about 7cm by 20 cm to avoid the hot spot at the target. Another stringent requirement of the beam at the target is that the distribution cannot have peak intensity larger than twice the average intensity.

The availability requirement of the Ring and Transport System is better than 98%.

WBS Descriptor Form

WBS 1.05.01 **PCR** PCR LI 01 038 **Revision** 0 **Revision Date** 7/13/1999

Title HEBT Sytems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

See Level 5 Descriptors

WBS Descriptor Form

WBS 1.05.01.01 **PCR** PCR RI 03 008 **Revision** 0 **Revision Date** _____

Title HEBT Magnets and Support

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

All effort after February 28, 2003 will be accomplished in WBS 1.5.10.1 as estimated in the ETC PCR RI 03 007.

WBS Descriptor Form

WBS 1.05.01.02 **PCR** PCR RI 03 008 **Revision** 1 **Revision Date** _____

Title HEBT High Power - Power Supplies

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

All effort after February 28, 2003 will be accomplished in WBS 1.5.4.1 as estimated in the ETC PCR RI 03 007.

WBS Descriptor Form

WBS 1.05.01.03 **PCR** PCR LI 00 007 **Revision** 1 **Revision Date** 3/10/2000
Title HEBT Vacuum System

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Vacuum of 5×10^{-8} Torr is required in HEBT to minimize the H- stripping by residual gas and the resulted beam loss.

Design, fabrication, assembly, test, installation and commissioning of the HEBT vacuum systems, including Linac and HEBT dump regions.

Total length: ~ 240m; six (8) $11\frac{1}{4}$ degree $5\frac{1}{4}$ m long dipole chambers, one 8.8 degree dipole chambers, eighteen (18) 2001/s ion pumps, five (5) turbopump stations, gate valves, vacuum gauges and the associated power supplies and controllers.

The dipole chambers will be purchased from experienced vendor based on BNL drawings and specifications. Other vacuum chambers and pipes will be designed, fabricated, welded, and tested at BNL; and then installed at ORNL.

WBS Descriptor Form

WBS 1.05.01.04 **PCR** PCR LI 00 041 **Revision** 2 **Revision Date** 7/6/2000

Title HEBT Instrumentation

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Preliminary design effort through May 31, 2000. All other scope moved to 1.5.7 per PCR LI 00 041.

WBS Descriptor Form

WBS 1.05.01.05 **PCR** PCR RI 03 008 **Revision** 0 **Revision Date** _____

Title HEBT Scraper, Collimator, Shielding

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

All effort after February 28, 2003 will be accomplished in WBS 1.5.8.1 as estimated in the ETC PCR RI 03 007.

WBS Descriptor Form

WBS 1.05.01.06 **PCR** PCR LI 00 007 **Revision** 0 **Revision Date** 7/13/1999

Title HEBT Debuncher and Compressor RF Sys

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS to be eliminated.

WBS Descriptor Form

WBS 1.05.02 **PCR** PCR LI 00 007 **Revision** 0 **Revision Date** 7/13/1999

Title Injection Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

See Level 4 Descriptors

WBS Descriptor Form

WBS 1.05.02.01 **PCR** PCR RI 03 008 **Revision** 0 **Revision Date** _____

Title Pulsed Magnets

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

All effort after February 28, 2003 will be accomplished, in WBS 1.5.9.3 as estimated in the ETC PCR RI 03 007.

WBS Descriptor Form

WBS 1.05.02.02 **PCR** PCR RI 03 008 **Revision** 1 **Revision Date** _____

Title Pulsed Power Supplies

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

As of March 1, 2003 this WBS is revised to include remaining scope from 1.5.9.2 as estimated in ETC PCR RI 03 007.

WBS Descriptor Form

WBS 1.05.02.03 **PCR** PCR RI 03 008 **Revision** 0 **Revision Date** _____

Title D.C. Magnets

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

All effort after February 28, 2003 will be accomplished in WBS 1.5.9.3 as estimated in the ETC PCR RI 03 007.

WBS Descriptor Form

WBS 1.05.02.04 **PCR** PCR RI 03 008 **Revision** 2 **Revision Date** _____

Title Injection DC Power Supplies

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

All effort after February 28, 2003 will be accomplished in WBS 1.5.4.1 as estimated in the ETC PCR RI 03 007.

WBS Descriptor Form

WBS 1.05.02.05 **PCR** PCR RI 03 008 **Revision** 0 **Revision Date** _____

Title Stripped Foil

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

All effort after February 28, 2003 will be accomplished in WBS 1.5.9.3 as estimated in the ETC PCR RI 03 007.

WBS Descriptor Form

WBS 1.05.02.06 **PCR** PCR SN 02 002 **Revision** 0 **Revision Date** 11/2/2001

Title Diamond Stripping Foil

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the Research and Development effort to design and test diamond film. Ongoing development effort with ORNL will be supported for the delivery of prototype diamond films to BNL, where they will be tested.

WBS Descriptor Form

WBS 1.05.03 **PCR** PCR LI 00 007 **Revision** 0 **Revision Date** 7/13/1999

Title Magnet Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

See Level 5 Descriptors

WBS Descriptor Form

WBS 1.05.03.01 **PCR** PCR RI 03 008 **Revision** 0 **Revision Date** _____

Title Ring Magnets

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

As of March 1, 2003 this WBS is revised to include remaining scope from 1.5.3.2 as estimated in ETC PCR RI 03 007.

WBS Descriptor Form

WBS 1.05.03.02 **PCR** PCR RI 03 008 **Revision** 0 **Revision Date** _____

Title Low Field Magnets

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

All effort after February 28, 2003 will be accomplished in WBS 1.5.3.1 as estimated in the ETC PCR RI 03 007.

WBS Descriptor Form

WBS 1.05.03.03 **PCR** PCR LI 00 007 **Revision** 1 **Revision Date** 3/10/2000

Title Magnet Transport Trailer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design and procure a transport trailer for moving magnets to the tunnel and in areas not covered by the crane. This trailer will be based on the magnet weights in the design manual and the AGS/Booster transporter trailer. This task includes preliminary design, design reviews, tunnel drawings and the performance specification. The trailer will be moved by a tractor or forklift provided by the ORNL rigging group. The trailer will be purchased from commercial vendors via competitive bids. Final testing and will be performed by the ORNL technicians and riggers

R0 WBS Title: Magnet Support and Transporters

WBS Descriptor Form

WBS 1.05.03.04 **PCR** PCR LI 00 007 **Revision** 1 **Revision Date** 3/10/2000
Title Magnet Measurements

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Perform magnetic measurements for all of the magnets required for the accumulator ring systems. This task includes both detailed 3D field mapping of the magnet aperture and end fields for each magnet type (20 units) and long coil integrated measurements of the all of the production ring magnet assemblies (52 assembled units). The assembled units will include quadrupole and correctors mounted and measured together. Existing AGS/RHIC (CAD) Department facilities and power supplies will be used for the magnetic measurements. Special fixtures unique to the large aperture SNS magnets will be procured and fabricated as needed. At the end of the testing program the magnet data will be packaged and presented to the ORNL SNS machine physics group.

WBS Descriptor Form

WBS 1.05.04 **PCR** PCR LI 00 007 **Revision** 0 **Revision Date** 7/13/1999
Title Power Supply System

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Perform magnetic measurements for all of the magnets required for the accumulator ring systems. This task includes both detailed 3D field mapping of the magnet aperture and end fields for each magnet type (20 units) and long coil integrated measurements of the all of the production ring magnet assemblies (52 assembled units). The assembled units will include quadrupole and correctors mounted and measured together. Existing AGS/RHIC (CAD) Department facilities and power supplies will be used for the magnetic measurements. Special fixtures unique to the large aperture SNS magnets will be procured and fabricated as needed. At the end of the testing program the magnet data will be packaged and presented to the ORNL SNS machine physics group.

WBS Descriptor Form

WBS 1.05.04.01 **PCR** PCR RI 03 008 **Revision** 0 **Revision Date** _____

Title DC Power Supplies

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

As of March 1, 2003 this WBS is revised to include remaining scope from 1.5.1.2, 1.5.10.2, 1.5.2.4, 1.5.4.2 and 1.5.9.4 as estimated in ETC PCR RI 03 007.

WBS Descriptor Form

WBS 1.05.04.02 **PCR** PCR RI 03 008 **Revision** 2 **Revision Date** _____

Title Main Ring 600, 1200, 1500 Watt Power Supplies

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

All effort after February 28, 2003 will be accomplished in WBS 1.5.4.1 as estimated in the ETC PCR RI 03 007.

WBS Descriptor Form

WBS 1.05.05 **PCR** PCR RI 00 009 **Revision** 3 **Revision Date** 5/5/2000

Title Ring Vacuum System

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, fabricate, assembly, test, install and commission the SNS accumulator ring vacuum system.
Total vacuum chamber length: 248 m
Average ring vacuum: 1e-8 Torr.

WBS Descriptor Form

WBS 1.05.05.01 **PCR** PCR LI 00 007 **Revision** 1 **Revision Date** 3/10/2000

Title Ring Vacuum Chambers

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, fabrication, assembly, test and installation of the accumulator ring vacuum chambers.

32 arc halfcell chambers of 4m each, 20 straight section quadrupole chambers and approximately 40 adaptor bellows and pipes at straight sections.

Components will be fabricated by vendor per SNS drawings and specifications. The chambers will be welded together and assembled into magnets at BNL, tested then shipped to ORNL for installation and commissioning.

R0 WBS Title: Vacuum Chamber

WBS Descriptor Form

WBS 1.05.05.02 **PCR** PCR LI 00 007 **Revision** 1 **Revision Date** 3/10/2000
Title Ring Vacuum Pumps

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, assembly, test, installation and commissioning of the accumulator ring vacuum pumps, power supplies and controllers.

Forty (40) 2001/s sputter ion pumps and the associated power supplies. Four (4) 200-l/s turbopump/dry mechanical pump stations will be purchased, each will rough down two adjacent vacuum sectors.

Pumps and power supplies will be purchased from vendor per SNS drawings and specifications. Control and interface to turbopump stations will be designed and built by BNL.

To achieve pressure of 1×10^{-9} Torr, twenty-eight (28) additional ion pumps (eliminated by V.E.) and sixty-four (64) titanium sublimation pumps (eliminated during internal review) have to be implemented in the near future.

R0 WBS Title: Vacuum Pumps

WBS Descriptor Form

WBS 1.05.05.03 **PCR** PCR LI 00 007 **Revision** 1 **Revision Date** 3/10/2000

Title Ring Gate Valves

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, assembly, test and installation of the accumulator ring sector gate valves and valve controllers.

Eight large aperture rf-shielded all-metal electropneumatic gate valves for ring vacuum sectors.

Gate valves will be purchased from vendor per SNS drawings and specifications. Control and interface to PLCs will be designed and built by BNL.

Two manual valves to isolate injection stripping foil box are eliminated during internal review resulted in longer pump down time during foil changes.

R0 WBS Title: Sector Valves

WBS Descriptor Form

WBS 1.05.05.04 **PCR** PCR RI 03 005 **Revision** 1 **Revision Date** _____

Title Ring Vacuum Instrumentation

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, assembly, test and installation of the accumulator ring vacuum gauges, PLC system and application software. Eight sets of vacuum gauges, one per ring vacuum sectors and 4 sets of gauges for turbo-pump manifolds. Four PLC systems for Ring, HEBT and RTBT. Bakeout system for extraction kickers. Application codes for the operation of valves, turbo-pumps, and gauges.

Hardware will be purchased based on SNS specification. Software will be developed by BNL personnel.

Additional vacuum gauges are needed for adequate monitoring, control and protection of the ring vacuum system from catastrophic failure.

R0WBS Title: Vacuum Instrumentation

WBS Descriptor Form

WBS 1.05.05.05 **PCR** PCR LI 00 007 **Revision** 1 **Revision Date** 3/10/2000
Title Vacuum Facility and Support

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Setup the clean room and vacuum assembly facility. Procure test equipment.

Set up TiN magnetron sputtering coating facility, develop the coating parameters and coat the ring vacuum chambers with ~ 100 Å TiN.

Test and commissioning of vacuum systems at ORNL.

One TiN coating setup with adjustable coil diameter, two portable leak detectors, several sets of vacuum gauges, RGAs, and turbo-pumps for assembly and testing.

Large capital equipment will be purchased through competitive bidding. Others will be purchased from reputable vendors.

R0 WBS Title: Facility and Support

WBS Descriptor Form

WBS 1.05.06 **PCR** PCR LI 00 007 **Revision** 0 **Revision Date** 7/13/1999
Title RF System

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Setup the clean room and vacuum assembly facility. Procure test equipment.

Set up TiN magnetron sputtering coating facility, develop the coating parameters and coat the ring vacuum chambers with ~ 100 Å TiN.

Test and commissioning of vacuum systems at ORNL.

One TiN coating setup with adjustable coil diameter, two portable leak detectors, several sets of vacuum gauges, RGAs, and turbo-pumps for assembly and testing.

Large capital equipment will be purchased through competitive bidding. Others will be purchased from reputable vendors.

R0 WBS Title: Facility and Support

WBS Descriptor Form

WBS 1.05.06.01 **PCR** PCR RI 03 011 **Revision** 1 **Revision Date** _____

Title RF System

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

As of March 1, 2003 this WBS is revised to include remaining scope from 1.5.6.2 as estimated in ETC PCR RI 03 007. PCR RI 03 011 transfers to BNL the responsibility for the design and build of the RF Junction Box.

WBS Descriptor Form

WBS 1.05.06.02 **PCR** PCR RI 03 008 **Revision** 1 **Revision Date** _____

Title RF System

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

All effort after February 28, 2003 will be accomplished in WBS 1.5.6.1 as estimated in the ETC PCR RI 03 007.

WBS Descriptor Form

WBS 1.05.07 **PCR** PCR LI 00 007 **Revision** 0 **Revision Date** 7/13/1999
Title Ring System Diagnostic Instrumentation

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Low level rf system refers to those components which operate at low voltage and current.

The beam pickup and diagnostic signals from the high level system are processed by the low level system. In turn, the low level system uses the processed signals to drive the high level system in such a way to optimize total performance.

There are several components. The beam current based feed-forward system reduces the impedance seen by the beam (Z_{beam}). Without such a system the beam loading parameter $Y = I_{\text{beam}} * Z_{\text{beam}} / V_{\text{rf}} = 4$. Generally, $Y=1$ is considered sound engineering practice. Additionally, the beam current is ramping throughout the 1 millisecond SNS cycle. A feed forward signal reduces the gain required for the phase and AGC loops in this case. The phase loop measures the beam and gap volt phases and adjusts the grid drive voltage to optimize performance. Additionally, these signals will be used to provide a signal to the MEBT chopper which will inject beam at the optimal phase. The automatic gain control (AGC) loop measures the magnitude of the gap voltage and adjusts the grid drive voltage accordingly. Simulations show that the phase and AGC loops allow for a 20% error in the feedforward signal without degrading performance.

Without these loops a 10% error in the feedforward signal causes beam to leak into the gap.

Since the beam current is much larger than the current needed to drive the gap voltage, the bulk of the current delivered by the tube goes to cancel the effect of the beam.

R0 WBS Title: Low Level Systems

WBS Descriptor Form

WBS 1.05.07.01 **PCR** PCR LI 00 041 **Revision** 2 **Revision Date** 6/19/2000
Title Beam Position Monitor System

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

HEBT : Dual plane stripline beam position monitor (BPM) pickup electrodes (PUEs) will be installed at every other quadrupole (alternating with corrector packages) to measure the position in the line.

Ring: Dual plane stripline BPM PUEs will be installed at every quadrupole to measure the average orbit in the ring.

RTBT: Dual plane stripline BPM PUEs will be installed at every other quadrupole (alternating with corrector packages) to measure the position in the line.

Number of Units:

HEBT: 20

Ring: 53

RTBT: 16

Method of Accomplishment: All PUEs will be designed by BNL and fabricated by BNL shops and outside vendors. They will be tested and calibrated by BNL. Microbunch (400MHz) electronics will be designed and built by LANL, and supplied by LANL for all HEBT BPMs and a few BPMs in the Ring. Macrobunch (1MHz) electronics will be designed and built by BNL, and provided for all Ring and RTBT BPMs. Design of digital portion of BPM electronics will be common between BNL and LANL, and design effort will be shared.

WBS Descriptor Form

WBS 1.05.07.02 **PCR** PCR LI 00 041 **Revision** 2 **Revision Date** 6/19/2000
Title Ionization Profile Monitors

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

: Electrons ionized from the residual gas are confined by a uniform magnetic field and swept from the beamline by a transverse electric field parallel to the magnetic field, amplified by a multi-channel plate, and collected by strip anodes on a ceramic circuit board. System bandwidth will permit turn-by-turn profile measurements. Vacuum bump will be permitted to increase signal early in the cycle.

Number of Units: 2 planes

Method of Accomplishment: The IPM detectors, vacuum chambers, magnets, and electronics will be fabricated, assembled and tested at BNL. Prototype work will be accomplished in conjunction with the RHIC IPM system.

WBS Descriptor Form

WBS 1.05.07.03 **PCR** PCR LI 00 041 **Revision** 2 **Revision Date** 6/19/2000
Title Beam Loss Monitors

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

A Beam Loss Monitor system which allows measurement of losses from the entrance to the Linac thru HEBT, the Ring, and RTBT to the Target and, provides a beam inhibit on excessive loss. An array of ion chambers will be used for the general loss measurements and scintillator/photo-multipliers will detect losses during the bunch interval.

Number of Units:

Linac: 90 Ion chambers, 4 scintillator/photo-multipliers

HEBT: 45 Ion chambers, 3 scintillator/photo-multipliers

Ring: 96 Ion chambers, 10 scintillator/photo-multipliers

RTBT: 57 Ion chambers, 3 scintillator/photo-multipliers

Method of Accomplishment: The ion chambers will be purchased commercially and assembled into a BNL designed housing and mount by a local vendor. The unit will be calibrated by BNL. The electronics will be designed by BNL and produced using local fabrication vendors.

WBS Descriptor Form

WBS 1.05.07.04 **PCR** PCR LI 00 041 **Revision** 2 **Revision Date** 6/20/2000
Title Ring Beam Current Monitors (BCM)

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

A Beam Current Monitor system which allows measurement of beam current from MEBT thru the Linac, HEBT, the Ring, and RTBT to the Target. A single transformer design will be used for monitoring micro, mini, and macro bunch intensity. Appropriate signal conditioning and interface electronics for these detectors will also be provided.

Number of Units:

MEBT: 2

Linac: 16

HEBT: 4

Ring: 1

RTBT: 5

Method of Accomplishment: LBNL will provide MEBT transformers. LANL will provide Linac transformers. BNL will provide HEBT, Ring, and RTBT transformers. All signal conditioning and interface electronics will be designed at BNL, and either fabricated at BNL or purchased.

WBS Descriptor Form

WBS 1.05.07.05 **PCR** PCR LI 00 041 **Revision** 2 **Revision Date** 6/20/2000
Title Ring Tune Monitor

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Tune measurement will be measured for both mini and micro bunches. The large amplitude injection betatron oscillations of the microbunches will be observed for the first few turns. Microbunch oscillations will be measured with the HF narrowband BPM electronics. Tune measurement of the minibunch will use a PLL system with a low power kicker. Space charge tune shift might be extracted from these measurements.

Number of Items: Two systems, two planes per system.

Method of Accomplishment: The Tune Kicker will be fabricated, assembled and tested at BNL. The amplifier will be purchased. Prototype work will be accomplished in conjunction with the RHIC Tune system.

WBS Descriptor Form

WBS 1.05.07.06 **PCR** PCR LI 00 041 **Revision** 2 **Revision Date** 6/20/2000
Title Wire Scanner Beam Profile Monitors

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Provide wires to measure the transverse density distributions and halos in HEBT, the Ring, and RTBT

Number of Items:

HEBT: 11 locations, 22 planes

Ring: 1 locations, 2 planes

RTBT: 5 locations, 10 planes

Method of Accomplishment: The Wires will be fabricated, assembled and tested at BNL. Two approaches are under consideration, and a combination of these two methods will probably be used. The numerical mix will probably be determined after prototype evaluation.

The first approach will employ a thin laser beam to neutralize a slice of the beam, with detection of beam profile by differential beam current measurements. A prototype will be built and installed in the AGS Linac.

The second approach is to use conventional carbon wires. A prototype will be built and installed in the RHIC ring to confirm wire heating and lifetime calculations. Linear motors are under consideration for simplicity, radiation hardness, and absence of vacuum penetrations. Readout of wire current and PMT (ie FBLM) readout are both under consideration. It is our intent to operate these wires in flying, crawling, and stationary modes.

WBS Descriptor Form

WBS 1.05.07.07 **PCR** PCR LI 00 041 **Revision** 2 **Revision Date** 6/20/2000
Title Ring Beam-In-Gap Cleaner/Monitor

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Ring beam in gap will be driven at the vertical betatron tune by a 5m long stripline kicker located a multiple of 90 degrees from the collimators, where it will be observed with a fast gated loss monitor. This has the dual benefits of measuring the gap beam and cleaning it, normally immediately before extraction. The hardware use MOSFET banks to supply 10 ns rise and fall time pulses to a transmission line kicker for turn-by-turn kicking.

Number of Items: One system, vertical kick

Method of Accomplishment: The Kicker and pulsers will be fabricated, assembled and tested at BNL. The fast solid state switches will be purchased. Prototype work will be accomplished in conjunction with the RHIC Tune/Damper system.

WBS Descriptor Form

WBS 1.05.07.08 **PCR** PCR LI 00 041 **Revision** 2 **Revision Date** 6/20/2000
Title Video Foil Monitor

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Radiation hardened video cameras will be installed in the ring injection area to detect the light emitted from stripping foils. This will allow monitoring of the beam position on the foils and foil condition. These images will be digitized and processed for analysis.

Number of Items: Two video cameras systems and image processing electronics.

Method of Accomplishment: The video cameras systems, lenses, and image processing electronics will be purchased. The camera mounts, optical alignment hardware and neutral density filter assemblies will be built using similar designs for existing BNL units.

Installation by others.

WBS Descriptor Form

WBS 1.05.08 **PCR** PCR LI 00 007 **Revision** 0 **Revision Date** 7/13/1999

Title Collimation and Shielding

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

See Level 4 Descriptors

WBS Descriptor Form

WBS 1.05.08.01 **PCR** PCR RI 03 012 **Revision** 1 **Revision Date** _____
Title Ring Collimator and Shielding

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Ring:

This task consists of the mechanical design and construction of three ring collimators, which are designed to be self-shielding devices. They will thus not only stop the primary halo particles impinging on them but also contain a large fraction of the secondary radiation that is generated, and the spallation products resulting from the primary particles interacting with the collimator internal structure. The only spallation products which can leave the collimator will be those generated in the cooling water, which will pass through an intermediate heat exchanger, thus confining the irradiated water. All three ring collimators are located in the straight section following the injection section. They will all have fixed apertures, which are shaped appropriately for the location and beam profile. The remainder of the collimator structure will be the same for all collimators. The secondary production of electrons and protons due to grazing interactions of the primary particles is of special concern for the ring collimators. This is due to the fact that the beam passes through these collimators many times and the build-up of these secondary particles could become unacceptably high. An experimental program is being carried out (WBS 1.1.3.5) to study this question. In addition the cyclic nature of the mechanical loads needs to be addressed. Installation by ORNL personnel.

Moveable shield:

This task will consist of developing a movable shield which will be used as additional shielding around areas of exceptionally high radiation while the machine is operating, or to be used around areas of high radiation to shield maintenance workers while the machine is shut down. This device will be heavy and must be easily moved remotely. This requirement essentially mandates the existence of an overhead crane. (additional shield scope removed during ETC, ref PCRs RI 03 007 and 008)

HEBT:

This task consists of designing the beam halo charge exchange foil mechanism, an appropriate collimator, and integrating this assembly into the HEBT line magnet system. The halo particles are changed to protons as they pass through the foil and are deflected out of the primary beam as they pass through the magnet, and stopped in a collimator. There will be three assemblies of the type described above in the HEBT line. There will be one for each of the x and y directions, and one for removing off momentum particles in the HEBT line bend. The charge exchange foil and associated mechanism will be based on experience gained from the main ring charge exchange foil design, and the collimator design will be based on the main ring collimator design. The primary areas of concern are the containment of residual activity due to spallation products in the collimator, activation of the surroundings, and the cyclic nature of the mechanical loads on the components.

RTBT:

This task consists of designing the collimators for the RTBT transfer line. There are two collimator types in this transfer line. Two units are similar to those in the Ring. The third one shields the transfer line from the particles scattered off the target. The design effort for the third unit has been transferred to the Target Systems Group. The primary area of concern for the first collimators is the possibility of a thermo-mechanical enhanced stress in the collimator structure in the event that an entire pulse is deposited in the collimator. Such a situation could result if there is a failure in the extraction system. In this case the collimator would experience the same mechanical shock load as the mercury target, since the pulse time structure is the same as the pulse on the target. In addition issues concerning the containment of activation products apply in this case. Installation by ORNL personnel.

WBS Descriptor Form

WBS 1.05.08.02 **PCR** PCR RI 03 008 **Revision** 1 **Revision Date** _____

Title Movable Shielding

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

All effort after February 28, 2003 will be accomplished in WBS 1.5.8.1 as estimated in the ETC PCR RI 03 007.

WBS Descriptor Form

WBS 1.05.08.03 **PCR** PCR LI 00 007 **Revision** 0 **Revision Date** 7/13/1999

Title Monitor Instrumentation

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS to be eliminated.

WBS Descriptor Form

WBS 1.05.09 **PCR** PCR LI 00 007 **Revision** 0 **Revision Date** 7/13/1999

Title Extraction System

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

See Level 4 descriptors.

WBS Descriptor Form

WBS 1.05.09.01 **PCR** PCR RI 03 008 **Revision** 1 **Revision Date** _____

Title Ring Extraction Pulsed Dipole Magnets

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

All effort after February 28, 2003 will be accomplished in WBS 1.5.9.3 as estimated in the ETC PCR RI 03 007.

WBS Descriptor Form

WBS 1.05.09.02 **PCR** PCR RI 03 008 **Revision** 3 **Revision Date** _____

Title Extraction Kicker Power Supply

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

All effort after February 28, 2003 will be accomplished in WBS 1.5.2.2 as estimated in the ETC PCR RI 03 007.

WBS Descriptor Form

WBS 1.05.09.03 **PCR** PCR RI 03 008 **Revision** 1 **Revision Date** _____

Title Special Injection & Extraction Magnets & Equipment

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

As of March 1, 2003 this WBS is revised to include remaining scope from 1.5.2.1, 1.5.2.3, 1.5.2.5 and 1.5.9.1 as estimated in ETC PCR RI 03 007.

WBS Descriptor Form

WBS 1.05.09.04 **PCR** PCR RI 03 008 **Revision** 1 **Revision Date** _____

Title Extraction Lambertson Power Supply

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

All effort after February 28, 2003 will be accomplished in WBS 1.5.4.1 as estimated in the ETC PCR RI 03 007.

WBS Descriptor Form

WBS 1.05.10 **PCR** PCR LI 00 007 **Revision** 1 **Revision Date** 3/10/2000

Title RTBT System

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

See level four descriptors

WBS Descriptor Form

WBS 1.05.10.01 **PCR** PCR RI 03 008 **Revision** 0 **Revision Date** _____

Title HEBT & RTBT Magnets

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

As of March 1, 2003 this WBS is revised to include remaining scope from 1.5.1.1 as estimated in ETC PCR RI 03 007.

WBS Descriptor Form

WBS 1.05.10.02 **PCR** PCR RI 03 008 **Revision** 2 **Revision Date** _____

Title RTBT High Power - Power Supplies

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

All effort after February 28, 2003 will be accomplished in WBS 1.5.4.1 as estimated in the ETC PCR RI 03 007.

WBS Descriptor Form

WBS 1.05.10.03 **PCR** PCR LI 00 007 **Revision** 1 **Revision Date** 3/10/2000
Title RTBT Vacuum System

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Vacuum of 10^{-7} Torr is required in RTBT to minimize beam loss due to beam-residual gas nuclear scattering and to reduce back streaming of residual gas into 10^{-9} Torr ring vacuum system.

Design, fabrication, assembly, test, installation and commissioning of the RTBT vacuum systems.

Total length: ~ 160m; one 17 degree dipole chambers, twelve (12) 2001/s ion pumps, three (3) turbopump stations, gate valves, vacuum gauges and the associated power supplies and controllers.

The 17-degree dipole chamber will be fabricated at BNL central shop. Other vacuum chambers and pipes will be designed and fabricated in-house.

The EDIA of other components are carried out together with the Ring vacuum components.

R0 WBS Title: RTBT Vacuum

WBS Descriptor Form

WBS 1.05.10.04 **PCR** PCR LI 00 041 **Revision** 2 **Revision Date** 7/6/2000

Title RTBT Instrumentation

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Preliminary design effort through May 31, 2000. All other scope moved to 1.5.7 per PCR LI 00 041.

WBS Descriptor Form

WBS 1.05.10.05 **PCR** PCR RI 03 008 **Revision** 2 **Revision Date** _____

Title RTBT Collimator and Shielding

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

All effort after February 28, 2003 will be accomplished in WBS 1.5.8.1 as estimated in the ETC PCR RI 03 007.

WBS Descriptor Form

WBS 1.05.11 **PCR** PCR LI 00 007 **Revision** 1 **Revision Date** 3/10/2000

Title Cabling

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The costs to procure the high power cable, low power control cable, signal cabling, and associated hardware for the HEBT, RTBT and Ring power supplies is included in this WBS. In addition, the cost of the cable tray to and from the power supplies, plus installation, within the RTBT, HEBT, and Ring service building is also included. The AC cabling to the power supplies and the cost to install the cabling is not included in this WBS.

R0 WBS Title: Cable

WBS Descriptor Form

WBS 1.05.11.01 **PCR** PCR LI 00 007 **Revision** 0 **Revision Date** 7/13/1999

Title High Power Cable

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The costs to procure the high power cable, and associated hardware for the HEPT, RTBT and Ring power supplies is included in this WBS. The AC cabling to the power supplies and the cost to install the cabling is not included in this WBS.

WBS Descriptor Form

WBS 1.05.11.02 **PCR** PCR LI 00 007 **Revision** 0 **Revision Date** 7/13/1999

Title Low Power Control Cable

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The costs to procure the low power control cable and associated hardware for the HEFT, RTBT and Ring power supplies is included in this WBS. The AC cabling to the power supplies and the cost to install the cabling is not included in this WBS.

WBS Descriptor Form

WBS 1.05.11.03 **PCR** PCR LI 00 007 **Revision** 0 **Revision Date** 7/13/1999

Title Signal Cable

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The costs to procure the signal cabling and associated hardware for the HEBT, RTBT and Ring power supplies is included in this WBS. The AC cabling to the power supplies and the cost to install the cabling is not included in this WBS.

WBS Descriptor Form

WBS 1.05.11.04 **PCR** PCR LI 00 007 **Revision** 0 **Revision Date** 7/13/1999

Title Tray

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The costs to procure the cable tray to and from the power supplies, plus installation, within the RTBT, HEFT, and Ring service building is also included. The AC cabling to the power supplies and the cost to install the cabling is not included in this WBS.

WBS Descriptor Form

WBS 1.05.12 **PCR** PCR LI 00 007 **Revision** 0 **Revision Date** 7/13/1999

Title Technical Support

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

See Level 4 Descriptors

WBS Descriptor Form

WBS 1.05.12.01 **PCR** PCR LI 00 007 **Revision** 1 **Revision Date** 3/10/2000

Title Project Management

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS contains the effort associated with the project office at BNL for the Ring and transfer line systems. The effort includes: the Senior Team Leader, his deputies, the mechanical and electrical system leaders management effort, systems engineering, project controls, installation and conventional facilities coordination, QA and ES&H, financial oversight, documentation and the project office secretary. This staff responses to all requests from the SNS project office at ORNL.

R0 WBS Title: Management

WBS Descriptor Form

WBS 1.05.12.02 **PCR** PCR LI 00 007 **Revision** 1 **Revision Date** 3/10/2000
Title Accelerator Physics

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The accelerator physics group is responsible to integrate the existing knowledge of accelerator physics, computer codes, and component capabilities to optimize the design parameters and performances. The important design concerns are the ring lattice structure, injection arrangements, space charge tune shift, halo formation by envelop oscillation, momentum spread, e-p instability, scraping and collimation of stray particle, density distribution at the target. All the design parameters are inter-related and need large and reliable computer codes to aid our design efforts. We also have to interact with collaborating SNS teams and world communities, such as ESS, JHF and muon colliders to improve on the design concept and tools

R0 WBS Title: Physics Support

WBS Descriptor Form

WBS 1.05.12.03 **PCR** PCR LI 00 007 **Revision** 1 **Revision Date** 3/10/2000
Title Application Software Support

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Another important area of responsibility for the accelerator physics group is to develop the needed application software for accelerator commissioning and operation. This needed in-depth knowledge of the accelerator design, diagnostics provided and computer control environment. Typical routines for orbit acquisition, orbit corrections, tune measurement, chromaticity correction, profile measurement, resonance corrections will be developed and provided for speedy commissioning. A computer-based model of the accelerator will also be created to simulate the performance of the accelerator under as built component condition. This model can also be used in conjunction with beam measurement for orbit correction and beam studies for improvements and upgrades.

R0 WBS Title: Software Support

WBS Descriptor Form

WBS 1.05.12.04 **PCR** PCR RI 00 004 **Revision** 1 **Revision Date** 5/3/2000
Title Injection Parameter Optimization

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers machine studies and benchmarking between machine and simulation codes to support the design of the SNS. A dedicated 200 MeV flat magnetic cycle is set at AGS Booster for SNS code benchmarking over a 2 year period. Studies will be mostly parasitic to the AGS high intensity proton runs. Study subjects include multiturn injection, painting, space charge effect, beam loss and beam profile, e-p instability, etc.

WBS Descriptor Form

WBS 1.05.12.05 **PCR** PCR RI 00 005 **Revision** 1 **Revision Date** 5/3/2000
Title Collimation Geometry Optimization

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the experimental studies which will be used to calibrate the collimation design of the SNS. The studies aim to check the validity of the codes used to calculate the total efficiency of the collimation system by performing collimation experiments at close to the SNS accumulator ring nominal energy of 1 GeV. These experiments will be performed in the U-70 synchrotron at Protvino, Russia; the AGS Booster at Brookhaven, and subject to approval, in the SPS synchrotron at CERN, Geneva. The program is planned for approximately 2 years.

WBS Descriptor Form

WBS 1.05.13 **PCR** PCR LI 00 007 **Revision** 0 **Revision Date** 7/13/1999

Title ORNL Field Coordination

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS account contains additional ORNL field coordination and technician labor required to achieve and efficient installation, pre-acceptance testing and commissioning of the Ring and Transfer Systems.
This activity is in addition to normal Title III supervision as it covers the transition to ORNL of the responsibility for these activities.

WBS Descriptor Form

WBS 1.05.13.01 **PCR** PCR OP 01 008 **Revision** 0 **Revision Date** 10/12/2001

Title Ring Field Coordination

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS account contains additional ORNL field coordination and technician labor required to achieve and efficient installation, pre-acceptance testing and commissioning of the Ring and Transfer Systems. This activity is in addition to normal Title III supervision as it covers the transition to ORNL of the responsibility for these activities.

WBS Descriptor Form

WBS 1.05.13.02 **PCR** PCR OP 01 008 **Revision** 1 **Revision Date** 10/12/2001

Title Ring Spares

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Spare parts and components for testing and commissioning the HEFT, ring and RTBT on the SNS site.

WBS Descriptor Form

WBS 1.05.13.03 **PCR** PCR OP 01 008 **Revision** 0 **Revision Date** 10/12/2001

Title Ring FC Power Supplies

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Field coordination activities connected to the HEBT-ring-RTBT power supplies.

WBS Descriptor Form

WBS 1.05.13.04 **PCR** PCR OP 01 008 **Revision** 0 **Revision Date** 10/12/2001

Title Ring FC Diagnostics

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Field coordination activities connected to the HEFT-ring-RTBT beam diagnostic systems.

WBS Descriptor Form

WBS 1.05.13.05 **PCR** PCR OP 01 008 **Revision** 0 **Revision Date** 10/12/2001

Title Injection Stripping Foil

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Field coordination activities connected to the ring injection stripping foil.

WBS Descriptor Form

WBS 1.05.13.14 **PCR** PCR OP 01 008 **Revision** 0 **Revision Date** 10/12/2001

Title Ring FC Mechanical

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Field coordination activities connected to the HEBT-ring-RTBT mechanical systems.

WBS Descriptor Form

WBS 1.05.13.15 **PCR** PCR AS 03 011 **Revision** 0 **Revision Date** _____

Title Ring Survey and Alignment Field Coordination

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Provide labor and materials for survey and alignment of ring components.

WBS Descriptor Form

WBS 1.05.13.18 **PCR** PCR OP 01 008 **Revision** 0 **Revision Date** 10/12/2001

Title Ring Installation Services

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Supervision and organzing labor, equipment and M&S for accelerator componnent installation.

WBS Descriptor Form

WBS 1.05.14 **PCR** PCR OP 01 008 **Revision** 0 **Revision Date** 10/12/2001

Title ORNL Ring Assembly & Installation

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

ORNL engineering, technician and Davis-bacon labor and M&S to assemble and install the HEBT-ring-RTBT on the SNS site.

WBS Descriptor Form

WBS 1.05.14.01 **PCR** PCR OP 01 008 **Revision** 0 **Revision Date** 10/12/2001

Title ORNL HEFT Assembly & Installation

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

ORNL engineering, technician and Davis-bacon labor and M&S to assemble and install the HEFT on the SNS site.

WBS Descriptor Form

WBS 1.05.14.02 **PCR** PCR OP 01 008 **Revision** 0 **Revision Date** 10/12/2001

Title ORNL Injection Assembly & Installation

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

ORNL engineering, technician and Davis-bacon labor and M&S to assemble and install the ring injection system on the SNS site.

WBS Descriptor Form

WBS 1.05.14.03 **PCR** PCR OP 01 008 **Revision** 0 **Revision Date** 10/12/2001

Title ORNL Magnet Assembly & Installation

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

ORNL engineering, technician and Davis-bacon labor and M&S to assemble and install the ring magnet system on the SNS site.

WBS Descriptor Form

WBS 1.05.14.04 **PCR** PCR OP 01 008 **Revision** 0 **Revision Date** 10/12/2001

Title ORNL Power Supply Assembly & Installation

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

ORNL engineering, technician and Davis-bacon labor and M&S to assemble and install the HEBT-ring-RTBT power supplies on the SNS site.

WBS Descriptor Form

WBS 1.05.14.05 **PCR** PCR OP 01 008 **Revision** 0 **Revision Date** 10/12/2001

Title ORNL Vacuum Assembly & Installation

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

ORNL engineering, technician and Davis-bacon labor and M&S to assemble and install the HEBT-ring-RTBT vacuum systems on the SNS site.

WBS Descriptor Form

WBS 1.05.14.06 **PCR** PCR OP 01 008 **Revision** 0 **Revision Date** 10/12/2001

Title ORNL RF Assembly & Installation

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

ORNL engineering, technician and Davis-bacon labor and M&S to assemble and install the ring RF system on the SNS site.

WBS Descriptor Form

WBS 1.05.14.07 **PCR** PCR OP 01 008 **Revision** 0 **Revision Date** 10/12/2001

Title ORNL Diagnostics Assembly & Installation

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

ORNL engineering, technician and Davis-bacon labor and M&S to assemble and install the HEBT-ring-RTBT diagnostics systems on the SNS site.

WBS Descriptor Form

WBS 1.05.14.08 **PCR** PCR OP 01 008 **Revision** 0 **Revision Date** 10/12/2001

Title ORNL Collimation & Shielding Assembly & Installation

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

ORNL engineering, technician and Davis-bacon labor and M&S to assemble and install the HEFT-ring-RTBT collimation and shielding on the SNS site.

WBS Descriptor Form

WBS 1.05.14.09 **PCR** PCR OP 01 008 **Revision** 0 **Revision Date** 10/12/2001

Title ORNL Extraction Assembly & Installation

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

ORNL engineering, technician and Davis-bacon labor and M&S to assemble and install the ring extraction system on the SNS site.

WBS Descriptor Form

WBS 1.05.14.10 **PCR** PCR OP 01 008 **Revision** 0 **Revision Date** 10/12/2001

Title ORNL RTBT Assembly & Installation

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

ORNL engineering, technician and Davis-bacon labor and M&S to assemble and install the RTBT on the SNS site.

WBS Descriptor Form

WBS 1.05.14.11 **PCR** PCR OP 01 008 **Revision** 0 **Revision Date** 10/12/2001

Title AC Distribution, Trays and Cables

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

ORNL labor and materials to provide for AC distribution and cables trays for the HEFT-ring-RTBT on the SNS site.

WBS Descriptor Form

WBS 1.05.14.12 **PCR** PCR OP 01 008 **Revision** 0 **Revision Date** 10/12/2001

Title BNL Installation Support

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

BNL labor and travel expenses to support HEFT-ring-RTBT installation and commissioning at the SNS site.

WBS Descriptor Form

WBS 1.06 **PCR** PCR LI 00 007 **Revision** 0 **Revision Date** 7/13/1999
Title Target Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The purpose of Target Systems is to safely provide low-energy neutrons from high-energy spallation reactions for short-pulse neutron scattering instruments (neutron source system): to develop three-proton beam dumps, one for the linac and two for the storage ring; and to implement the neutronic shielding, and activation analysis for the SNS Project.

Some general design parameters include:

Beam/Power:	1-GeV proton beam, 2 MW, 60 Hertz, < 1 micro-sec/pulse
Target/Container:	Hg/SS316
Moderators:	2 Supercritical Hydrogen, 2 Ambient Water
Reflector:	Pb
Beam Lines:	18

Target systems is broken down into the following WBS elements: Line Item 1.6.1 – Target Assemblies, 1.6.2 – Moderator Systems, 1.6.3 – Reflector Assemblies, 1.6.4 – Vessel Systems, 1.6.5 – Target Station Shielding, 1.6.6 – Target Utilities System, 1.6.7 – Remote Handling System, 1.6.8 – Controls, 1.6.9 – Beam Dumps, 1.6.10 – Technical Support, 1.6.10.2 – Accelerator and Target System Neutronics and Shielding; R&D 1.1.4 – Neutron source System Development, 1.1.5 – Mercury Target System Development, 1.1.6 – Materials Qualification, 1.1.7 – Cold Moderator System Development, and 1.1.10 – Robotics and Remote Handling Development.

Target Systems plans to use the following method of accomplishment. For design, ORNL will perform Title I design for all systems; Title II will be performed by ORNL for some subsystems and by subcontractors for others. Detailed design and fab subcontractors will be awarded for WBS 1.6.6 (Utilities) and 1.6.7 (Remote Handling) with ORNL oversight. For fabrication and assembly, ORNL will prepare procurement specifications, award subcontract, follow vendor performance, factory testing, and shipment to SNS site. Installation will be performed primarily by Davis Bacon personnel but some installation will be performed by fabrication subcontractors and ORNL technicians. Testing and commissioning will be performed by a team made up of CM, subcontractors, fabrications subcontractors, ORNL engineers (Title III) technicians, and Pre-Ops staff (for commissioning only).

Because of the activation generated in the Hg, the mercury target, shielding and maintenance systems will be part of a nuclear facility and must be designed in accordance with appropriate safety requirements.

WBS Descriptor Form

WBS 1.06.01 **PCR** PCR TG 00 014 **Revision** 1 **Revision Date** 9/15/2000
Title Target Assemblies

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The function of the target assembly to provide a contained volume of mercury to produce neutrons through interactions with the high-energy proton beam. It consists of three main elements: the target plug (See WBS1.6.1.1), the target process system (See WBS 1.6.1.2), and the target transporter (See WBS 1.6.1.3). The assembly and testing of the system is defined as WBS 1.6.1.4. The target assemblies must safely contain the flowing liquid mercury target material and transport the absorbed proton beam power to secondary cooling systems.

The system will be designed by the SNS staff, supported by design contracts. The components will be obtained from equipment fabricators using a combination of build-to-print drawings and performance specifications. The majority of components will be installed by construction labor with a few key components being installed by SNS operating technicians.

WBS Descriptor Form

WBS 1.06.01.01 **PCR** PCR TG 00 014 **Revision** 1 **Revision Date** 9/15/2000
Title Target Module

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The target plug consists of a target module mounted on a moveable carriage assembly. The target module consists of a mercury vessel for containing the mercury surrounded by a second water-cooled vessel for containing leaks from the mercury vessel. The carriage assembly includes passive shielding surrounding the approximately 25 feet of piping connecting the target module to the process systems. The carriage is supported from wheels for moving the target module to a hot cell for maintenance.

Rev.0 Title: Target Module. Modified via PCR TG-00-014

WBS Descriptor Form

WBS 1.06.01.02 **PCR** PCR TG 00 014 **Revision** 1 **Revision Date** 9/15/2000
Title Target Process System

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The target process systems provide the components required to process, circulate and cool the mercury as well as the water in the shroud surrounding the target. The mercury loop includes the piping, main circulating pump, and mercury to water heat exchanger along with valves, storage tanks, control and monitoring sensors, necessary for operation. Since the mercury will be radioactive, the system is located in a hot cell and will be operated and maintained by remote means. Components expected to require change-out will be connected by remotely operated flanged connections. A continuous stainless steel catch pan will be provided to route any spilled mercury to the storage tank. The water system includes the piping and valves necessary to connect the water supply to the shroud to a cooling loop provided by utilities.

WBS Descriptor Form

WBS 1.06.01.03 **PCR** PCR TG 00 014 **Revision** 1 **Revision Date** 9/15/2000

Title Target Transport System

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The target transporter system provides the components for moving the plug between the maintenance cell and its operational position. The system also provides precisely aligned rails on which the plug moves and components for holding it in place at the end of its travel.

WBS Descriptor Form

WBS 1.06.01.04 **PCR** PCR TG 00 014 **Revision** 1 **Revision Date** 9/15/2000

Title Assembly and Testing

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS includes the description and cost of installing the system which includes the effort required to assemble the system components and system testing and to demonstrate it's readiness for operation. Key among these test are; 1) the ability to remove and install the target module and other components expected to be replaced during the life of the facility, 2) the ability to load and unload mercury, and 3) the ability to check the system against leaks.

WBS Descriptor Form

WBS 1.06.01.05 **PCR** PCR TG 02 001 **Revision** 0 **Revision Date** 12/11/2001
Title Solid Target

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS will contain work on the concept definition and detail design of a target system that may be used for the commissioning and initial operation of SNS. The target will be composed of pieces of metal, supported in a structural frame, and cooled by water. The activities in this WBS will address the design of the target, its cooling system, and its integration into the target building and systems.

WBS Descriptor Form

WBS 1.06.02 **PCR** PCR TG 02 004 **Revision** 3 **Revision Date** 4/12/2002
Title Moderator Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The proposed target station is scoped for four moderators, two above and two below the target. Three of the moderators are hydrogen and operate at 20 K and above the critical pressure, which removes any concerns of hydrogen boiling within the system. Each of the hydrogen moderators is serviced by a completely independent circulating loop.

Both of the top moderators are cryogenic hydrogen. The upstream moderator is decoupled and internally poisoned and has beam lines viewing both sides. The downstream moderator is not poisoned and is viewed from one side only. It has light water pre-moderator on all sides, other than the viewed face. As for cooling and pre-moderation, the top moderators are connected in series to share a common water loop.

The bottom upstream moderator is light water at 'controlled' ambient temperature. The downstream moderator is a coupled cryogenic hydrogen moderator identical to the top downstream. The bottom moderators are connected in series to share a common water loop. The upstream moderator is decoupled and internally poisoned and has beam lines viewing both sides. The downstream moderator is not poisoned and is viewed from one side only.

The moderators will be fabricated from 6061-T6 Aluminum. The rigid piping feeding the moderators, however, will be a combination of 304 Stainless Steel and Invar36 thus requiring bi-metal transition joints. The decoupling and poison materials will be Cadmium and Gadolinium respectively.

WBS Descriptor Form

WBS 1.06.02.00 **PCR** PCR TG 02 004 **Revision** 1 **Revision Date** 4/12/2002

Title Moderator Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS Descriptor Form

WBS 1.06.02.01 **PCR** PCR TG 02 004 **Revision** 3 **Revision Date** 4/12/2002
Title Ambient Moderator Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The scope of 1.6.2.1 involves the design, procurement, and fabrication of the two bottom moderators. One of the bottom moderators is light water at 'controlled' ambient temperature. The other is a coupled cryogenic hydrogen moderator. The bottom moderators are connected in series to share a common water loop. The upstream moderator is decoupled and internally poisoned and has beam lines viewing both sides. The downstream moderator is not poisoned and is viewed from one side only.

The moderators will be fabricated from 6061-T6 Aluminum. The rigid piping feeding the moderators, however, will be a combination of 304 Stainless Steel and Invar36 thus requiring bi-metal transition joints. The decoupling and poison materials will be Cadmium and Gadolinium respectively. Design will be performed by in-house staff with subcontractor fabrication.

Rev. 1 Title: Ambient Moderator Systems. Modified via PCR TG-00-014

WBS Descriptor Form

WBS 1.06.02.02 **PCR** PCR TG 02 004 **Revision** 3 **Revision Date** 4/12/2002
Title Cryogenic Moderator Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The scope of 1.6.2.2 involves the design, procurement, and fabrication of two cryogenic moderator assemblies along with all of the various modules comprising the hydrogen service loop. Both top moderators are hydrogen and operate at about 20 K and above the critical pressure, which removes any concerns of hydrogen boiling within the system. The two moderators are each serviced by a completely independent circulating hydrogen loop. The upstream moderator is decoupled and internally poisoned and has beam lines viewing both sides. The downstream moderator is not poisoned and is viewed from one side only. It has light water pre-moderator on all sides, other than the viewed face.

The moderators will be fabricated from 6061-T6 Aluminum. The rigid piping feeding the moderators, however, will be a combination of 304 Stainless Steel and Invar36 thus requiring bi-metal transition joints. The decoupling and poison materials will be Cadmium and Gadolinium respectively. Design of the cryogenic moderators will be performed by in-house staff with subcontractor fabrication.

Rev. 1 Title: Cryogenic Moderator Systems. Modified via PCR TG-00-014

WBS Descriptor Form

WBS 1.06.02.03 **PCR** PCR TG 02 004 **Revision** 3 **Revision Date** 4/12/2002
Title Assembly and Testing

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The scope of 1.6.2.3 involves the assembly, testing and installation of the moderator systems.

For the moderators, this includes the assembly (including NDE of welds) and leak testing of the moderator vessels, final installation of these vessel assemblies into the inner plug, and appropriate interfaces with conventional facilities and I&C.

For the three circulating hydrogen loops this includes the installation of Hydrogen Utility Room modules comprising the service loop, installation of the hydrogen vent system, and appropriate interfaces with conventional facilities (including the refrigerator interface) and I&C.

A mixture of subcontractor, in-house craft (ORNL), and Davis-Bacon labor will perform installation. These tasks will be carried out with SNS engineering oversight.

WBS Descriptor Form

WBS 1.06.03 **PCR** PCR TG 00 014 **Revision** 2 **Revision Date** 9/15/2000
Title Reflector Assemblies

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The cost estimate addresses the anticipated costs to design, manufacture, assemble, test, and install the Reflector Plug Assemblies. The functions performed by the Reflector Plugs are: (1) to maximize the amount of reflector material within a radius of one meter from the center of the target, (2) to provide a beam path from the moderators to the experiments, (3) to provide decoupler material between the moderators to reduce cross-talk, and (4) to provide shielding that requires active cooling.

Two subassemblies make up the Reflector Assemblies: (1) the inner reflector plug and, (2) the middle reflector plug. Also included in the estimate for 1.6.3 are the estimated costs for alignment fixtures, pressure test equipment, and a dummy (mockup) inner plug, as well as a spare inner plug assembly and a support stand for the spare plug.

Title I design will be performed by ORNL. Detail design, fabrication, and component proof testing will be subcontracted with ORNL oversight. Installation of the middle plugs will be done by Davis-Bacon crafts with ORNL oversight. The inner reflector plug will be assembled, tested and installed by ORNL personnel.

WBS Descriptor Form

WBS 1.06.03.01 **PCR** PCR TG 00 014 **Revision** 1 **Revision Date** 9/15/2000
Title Plug Assembly

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The cost estimate addresses the anticipated costs to design, manufacture, and perform component testing of the Reflector Plug Assemblies. The functions performed by the Reflector Plugs are: (1) to maximize the amount of reflector material within a radius of one meter from the center of the target, (2) to provide a beam path from the moderators to the experiments, (3) to provide decoupler material between the moderators to reduce cross-talk, and (4) to provide shielding that requires active cooling.

Two subassemblies make up the Reflector Assemblies: (1) the inner reflector plug and, (2) the middle reflector plug.

Title I design will be performed by ORNL. Detail design, fabrication, and component proof testing will be subcontracted with ORNL oversight.

WBS Descriptor Form

WBS 1.06.03.02 **PCR** PCR TG 00 014 **Revision** 1 **Revision Date** 9/15/2000
Title Assembly and Testing

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The cost estimate addresses the anticipated costs to assemble, test and install the Reflector Plug Assemblies. The functions performed by the Reflector Plugs are: (1) to maximize the amount of reflector material within a radius of one meter from the center of the target, (2) to provide a beam path from the moderators to the experiments, (3) to provide decoupler material between the moderators to reduce cross-talk, and (4) to provide shielding that requires active cooling.

The scope of the cost estimate for installation includes not only the effort required to assemble and install the plugs, but also the test fixtures and effort required to demonstrate its readiness for operation. This includes alignment fixtures, pressure test equipment, and a dummy (mockup) inner plug for setting alignment features during initial installation and for proving handling procedures. Also included is an estimate for a spare inner plug assembly and a support stand for the spare plug.

Installation of the middle plugs will be done by Davis-Bacon crafts with ORNL oversight. The inner reflector plug will be assembled, tested and installed by ORNL personnel.

WBS Descriptor Form

WBS 1.06.04 **PCR** PCR TG 00 014 **Revision** 2 **Revision Date** 9/15/2000
Title Vessel Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The cost estimate addresses the anticipated costs to design, manufacture, assemble, test, and install the Reflector Vessel and the Proton Beam Window. The components in Vessel Systems provide containment for those replaceable items that require active cooling, provide a collection volume in the event of a leak in the target, moderators, or reflector plugs, and provides shielding within the shutter radius. The vessel provides active water cooling for shielding at the vessel centerline.

Vessel Systems is composed of two main elements: the core vessel and associated shielding, and the proton beam window assembly. The estimate for 1.6.4.4 includes the estimated costs for the mockup test stand, which contains the equipment used in assembly and preinstallation checkout: alignment fixtures, pressure test equipment, and a mockup of the vessel/shutter interface. WBS 1.6.4.4 also includes the estimated costs for a dummy (mockup) proton beam window, a spare proton beam window assembly; a support stand for the spare window assembly, the design validation test stand, the proton beam window seal test, and the proton beam window remote handling test.

Title I design will be performed by ORNL. Detail design, fabrication, and component proof testing of the vessel will be subcontracted with ORNL oversight. Installation of the vessel will be done by Davis-Bacon crafts with ORNL oversight. The proton beam window will be designed, assembled (from components fabricated by subcontractors), tested and installed by ORNL personnel. Final system tests will be performed by ORNL technicians.

WBS Descriptor Form

WBS 1.06.04.01 **PCR** PCR TG 00 014 **Revision** 1 **Revision Date** 9/15/2000
Title Core Vessel

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The core vessel is composed of the support cylinder, the vessel, and the shielding inside of the shutter radius. The core vessel contains the interface ports for the proton beam, the target, the neutron flight paths (beam lines), the core vessel inserts, and the shutter inserts. The bottom of the vessel has a containment volume for use in the event of a leak of mercury, water, or hydrogen within the vessel. A drain at the bottom of the vessel leads to a cleanout within the target cell that could be used in the event of an accident.

Title I design will be performed by ORNL. Detail design, fabrication, and component proof testing will be performed by the fabrication subcontractor with ORNL oversight.

WBS Descriptor Form

WBS 1.06.04.02 **PCR** PCR TG 00 014 **Revision** 1 **Revision Date** 9/15/2000
Title Proton Beam Window Assembly

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The proton beam window assembly provides a pressure barrier between the rough vacuum or helium environment inside the reflector vessel and the high vacuum of the proton beam. The high radiation exposure has two effects on the window: a high rate of internal heat generation and radiation damage of the metal structure. To dissipate the heat, the window is a double-layer design with water cooling between the layers. Because of the radiation damage, the window assembly is designed to facilitate frequent replacement using remote handling techniques.

The proton beam window is made up of a double-walled window, a window frame, inflatable seals to facilitate replacement, a spool piece containing the Harp, a shield block, and water, helium, vacuum, and electrical connections. The cost estimate for the proton beam window assembly also includes an insert that provides alignment features for the proton beam window and the beam diagnostics, and shield blocks above the proton beam window.

The proton beam window will be designed, assembled (from components fabricated by subcontractors), tested and installed by ORNL personnel.

WBS Descriptor Form

WBS 1.06.04.03 **PCR** PCR TG 00 014 **Revision** 1 **Revision Date** 9/15/2000
Title Upper Vessel assembly

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS 1.6.4.3 has been cancelled. Those items formerly included in this WBS have been moved to WBS 1.6.4.1.

R0 WBS Description. Modified via PCR TG-00-014.

The upper vessel makes up the upper half of the vessel and contains the interface ports for the connections between the moderator and reflector systems and the required utilities and instrumentation. The upper vessel includes the removable upper head for access to the components inside the vessel.

Title I design will be performed by ORNL. Detail design, fabrication, and component proof testing will be performed by the fabrication subcontractor with ORNL oversight.

WBS Descriptor Form

WBS 1.06.04.04 **PCR** PCR TG 00 014 **Revision** 1 **Revision Date** 9/15/2000
Title Assembly and Testing

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The cost estimate addresses the anticipated costs to assemble, test, and install the Reflector Vessel and the Proton Beam Window. The scope of the cost estimate for installation includes not only the effort required to assemble and install the vessel and window assemblies, but also the test fixtures and effort required to demonstrate readiness for operation. This includes alignment fixtures, pressure test equipment, and a dummy (mockup) proton beam window for setting alignment features during initial installation and for proving handling procedures. Also included is an estimate for a spare proton beam window and a support stand for the spare window.

Installation of the vessel will be done by Davis-Bacon crafts with ORNL oversight. The proton beam window will be designed, assembled (from components fabricated by subcontractors), tested and installed by ORNL personnel. Final system tests will be performed by ORNL technicians.

WBS Descriptor Form

WBS 1.06.05 **PCR** _____ **Revision** 2 **Revision Date** 2/14/2001

Title Target Station Shielding

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Target Station Shielding includes the shielding and shutter equipment external to the core vessel flanges (140 inch diameter) extending out to the interface with the Instrument systems at the chopper archways at about 504 inch diameter. Major interfaces include the Conventional Facilities (1.8), the Ring Beam Transport (1.5), and the Instrument System (1.7). More detailed descriptions with method of accomplishments and special requirements are given in each of the level 4 forms.

WBS Descriptor Form

WBS 1.06.05.01 **PCR** PCR TG 03 005 **Revision** 2 **Revision Date** _____
Title Bulk Shielding

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Shield blocks located inside the liner (400" diameter) and external to the core vessel flanges (140" diameter) and the chopper archways out to 504" diameter. There are about 200 uniquely shaped blocks inside the liner that weigh about 20 tons each. There are another 50 uniquely shaped blocks in the chopper archways external to the liner that are fabricated from virgin steel. These blocks will be designed by the SNS engineering staff for size and tolerances. There are also steel shield blocks above the chopper archway lintel about 40 inches radial depth extending to an elevation 104 inches above the proton beam plane to shield the instrument hall from the radiation spray created by the T0 choppers. The blocks will be fabricated by a subcontract fabrication vendor and delivered to the SNS site. Davis-Bacon crafts under the supervision of a field construction-engineering subcontractor will install the blocks. Installation includes placement, grouting and filling the cracks with sand or concrete. SNS engineering staff will be available for consultation and will document the fabrication and installation as part of the usual Title III activity.

WBS Descriptor Form

WBS 1.06.05.02 **PCR** _____ **Revision** 2 **Revision Date** 2/14/2001
Title External Shell and Liners

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Steel liner (about 400" diameter and 235" tall) that surrounds the shielding and provides final containment for accidental water and mercury spills. This liner is about 1 inch thick and has an emergency drain in the center of a slightly dished bottom. There is also a liner section that connects the target cell liner (1.6.7) to the reflector vessel (1.6.4) and surrounds the target module (1.6.1). The liner will have alignment features that permit the accurate positioning of the outer inserts. The liner will be designed by the SNS engineering staff, it will be shop fabricated in sections by a steel fabrication subcontractor, and installed in the SNS facility by the same subcontractor. The Conventional Facilities (1.5) will install a 40-inch thick concrete collar around the liner that will also contribute to the shielding effectiveness. A field construction-engineering subcontractor will coordinate the installation activities. SNS engineering staff will be available for consultation and will document the fabrication and installation as part of the usual Title III activity.

R1 WBS Title: External Shell and Liners

WBS Descriptor Form

WBS 1.06.05.03 **PCR** _____ **Revision** 1 **Revision Date** 2/18/2001
Title Shutter Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Neutron shutter system interfacing at core vessel (1.6.4) and extending outward to neutron beam lines (1.6.5.4). There are 18 shutters total with 12 single channel shutters and 6 multi-channel shutters. The 12 single shutters consist of a welded steel shutter housing with flanges matching the reflector vessel. The shutter housing encloses the 20-ton steel shutter gate that translates vertically to block the neutron beam when that is desirable. The shutter gates each contain an insert through the shutter that “floats” within an oversized opening that allows the insert to be accurately positioned using external alignment features. There is another 20-ton top block on the top of each shutter that shields the gate and supports the gear drive to move the gate. The gear drive system is a commercial gear motor system. The six wide shutters are segmented vertically and the total weight is about 75 tons per shutter.

The shutter system will be designed by SNS engineering staff, fabricated by subcontract vendors and installed by Davis-Bacon crafts under the supervision of a field construction-engineering subcontractor. SNS engineering staff will be available for consultation and will document the fabrication and installation as part of the usual Title III activity.

WBS Descriptor Form

WBS 1.06.05.04 **PCR** _____ **Revision** 1 **Revision Date** 2/14/2001

Title Neutron Beamline Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Neutron Beam line systems interfacing at the shutter (1.6.5.3) and ending at the liner nozzle (1.6.5.2) including the neutron beam window in the shutter housing. This primarily consists of the outboard shutter insert support system. The neutron beam line system will be designed by SNS engineering staff, fabricated by subcontract vendors and installed by Davis-Bacon crafts under the supervision of a field construction-engineering subcontractor. SNS engineering staff will be available for consultation and will document the fabrication and installation as part of the usual Title III activity.

R0 WBS Title: Neutron Beamline Systems

WBS Descriptor Form

WBS 1.06.05.05 **PCR** _____ **Revision** 1 **Revision Date** 2/14/2001

Title Roof Structure

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Roof structure and shine shield directly above the target shielding composed of reinforced concrete beams and sealing membrane. This structure covers the 32 foot diameter circular opening of the liner and interfaces directly with the floor of the high bay. The sealing membrane will be a coated fabric to minimize the exchange of air between the high bay and the activated air around the bulk shield blocks and the shutters. The roof structure will be designed by SNS engineering staff, fabricated by subcontract vendors and installed by Davis-Bacon crafts under the supervision of a field construction-engineering subcontractor. SNS engineering staff will be available for consultation and will document the fabrication and installation as part of the usual Title III activity.

WBS Descriptor Form

WBS 1.06.05.06 **PCR** _____ **Revision** _____ **Revision Date** _____

Title Assembly and Testing

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS Descriptor Form

WBS 1.06.05.07 **PCR** PCR TG 03 005 **Revision** 0 **Revision Date** _____

Title RTBT Flight Tube

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, fabricate and install the flight (beam) tube between the diagnostic harp in the RTBT and the proton beam window in the target monolith. This includes shielding surrounding the flight tube.

WBS Descriptor Form

WBS 1.06.06 **PCR** _____ **Revision** 1 **Revision Date** 9/15/2000
Title Target Utility Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS element 1.6.6 addresses Titles I & II design, component costs, spares, installation and test & checkout of the cooling water, vacuum and helium systems servicing Target and Beam Dump technical components. Planned method of accomplishment is as follows: Title I by ORNL; Title II (detail design) by ORNL and AE; AE support by ORNL; Procurement by ORNL, AE/CM and FPSC (as appropriate); Installation and Construction by FPSC Davis-Bacon Crafts; Testing by FPSC & CM with ORNL Oversight; Examination and Inspection by ORNL; and Title III by ORNL & AE.

Rev. 0 Title Target Utility Systems. Modified via PCR TG-00-015

WBS Descriptor Form

WBS 1.06.06.01 **PCR** _____ **Revision** 1 **Revision Date** 9/15/2000

Title Cooling Water Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS element 1.6.6.1 addresses Titles I & II design, component costs, spares, installation and test & checkout of the cooling water systems servicing Target and Beam Dump technical components. Planned method of accomplishment is as follows: Title I by ORNL; Title II (detail design) by ORNL and AE; AE support by ORNL; Procurement by ORNL, AE/CM and FPSC (as appropriate); Installation and Construction by specialty contractor and FPSC Davis-Bacon Crafts; Testing by FPSC & CM with ORNL Oversight; Examination and Inspection by ORNL; and Title III by ORNL & AE.

WBS Descriptor Form

WBS 1.06.06.02 **PCR** _____ **Revision** 1 **Revision Date** 9/15/2000
Title Vacuum Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS element 1.6.6.2 addresses Title II design, component costs, spares and installation of the Target and Beam Stop Vacuum Systems servicing the core vessel, the inflatable seals, mercury loop equipment, inner and shutter inserts, and cooling water systems. Planned method of accomplishment is as follows: Title I by ORN; Title II (detail design) by ORNL and AE; AE support by ORNL; Procurement by ORNL, AE/CM and FPSC (as appropriate); Installation and Construction by FPSC Davis-Bacon Crafts; Testing by FPSC & CM with ORNL Oversight; Examination and Inspection by ORNL; and Title III by ORNL.

Rev. 0 Title: Vacuum Systems, Modified via PCR TG-00-015

WBS Descriptor Form

WBS 1.06.06.03 **PCR** _____ **Revision** 1 **Revision Date** 9/15/2000
Title Helium Gas Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS element 1.6.6.3 addresses Title II design, component costs, spares and installation of the Target and Beam Dump Helium Distribution System. Planned method of accomplishment is as follows: Title I by ORNL; Title II (detail design) by ORNL and AE; AE support by ORNL; Procurement by ORNL, AE/CM and FPSC as appropriate, Installation and Construction by FPSC Davis-Bacon Crafts, Testing by FPSC & CM with ORNL Oversight, Examination and Inspection by ORNL; and Title III by ORNL.

Rev. 0 Title: Helium Gas Systems, Modified via PCR TG-00-015

WBS Descriptor Form

WBS 1.06.06.04 **PCR** _____ **Revision** 1 **Revision Date** 9/15/2000

Title Assembly and Testing

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS element 1.6.6.4 addresses Title III , Test & Checkout, and Examination and Inspection for the Target and Beam Stop Utilities Systems (cooling water, vacuum and helium). Work is to be performed by ORNL with Craft/Technician support as required.

Rev. 0 Title: Assembly and Testing. Modified via PCR TG-00-015

WBS Descriptor Form

WBS 1.06.07 **PCR** _____ **Revision** 1 **Revision Date** 9/15/2000
Title Remote Handling Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The target station remote handling systems will provide only the tooling to perform an identified set of remote operations. These operations will be confined to the target cell, high bay and utility vault.

The remote handling system is composed of five distinct subsystems:

1. Maintenance Cells Remote Handling Systems;

The configuration of the target and transfer cells, including the remote handling equipment is based on conventional arrangements used widely in the nuclear industry. This approach is designed to take advantage of commercially available equipment for most of the major components such as shielding windows, through-the-wall manipulators, bridge cranes and telemanipulators. Costs have been obtained from established vendors for this equipment, including testing and installation support.

2. High Bay Remote Handling Systems;

Specific high bay maintenance tasks have been identified as requiring remote handling equipment at facility start-up. Written procedures for these tasks have been prepared based on existing large component handling systems at other facilities. Necessary remote handling tooling has been identified and sized in the procedures along with important functional characteristics.

3. Utility Vault Remote Handling Systems

Personnel support tooling has been listed and catalog costed. The tooling configuration is based on similar equipment at other accelerator facilities.

4. Beam Dump Remote Handling Systems

A single remote handling operation was identified for the replacement and handling of beam dump modules

5. Remote Handling Control Room

Standard control equipment and software programming costs were developed in conjunction with the target system control engineer to insure system continuity.

WBS Descriptor Form

WBS 1.06.07.01 **PCR** _____ **Revision** 1 **Revision Date** 9/15/2000
Title Maintenance Cell Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The maintenance cell remote handling equipment includes all the general purpose and in-cell tooling required to maintain the in-cell process systems. This primarily includes a few large, commercial remote handling systems:

- Shielding windows,
- Through-the-wall mechanical manipulators,
- In-cell bridge crane,
- Bridge mounted telemanipulator
- Assembly tooling,
- Disassembly tooling,
- Large component handling fixtures.

Each of the major systems will be designed and fabricated by a commercial vendor. The AECM will handle conventional installation with technical support provided by the vendor for special requirements.

Rev. 0 Title: Maintenance Cell Systems. Modified via PCR TG-00-014

WBS Descriptor Form

WBS 1.06.07.02 **PCR** _____ **Revision** 1 **Revision Date** 9/15/2000
Title High Bay Maintenance Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The High Bay remote handling equipment includes task specific handling containers and tooling to safely move activated and contaminated components to the hot cell or hot storage. This includes a portable manipulator system and several large component handling fixtures and shielding casks. The portable manipulator will be designed and fabricated as stand-alone units by commercial vendors. Installation of all systems will be performed by the AECM with limited technical support from the vendors.

The portable manipulator is required to perform remote operations in radiation zones, primarily in the high bay during plug change-out. Specifically, the manipulator will be used to disconnect pipe fittings, monitor radiation, install local shield blankets and take HP swipes. The manipulator system may also be used in the utility vault and beam dump facilities.

Rev. 0 Title: High Bay Maintenance Systems. Modified via PCR TG-00-014

WBS Descriptor Form

WBS 1.06.07.03 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Utility Vault Maintenance Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

A limited amount of maintenance equipment will be provided for maintenance of the utility systems. This equipment will facilitate safe handling of contaminated process piping and fittings. Included are commercial handling devices such as portable hoists and commercially available shielding screens.

WBS 1.06.07.04 scope transferred to WBS 1.06.07.03 via PCR TG-00-014

WBS Descriptor Form

WBS 1.06.07.04 **PCR** PCR TG 03 003 **Revision** 1 **Revision Date** _____

Title Beam Dump Maintenance Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

A handling shielding cask and accompanying handling fixtures will be provided to facilitate the non-contact replacement of a ring extraction dump.

WBS 1.6.7.5 scope transferred to WBS 1.06.07.04 via PCR TG-00-014

WBS 1.6.7.4 subsequently eliminated via PCR TG 03 003.

WBS Descriptor Form

WBS 1.06.07.05 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001
Title Remote Handling Control Room

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Computers, software and interconnection hardware will be required to link and monitor the maintenance system controllers. Specific maintenance equipment to be provided with integrated control systems include:

- In-cell bridge Crane
- In-cell bridge mounted telemanipulator
- In-cell tooling
- Video monitoring system
- Portable manipulator

In addition, the maintenance control system will be linked to the facility equipment such as the intracell door, cell lighting and the HVAC system. Monitoring links will be provided to also line the maintenance control station to the main SNS control station.

WBS 1.06.07.06 scope transferred to WBS 1.06.07.05 via PCR TG-00-014

WBS Descriptor Form

WBS 1.06.07.06 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001
Title Remote Handling Installation and Startup

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Installation of the remote handling equipment will be accomplished primarily by the A&E construction manager (AECM). Specialized services and technical assistance will be provided by some vendors and from ORNL in the case of complex equipment such as the in-cell tooling, manipulators and shielding windows.

1. The AECM will be responsible for overall planning of the target station construction and installation planning.
2. The remote handling Lead Design Engineers will be responsible for detailed documentation and monitoring of the remote handling equipment installation in the target station.
3. Remote handling will provide pre-ops testing of the completed tooling systems. ORNL will provide all labor. It is assumed that all components have been installed and individually, functionally tested prior to per-ops testing.

WBS 1.06.07.07 scope transferred to WBS 1.06.07.06 via PCR TG-00-014

WBS R0 title: Assembly and Testing. Modified via PCR TG-00-014

WBS Descriptor Form

WBS 1.06.07.07 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001

Title DELETED

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS 1.06.07.07 scope transferred to WBS 1.06.07.06 via PCR TG-00-014

WBS Descriptor Form

WBS 1.06.08 **PCR** _____ **Revision** 1 **Revision Date** 9/15/2000

Title Controls

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Specify the process instrumentation to be used in the target assembly, reflector systems, vessel systems, shielding systems, target utilities, and beam dump system. Provide a PLC development system for development and testing of PLC software and hardware. Provide requirements for a Target Protection System (TPS) and oversee its design and fabrication by a safety-qualified vendor. Specify instrumentation cabling for the target process instruments and oversee routing and installation of the cabling.

Rev. 0 Title: Controls. Modified via PCR TG-00-014

WBS Descriptor Form

WBS 1.06.08.01 **PCR** _____ **Revision** 1 **Revision Date** 9/15/2000

Title Controls Integration

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, fabricate, and test the hardware and software for a PLC development system. The development system includes a simulation panel for testing software and hardware.

Provide PLC training for engineers who will write control logic for target systems.

Provide for travel to vendors, conferences, collaborating laboratories, etc.

Provide integration support for WBS 1.6.8.

Rev. 0 Title: Controls Integration. Modified via PCR TG-00-014

WBS Descriptor Form

WBS 1.06.08.02 **PCR** _____ **Revision** 1 **Revision Date** 9/15/2000

Title Target Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Specify and design non-safety and safety significant process instrumentation for the mercury loop, target assembly, and shutters.
Design and fabricate the Nuclear Facility Safety Significant system (NFSS) panels in the Main and Target Control Rooms. Design, procure, fabricate, and install the cables for the non-safety and safety significant systems.
Provide engineering support for testing and startup of target assembly equipment.

Rev. 0 Title: Target Systems. Modified via PCR TG-00-014

WBS Descriptor Form

WBS 1.06.08.03 **PCR** _____ **Revision** 0 **Revision Date** 9/15/2000

Title Moderator Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Specify and design non-safety, safety significant, and equipment protection process instrumentation for the target utility water loops, helium systems, and vacuum systems in the Target Building and in the Beam Dumps. Design, procure, fabricate, and install process instrument cables for the utility instruments.
Provide engineering and technical support for testing and startup of utility systems equipment.

WBS Descriptor Form

WBS 1.06.08.04 **PCR** _____ **Revision** 1 **Revision Date** 9/15/2000
Title Reflector Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Develop requirements for the Target Protection System (TPS) and procure the TPS from a vendor with experience developing safety grade shut down systems. Provide oversight of the vendor selected to design and build the TPS. Develop interfaces to the Front End and Ring for safety grade shut down of the beam. Provide TPS cables within the Target Building and to the Front End for trip, Ring for trip bypass, and to the Target and Main Control Rooms for the facility operators. Fabricate and install the TPS. Ensure that the safety grade documents are provided for TPS design and operation. Provide engineering and technician support for startup testing of the TPS.

Rev. 0 Title: Reflector Systems. Modified via PCR TG-00-014

WBS Descriptor Form

WBS 1.06.08.05 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999

Title Vessel Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Specify and design control and safety process instrumentation for the vessel systems.
The process instruments are purchased and installed by WBS 1.6.4.
Provide engineering support for testing and startup of the vessel systems equipment

WBS Descriptor Form

WBS 1.06.08.06 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999

Title Shielding Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Specify and design control and safety process instrumentation for the shielding systems.
The process instruments are purchased and installed by WBS 1.6.5.
Provide engineering support for testing and startup of the shielding systems equipment

WBS Descriptor Form

WBS 1.06.08.07 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999

Title Target Utility Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Specify and design control and safety process instrumentation for the target utility systems.
The process instruments are purchased and installed by WBS 1.6.6.
Provide engineering support for testing and startup of the target utility systems equipment

WBS Descriptor Form

WBS 1.06.08.08 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999

Title Remote Handling System

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS Descriptor Form

WBS 1.06.08.09 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999

Title Beam Dump Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Specify and design control and safety process instrumentation for the beam dump systems.
The process instruments are purchased and installed by WBS 1.6.9.
Provide engineering support for testing and startup of the beam dump systems equipment

WBS Descriptor Form

WBS 1.06.08.10 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999

Title Cabling

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Specify instrumentation cables for the target systems WBSs 1.6.1, 1.6.3, 1.6.4, 1.6.5, 1.6.6, 1.6.9. Provide control system cabling for WBSs 1.6.2 and 1.6.7.

.Interface with the A/E to install cable trays and raceways.

Work with a contractor and with ORNL technicians to install cables.

WBS Descriptor Form

WBS 1.06.08.11 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999

Title Personnel Safety Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS Descriptor Form

WBS 1.06.09 **PCR** _____ **Revision** 1 **Revision Date** 9/15/2000
Title Beam Dumps

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The three beam dumps receive proton beam, shield the beam stops and dissipate the energy safely. The LINAC dump (1.6.9.1) is located at the end of the LINAC and is used to tune the accelerator independent of the remainder of the facility (ring or target). The Ring Injection dump (1.6.9.2) is used to intercept the scrape off particles from the ring bunching process. The Ring Extraction dump (1.6.9.3) is used to tune the LINAC and ring combination when the target system is not available. Major interfaces include the Conventional Facilities (1.8), the Ring Beam Transport (1.5), and the High-Energy Beam Transport (1.5). The beam dump utility system is part of 1.6.6. More detailed descriptions with method of accomplishments and special requirements are given in each of the level 4 forms.

WBS Descriptor Form

WBS 1.06.09.01 **PCR** _____ **Revision** 1 **Revision Date** 9/15/2000
Title Linac Beam Dump

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The LINAC dump is designed for 33 kW operation with a duty cycle of 10% (500 hrs per year). Major components supplied by 1.6.9 include a water-traced steel beam stop, helium-filled steel enclosure, a vacuum window, a large array of steel shield blocks. The associated utility systems are part of 1.6.6. The beam dump equipment is housed in an underground concrete enclosure with a surface utility building (provided by Conventional Facilities 1.8) to house the cooling equipment, HVAC equipment and other utility equipment. The equipment will be fabricated by subcontract fabrication vendors and delivered to the SNS site. Davis-Bacon crafts under the supervision of a field construction-engineering subcontractor will install the equipment. Installation includes shield block placement, grouting and filling the cracks with sand or concrete. SNS engineering staff will be available for consultation and will document the fabrication and installation as part of the usual Title III activity.

Rev 0 Title: Linac Beam Dump. Modified via PCR TG-00-015

WBS Descriptor Form

WBS 1.06.09.02 **PCR** _____ **Revision** 1 **Revision Date** 9/15/2000
Title Ring Injection Dump

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Ring Injection dump is designed for 200 kW operation with a duty cycle of 100% (5000 hrs per year). Major components supplied by 1.6.9 include a water-cooled copper beam stop, helium-filled steel enclosure, a vacuum window, a large array of steel shield blocks. The associated utility systems are provided by 1.6.6. The beam dump equipment is housed in an underground concrete enclosure with a surface utility building (provided by Conventional Facilities 1.8) to house the cooling equipment and other equipment. The equipment will be fabricated by subcontract fabrication vendors and delivered to the SNS site. Davis-Bacon crafts under the supervision of a field construction-engineering subcontractor will install the equipment. Installation includes shield block placement, grouting and filling the cracks with sand or concrete. SNS engineering staff will be available for consultation and will document the fabrication and installation as part of the usual Title III activity.

WBS Descriptor Form

WBS 1.06.09.03 **PCR** _____ **Revision** 1 **Revision Date** 9/15/2000
Title Ring Extraction Dump

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Ring Extraction dump is designed for 33 kW operation with a duty cycle of 10% (500 hrs per year). Major components supplied by 1.6.9 include a water-traced steel beam stop, helium-filled steel enclosure, a vacuum window, a large array of steel shield blocks. The associated utility systems is part of 1.6.6. The beam dump equipment is housed in an underground concrete enclosure with a surface utility building (provided by Conventional Facilities 1.8) to house the cooling equipment and other equipment. The equipment will be fabricated by subcontract fabrication vendors and delivered to the SNS site. Davis-Bacon crafts under the supervision of a field construction-engineering subcontractor will install the equipment. Installation includes shield block placement, grouting and filling the cracks with sand or concrete. SNS engineering staff will be available for consultation and will document the fabrication and installation as part of the usual Title III activity.

WBS Descriptor Form

WBS 1.06.09.04 **PCR** _____ **Revision** _____ **Revision Date** _____

Title Assembly and Testing

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS Descriptor Form

WBS 1.06.10 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999
Title Technical Support

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Project Management and Technical Support for line item development as well as oversight for the R&D (WBS 1.6.10.1) is included in WBS 1.6.10. Also included is the Shielding and Neutronics analysis for the entire project (WBS 1.6.10.2 – see section 1.6.10.2), University support (WBS 1.6.10.3) and the Integrated System Startup and Testing (WBS 1.6.10.4).

The management sections includes the Senior Team Leader (STL), the Deputy STL, the Lead Engineer, Project Engineer, Project Analyst, and support from others which includes QA, Safety, RAMI, etc.

WBS Descriptor Form

WBS 1.06.10.01 **PCR** _____ **Revision** _____ **Revision Date** _____

Title Management and Physics Support

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS Descriptor Form

WBS 1.06.10.02 **PCR** _____ **Revision** _____ **Revision Date** _____

Title Accel/Target Sta Neut and Shldg Analysis

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS Descriptor Form

WBS 1.06.10.03 **PCR** _____ **Revision** _____ **Revision Date** _____

Title Systems Analysis

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS Descriptor Form

WBS 1.06.10.04 **PCR** _____ **Revision** _____ **Revision Date** _____

Title Integrated Systems Startup and Testing

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS Descriptor Form

WBS 1.06.11 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999

Title ORNL Field Coordination

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS account contains additional ORNL field coordination and technician labor required to achieve and efficient installation, pre-acceptance testing and commissioning of the Target System.

This activity is in addition to normal Title III supervision as it covers the transition to ORNL of the responsibility for these activities.

WBS Descriptor Form

WBS 1.06.11.01 **PCR** _____ **Revision** _____ **Revision Date** _____

Title ORNL Field Coordination

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS Descriptor Form

WBS 1.07 **PCR** PCR IS 02 003 **Revision** 2 **Revision Date** 8/21/2002
Title Instrument Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Instrument Systems scope includes the neutron scattering instruments located on the neutron beam ports surrounding the target. The Spallation Neutron Source (SNS) will initially have one target station operating at 60 Hz. This station will have at least 18 neutron beams. A target building houses the target and experiment hall. Most of the neutron scattering instruments will fit entirely within this building, but a few long-flight-path instruments will extend outside the target building. Also included in the Instrument Systems scope is an equipment set to partially equip supporting laboratories.

WBS Descriptor Form

WBS 1.07.01 **PCR** PCR IS 02 003 **Revision** 2 **Revision Date** 8/21/2002

Title Instrument Support Facilities

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Instrument Support Facilities include equipment for instrument support use. A complement of equipment for the laboratories is included in this section. The buildings housing the laboratories and local machine shop are provided by Conventional Facilities.

WBS Descriptor Form

WBS 1.07.01.01 **PCR** PCR IS 02 003 **Revision** 2 **Revision Date** 8/21/2002

Title Laboratory Equipment

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS item includes a set of equipment for laboratory use to support instruments. The buildings housing the laboratories are provided by Conventional Facilities.

WBS Descriptor Form

WBS 1.07.02 **PCR** PCR IS 02 003 **Revision** 2 **Revision Date** 8/21/2002

Title Technical Support

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Technical Support encompasses project management and project support activities such as scheduling, cost control, secretarial, and engineering management. Also included are ES&H, QA/QC support and procurement liaison.

WBS Descriptor Form

WBS 1.07.02.01 **PCR** PCR IS 02 003 **Revision** 2 **Revision Date** 8/21/2002

Title Management

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Management encompasses project management and project support activities such as scheduling, cost control, secretarial, and engineering management. Also included are ES&H, QA/QC support and procurement liaison.

WBS Descriptor Form

WBS 1.07.02.02 **PCR** PCR IS 02 003 **Revision** 2 **Revision Date** 8/21/2002

Title Other Technical Support

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Other Technical Support includes computer support, software maintenance and other miscellaneous project activities.

WBS Descriptor Form

WBS 1.07.03 **PCR** _____ **Revision** 1 **Revision Date** 4/24/2001

Title Shared Design/Construction

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS item includes design, procurement, fabrication, and installation activities which are shared by more than one instrument concept. Items included under this WBS are: 1.07.03.01 Project Interface Activities; 1.07.03.02 Data Acquisition; 1.07.03.03 Detectors; 1.07.03.04 Choppers; 1.07.03.05 Sample Environment; 1.07.03.06 Optical Elements; 1.07.03.07 Shielding; and 1.07.03.08 Uninstrumented Beamlines

WBS Descriptor Form

WBS 1.07.03.01 **PCR** _____ **Revision** 1 **Revision Date** 4/24/2001

Title Other SNS Project Interface

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS item includes all activities related to interface between Instrument Systems and the SNS project outside of Instrument Systems. Work will consist of reviews of documentation and designs, and meetings between engineers and scientists in Instrument Systems and their counterparts in the Target Systems and Conventional Facilities groups. Also included are software related training and coordination, for example, for the CAD engineering software package. Required scientific effort, engineering effort and travel expenses are a part of this WBS.

Title Change. R0 Title: Other SNS Project Interface

WBS Descriptor Form

WBS 1.07.03.02 **PCR** _____ **Revision** 1 **Revision Date** 4/24/2001
Title Data Acquisition

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Data acquisition systems and equipment that are shared by two or more neutron scattering instruments are included in this WBS. It is envisioned that a large portion of the Data Acquisition system will be common to all instruments. The Shared Data Acquisition scope will include 1. software development; 2. prototype system development; 3. histogram/storage development; 4. design of the X-Y detector electronics; 5. design of the PSD electronics; 6. development of simulators; 7. design of timing modules; and 8. general support for all instruments. The procurement of required test equipment, such as oscilloscopes, computers and NIM electronics is included, as is the cost of travel.

WBS Descriptor Form

WBS 1.07.03.03 **PCR** _____ **Revision** 1 **Revision Date** 4/24/2001
Title Detectors

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Detector systems and equipment that are shared by two or more neutron scattering instruments are included in the WBS. The Shared Detector scope will include 1. the development of a gas detector laboratory; 2. the development of a scintillator detector laboratory; and 3. general instrument support. The procurement of required test equipment, such as oscilloscopes, computers and NIM electronics is included.

WBS Descriptor Form

WBS 1.07.03.04 **PCR** _____ **Revision** 1 **Revision Date** 4/24/2001
Title Neutron Choppers

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Chopper systems and equipment that are shared by two or more neutron scattering instruments are included in the WBS. The Shared Chopper scope will include 1. the assembly and test of 2 T0 prototypes; 2. the assembly and test of an E0 prototype including a slit package; 3. the writing of a bandwidth chopper specification; 4. the design and procurement of a cooling water system; and 5. the specification and procurement of a predictive maintenance system.

WBS Descriptor Form

WBS 1.07.03.05 **PCR** _____ **Revision** 1 **Revision Date** 4/24/2001
Title Sample Environment

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Sample Environment systems and equipment that are shared by two or more neutron scattering instruments are included in this WBS. The tasks, which will be performed by the Sample Environment Team Leader, include 1. coordination between SNS instrument scientists and user groups to prioritize sample environment needs, 2. development of procedures and specifications for specific devices and general operations, 3. identification of vendors and products that meet specifications, 4. work with the data acquisition group to select control instrumentation, 5. determination of instrument/sample environment interface geometries, and 6. planning and design for a testing and repair laboratory.

WBS Descriptor Form

WBS 1.07.03.06 **PCR** _____ **Revision** 1 **Revision Date** 4/24/2001

Title Optical Elements

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Optical Elements that are shared by two or more neutron scattering instruments are included in the WBS. The Shared Optics scope will include 1. the specification and procurement of prototype inserts for the Design Validation Test Stand; 2. design of the core vessel and shutters (including testing of safety-related windows); and 3. design, procurement and installation of a neutron optics test station.

WBS Descriptor Form

WBS 1.07.03.07 **PCR** _____ **Revision** 1 **Revision Date** 4/24/2001
Title Shielding

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Shielding assemblies and components that are shared by two or more neutron scattering instruments are included in the WBS. The Shared Shielding scope will include the following tasks: 1. seismic qualification, radiological evaluations, design, reviews and documentation for shared shielding configurations; 2. specification and procurement activities for the installation of a 35" thick concrete skirt under the instrument positions out to 10M from the target; 3. design, performance and documentation related to a shielding benchmarking experiment; and 4. coordination of activities for the design and installation of shielding close to the target.

WBS Descriptor Form

WBS 1.07.04 **PCR** _____ **Revision** 1 **Revision Date** 8/31/2000

Title High Resolution Backscattering Spectrometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS item includes all activities which are not covered under WBS 1.7.3 - Shared Design Activities - required for the design, procurement, fabrication, installation, and testing of the High Resolution Backscattering Spectrometer (Instrument 1). Commissioning of the instrument is not included.

Rev. 0 Title: Instrument #1 Set #1. Modified via PCR IS-00-002

WBS Descriptor Form

WBS 1.07.04.01 **PCR** PCR IS 02 003 **Revision** 2 **Revision Date** 8/21/2002

Title System Integration - High Resolution Backscattering Spectrometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS item includes the activities necessary to ensure that the individual component designs are appropriate for the instrument, as well as layout and systems analyses. Included are effort for coordination meetings and travel expenses.

WBS Descriptor Form

WBS 1.07.04.02 **PCR** _____ **Revision** 1 **Revision Date** 8/31/2000

Title Data Acquisition - High Resolution Backscattering Spectrometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, fabrication, installation, and testing of data acquisition electronics and software specific to the High Resolution Backscattering Spectrometer are included in this WBS.

Rev. 0 Title: Data Acquisition - Instrument #1 Set #1. Modified via PCR IS-00-002

WBS Descriptor Form

WBS 1.07.04.03 **PCR** _____ **Revision** 1 **Revision Date** 8/31/2000

Title Detectors - High Resolution Backscattering Spectrometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, fabrication, installation, and testing of detectors and mounts specific to the High Resolution Backscattering Spectrometer are included in this WBS.

Rev. 0 Title: Detectors - Instrument #1 Set #1. Modified via PCR IS-00-002

WBS Descriptor Form

WBS 1.07.04.04 **PCR** PCR IS 02 003 **Revision** 2 **Revision Date** 8/21/2002

Title Choppers - High Resolution Backscattering Spectrometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, fabrication, installation, and testing of neutron choppers specific to the High Resolution Backscattering Spectrometer are included in this WBS. This instrument will have three bandwidth-limiting choppers.

WBS Descriptor Form

WBS 1.07.04.05 **PCR** _____ **Revision** 1 **Revision Date** 8/31/2000

Title Sample Environment - High Resolution Backscattering Spectrometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, fabrication, installation, and testing of sample environment equipment specific to the High Resolution Backscattering Spectrometer are included in this WBS.

Rev. 0 Title: Sample Environment - Instrument #1 Set #1. Modified via PCR IS-00-002

WBS Descriptor Form

WBS 1.07.04.06 **PCR** _____ **Revision** 1 **Revision Date** 8/31/2000

Title Optical Elements - High Resolution Backscattering Spectrometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, fabrication, installation, and testing of neutron optical components specific to the High Resolution Backscattering Spectrometer are included in this WBS. This includes items such as neutron guides and associated mounting/alignment fixtures, and inserts located internal to the Target Monolith.

Rev. 0 Title: Optical Elements - Instrument #1 Set #1. Modified via PCR IS-00-002

WBS Descriptor Form

WBS 1.07.04.07 **PCR** PCR IS 02 003 **Revision** 2 **Revision Date** 8/21/2002

Title Shielding - High Resolution Backscattering Spectrometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, fabrication, installation, and radiological calculations for shielding elements specific to the High Resolution Backscattering Spectrometer are included in this WBS.

WBS Descriptor Form

WBS 1.07.04.08 **PCR** _____ **Revision** 1 **Revision Date** 8/31/2000

Title Instrument Specific - High Resolution Backscattering Spectrometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, fabrication, installation, and testing of components specific to this instrument are included in this WBS. This includes items such as the secondary flight path, vacuum systems, crystal analyzers, radial collimators and filter cryostat.

Rev. 0 Title: Instrument Specific - Instrument #1 Set #1. Modified via PCR IS-00-002

WBS Descriptor Form

WBS 1.07.05 **PCR** _____ **Revision** 1 **Revision Date** 8/31/2000

Title Magnetism Reflectometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS item includes all activities which are not covered under WBS 1.7.3 - Shared Design Activities - required for the design, procurement, fabrication, installation, and testing of the instrument. Commissioning of the instrument is not included.

Rev. 0 Title: Instrument #2 Set #1. Modified via PCR IS-00-004

WBS Descriptor Form

WBS 1.07.05.01 **PCR** _____ **Revision** 0 **Revision Date** 8/31/2000

Title System Integration - Magnetism Reflectometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS item includes the activities necessary to finally assemble the instrument from the pre-assembled subcomponents and to put the shielding in place. It also includes testing of the overall system controls.

WBS Descriptor Form

WBS 1.07.05.02 **PCR** _____ **Revision** 0 **Revision Date** 8/31/2000

Title Data Acquisition - Magnetism Reflectometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, fabrication, pre-installation, and testing of data acquisition electronics and software specific to the Magnetism Reflectometer are included in this WBS.

WBS Descriptor Form

WBS 1.07.05.03 **PCR** _____ **Revision** 0 **Revision Date** 8/31/2000

Title Detectors - Magnetism Reflectometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, fabrication, pre-installation, and testing of detectors and mounts specific to the Magnetism Reflectometer are included in this WBS.

WBS Descriptor Form

WBS 1.07.05.04 **PCR** PCR IS 02 003 **Revision** 1 **Revision Date** 8/21/2002

Title Choppers - Magnetism Reflectometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, fabrication, pre-installation, and testing of neutron choppers specific to the Magnetism Reflectometer are included in this WBS. This instrument will have three bandwidth-limiting choppers.

WBS Descriptor Form

WBS 1.07.05.05 **PCR** _____ **Revision** 0 **Revision Date** 8/31/2000

Title Sample Environment - Magnetism Reflectometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, fabrication, pre-installation, and testing of sample environment equipment specific to the Magnetism Reflectometer are included in this WBS.

WBS Descriptor Form

WBS 1.07.05.06 **PCR** _____ **Revision** 0 **Revision Date** 8/31/2000

Title Optical Elements - Magnetism Reflectometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, fabrication, pre-installation, and testing of neutron optical components specific to the Magnetism Reflectometer are included in this WBS. This includes items such as neutron guides/benders and associated mounting/alignment fixtures, inserts located internal to the Target Monolith, collimators, and polarizing/analyzing optics.

WBS Descriptor Form

WBS 1.07.05.07 **PCR** PCR IS 02 003 **Revision** 1 **Revision Date** 8/21/2002

Title Shielding - Magnetism Reflectometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, fabrication, pre-installation, and radiological calculations for shielding elements specific to the Magnetism Reflectometer are included in this WBS.

WBS Descriptor Form

WBS 1.07.05.08 **PCR** _____ **Revision** 0 **Revision Date** 8/31/2000

Title Instrument Specific - Magnetism Reflectometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, fabrication, pre-installation, and testing of components specific to the Magnetism Reflectometer are included in this WBS. This includes items such as the platform for instrument operation, personnel protection systems, and beam interlocks.

WBS Descriptor Form

WBS 1.07.06 **PCR** _____ **Revision** 1 **Revision Date** 9/1/2000

Title Liquids Reflectometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS item includes all activities which are not covered under WBS 1.7.3 - Shared Design Activities - required for the design, procurement, fabrication, installation, and testing of the Liquids Reflectometer. Commissioning of the instrument is not included.

Rev. 0 Title: Instrument #3 Set #1. Modified via PCR IS-00-006

WBS Descriptor Form

WBS 1.07.06.01 **PCR** _____ **Revision** 0 **Revision Date** 9/1/2000

Title System Integration - Liquids Reflectometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS item includes the activities necessary to finally assemble the Liquids Reflectometer from the pre-assembled subcomponents and to put the shielding in place. It also includes testing of the overall system controls.

WBS Descriptor Form

WBS 1.07.06.02 **PCR** _____ **Revision** 0 **Revision Date** 9/1/2000

Title Data Acquisition - Liquids Reflectometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, fabrication, pre-installation, and testing of data acquisition electronics and software specific to the Liquids Reflectometer are included in this WBS.

WBS Descriptor Form

WBS 1.07.06.03 **PCR** _____ **Revision** 0 **Revision Date** 9/1/2000

Title Detectors - Liquids Reflectometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, fabrication, pre-installation, and testing of detectors and mounts specific to the Liquids Reflectometer are included in this WBS.

WBS Descriptor Form

WBS 1.07.06.04 **PCR** PCR IS 02 003 **Revision** 1 **Revision Date** 8/21/2002

Title Choppers - Liquids Reflectometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, fabrication, pre-installation, and testing of neutron choppers specific to the Liquids Reflectometer are included in this WBS. This instrument will have three bandwidth-limiting choppers.

WBS Descriptor Form

WBS 1.07.06.05 **PCR** _____ **Revision** 0 **Revision Date** 9/1/2000

Title Sample Environment - Liquids Reflectometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, fabrication, pre-installation, and testing of sample environment and positioning equipment specific to the Liquids Reflectometer are included in this WBS.

WBS Descriptor Form

WBS 1.07.06.06 **PCR** _____ **Revision** 0 **Revision Date** 9/1/2000

Title Optical Elements - Liquids Reflectometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, fabrication, pre-installation, and testing of neutron optical components specific to the Liquids Reflectometer are included in this WBS. This includes items such as neutron guides/benders and associated mounting/alignment fixtures, inserts located internal to the target monolith, collimators, and polarizing/analyzing optics.

WBS Descriptor Form

WBS 1.07.06.07 **PCR** _____ **Revision** 0 **Revision Date** 9/1/2000

Title Shielding - Liquids Reflectometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, fabrication, pre-installation, and testing of shielding elements specific to the Liquids Reflectometer are included in this WBS.

WBS Descriptor Form

WBS 1.07.06.08 **PCR** _____ **Revision** 0 **Revision Date** 9/1/2000

Title Instrument Specific - Liquids Reflectometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, fabrication, pre-installation, and testing of components specific to the Liquids Reflectometer are included in this WBS. This includes items such as the platform for instrument operation, personnel protection systems, and beam interlocks.

WBS Descriptor Form

WBS 1.07.07 **PCR** PCR IS 02 003 **Revision** 1 **Revision Date** 8/21/2002

Title Wide Angular Range Chopper Spectrometer (Technical Support Only)

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS item has historical costs for up-front technical development by the SNS project for an instrument that is either not funded by the SNS (IDT instrument) or has not been selected or approved.

WBS Descriptor Form

WBS 1.07.07.01 **PCR** PCR IS 02 003 **Revision** 1 **Revision Date** 8/21/2002

Title System Integration - Wide Angular Range Chopper Spectrometer (Technical

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS item has historical costs for up-front technical development by the SNS project for an instrument that is either not funded by the SNS (IDT instrument) or has not been selected or approved.

WBS Descriptor Form

WBS 1.07.07.04 **PCR** PCR IS 02 003 **Revision** 1 **Revision Date** 8/21/2002

Title Choppers - Wide Angular Range Chopper Spectrometer (Technical Support)

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS item has historical costs for up-front technical development by the SNS project for an instrument that is either not funded by the SNS (IDT instrument) or has not been selected or approved.

WBS Descriptor Form

WBS 1.07.07.07 **PCR** PCR IS 02 003 **Revision** 1 **Revision Date** 8/21/2002

Title Shielding - Wide Angular Range Chopper Spectrometer (Technical Support)

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS item has historical costs for up-front technical development by the SNS project for an instrument that is either not funded by the SNS (IDT instrument) or has not been selected or approved.

WBS Descriptor Form

WBS 1.07.08 **PCR** PCR IS 01 012 **Revision** 1 **Revision Date** 10/22/2001
Title Extended-Q Small Angle Diffractometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS item includes all activities which are not covered under WBS 1.7.3 - Shared Design Activities - required for the design, procurement, fabrication and testing of the Extended-Q Small Angle Diffractometer (SANS) (Instrument 4). Installation and commissioning of the instrument are not included.

WBS Descriptor Form

WBS 1.07.08.01 **PCR** PCR IS 02 003 **Revision** 2 **Revision Date** 8/21/2002

Title System Integration - Extended Q-Range Small Angle Diffractometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS item includes the activities necessary to provide interlab and interdivisional liaison, and coordination with the other planned instruments for the SNS throughout the life of the project.

WBS Descriptor Form

WBS 1.07.08.02 **PCR** PCR IS 01 012 **Revision** 1 **Revision Date** 10/22/2001

Title Data Acquisition - Instrument 4

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, fabrication, and testing of data acquisition electronics and software specific to the SANS instrument are included in this WBS.

WBS Descriptor Form

WBS 1.07.08.03 **PCR** PCR IS02 003 **Revision** 2 **Revision Date** 8/21/2002

Title Detectors - Extended Q-Range Small Angle Diffractometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, fabrication, and testing of the detector assembly, beam monitor and the low angle detector vessel for the SANS instrument are included in this WBS.

WBS Descriptor Form

WBS 1.07.08.04 **PCR** PCR IS 02 003 **Revision** 2 **Revision Date** 8/21/2002

Title Choppers - Extended Q-Range Small Angle Diffractometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, fabrication, and testing of neutron choppers specific to the SANS instrument are included in this WBS. These will include three low speed single disk bandwidth-limiting choppers.

WBS Descriptor Form

WBS 1.07.08.05 **PCR** PCR IS 02 003 **Revision** 2 **Revision Date** 8/21/2002

Title Sample Environment - Extended Q-Range Small Angle Diffractometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, fabrication, and testing of sample environment equipment specific to the SANS instrument are included in this WBS.

WBS Descriptor Form

WBS 1.07.08.06 **PCR** PCR IS 02 003 **Revision** 2 **Revision Date** 8/21/2002

Title Optical Elements - Extended Q-Range Small Angle Diffractometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, fabrication, and testing of neutron optical components specific to the SANS instrument are included in this WBS. This includes items such as neutron guides, associated mounting/alignment fixtures, and inserts located internal to the Target Monolith.

WBS Descriptor Form

WBS 1.07.08.07 **PCR** PCR IS 02 003 **Revision** 2 **Revision Date** 8/21/2002
Title Shielding - Extended-Q Small Angle Diffractometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, fabrication, and testing of components specific to the SANS instrument are included in this WBS. This includes instrument hutches, data analysis system and the personnel protection system.

WBS Descriptor Form

WBS 1.07.08.08 **PCR** PCR IS 02 003 **Revision** 2 **Revision Date** 8/21/2002

Title Instrument Specific - Extended-Q Small Angle Diffractometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, fabrication, and radiological calculations for the shielding elements specific to the SANS instrument are included in this WBS. Shielding includes concrete blocks, monolithic poured concrete and steel blocks.

WBS Descriptor Form

WBS 1.07.09 **PCR** PCR IS 02 003 **Revision** 1 **Revision Date** 8/21/2002

Title Engineering Diffractometer - VULCAN (Technical Support Only)

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS item has historical costs for up-front technical development by the SNS project for an instrument that is either not funded by the SNS (IDT instrument) or has not been selected or approved.

WBS Descriptor Form

WBS 1.07.09.01 **PCR** PCR IS 02 003 **Revision** 1 **Revision Date** 8/21/2002

Title System Integration - Engineering Diffractometer - VULCAN (Technical Support)

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS item has historical costs for up-front technical development by the SNS project for an instrument that is either not funded by the SNS (IDT instrument) or has not been selected or approved.

WBS Descriptor Form

WBS 1.07.09.04 **PCR** PCR IS 02 003 **Revision** 1 **Revision Date** 8/21/2002

Title Choppers - Engineering Diffractometer - VULCAN (Technical Support Only)

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS item has historical costs for up-front technical development by the SNS project for an instrument that is either not funded by the SNS (IDT instrument) or has not been selected or approved.

WBS Descriptor Form

WBS 1.07.09.07 **PCR** PCR 02 003 **Revision** 1 **Revision Date** 8/21/2002

Title Shielding - Engineering Diffractometer - VULCAN (Technical Support Only)

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS item has historical costs for up-front technical development by the SNS project for an instrument that is either not funded by the SNS (IDT instrument) or has not been selected or approved.

WBS Descriptor Form

WBS 1.07.10 **PCR** PCR IS 02 003 **Revision** 2 **Revision Date** 8/21/2002

Title Powder Diffractometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS item includes all activities which are not covered under WBS 1.7.3 - Shared Design Activities - required for the design, procurement, fabrication and testing of the General Purpose Powder Diffractometer (Instrument 5). Installation and commissioning of the instrument are not included.

WBS Descriptor Form

WBS 1.07.10.01 **PCR** PCR IS 02 003 **Revision** 2 **Revision Date** 8/21/2002

Title System Integration - Powder Diffractometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS item includes the activities necessary to provide interlab and interdivisional liaison, and coordination with the other planned instruments for the SNS throughout the life of the project.

WBS Descriptor Form

WBS 1.07.10.02 **PCR** PCR IS 02 003 **Revision** 2 **Revision Date** 8/21/2002

Title Data Acquisition - Powder Diffractometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, fabrication, and testing of data acquisition electronics and software specific to the Powder Diffractometer are included in this WBS.

WBS Descriptor Form

WBS 1.07.10.03 **PCR** PCR IS 02 003 **Revision** 2 **Revision Date** 8/21/2002

Title Detectors - Powder Diffractometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, fabrication, and testing of detectors and mounts specific to the Powder Diffractometer are included in this WBS.

WBS Descriptor Form

WBS 1.07.10.04 **PCR** PCR IS 02 003 **Revision** 2 **Revision Date** 8/21/2002
Title Choppers - Powder Diffractometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, fabrication, and testing of neutron choppers specific to the Powder Diffractometer are included in this WBS. These will include two low speed single disk bandwidth-limiting choppers and one T0 chopper.

WBS Descriptor Form

WBS 1.07.10.05 **PCR** PCR IS 02 003 **Revision** 2 **Revision Date** 8/21/2002

Title Sample Environment - Powder Diffractometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, fabrication, and testing of sample environment equipment specific to the Powder Diffractometer are included in this WBS.

WBS Descriptor Form

WBS 1.07.10.06 **PCR** PCR IS 02 003 **Revision** 2 **Revision Date** 8/21/2002

Title Optical Elements - Powder Diffractometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, fabrication, and testing of neutron optical components specific to the Powder Diffractometer are included in this WBS. This includes items such as neutron guides, and associated mounting/alignment fixtures, and inserts located internal to the Target Monolith.

WBS Descriptor Form

WBS 1.07.10.07 **PCR** PCR IS 02 003 **Revision** 2 **Revision Date** 8/21/2002

Title Shielding - Powder Diffractometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, fabrication, and radiological calculations for shielding elements specific to the Powder Diffractometer are included in this WBS. Shielding includes concrete blocks, monolithic poured concrete and steel blocks.

WBS Descriptor Form

WBS 1.07.10.08 **PCR** PCR IS 02 003 **Revision** 2 **Revision Date** 8/21/2002

Title Instrument Specific - Powder Diffractometer

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Design, procurement, fabrication, and testing of components specific to the Powder Diffractometer are included in this WBS. This includes instrument enclosure, vacuum system, interchangeable guide assembly and the personnel protection system.

WBS Descriptor Form

WBS 1.07.11 **PCR** PCR 02 003 **Revision** 1 **Revision Date** 8/21/2002

Title Cold Neutron Chopper Spectrometer (Technical Support Only)

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS item has historical costs for up-front technical development by the SNS project for an instrument that is either not funded by the SNS (IDT instrument) or has not been selected or approved.

WBS Descriptor Form

WBS 1.07.11.04 **PCR** PCR 02 003 **Revision** 1 **Revision Date** 8/21/2002

Title Choppers - Cold Neutron Chopper Spectrometer (Technical Support Only)

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS item has historical costs for up-front technical development by the SNS project for an instrument that is either not funded by the SNS (IDT instrument) or has not been selected or approved.

WBS Descriptor Form

WBS 1.07.11.07 **PCR** PCR IS 02 003 **Revision** 1 **Revision Date** 8/21/2002

Title Shielding - Cold Neutron Chopper Spectrometer (Technical Support Only)

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS item has historical costs for up-front technical development by the SNS project for an instrument that is either not funded by the SNS (IDT instrument) or has not been selected or approved.

WBS Descriptor Form

WBS 1.07.12 **PCR** PCR IS 02 003 **Revision** 1 **Revision Date** 8/21/2002

Title High Pressure Diffractometer (Document Control Only)

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Document Control Only

WBS Descriptor Form

WBS 1.07.13 **PCR** PCR IS 02 003 **Revision** 1 **Revision Date** 8/21/2002

Title Disordered Materials Diffractometer (Document Control Only)

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Document Control Only

WBS Descriptor Form

WBS 1.07.14 **PCR** PCR IS 02 003 **Revision** 2 **Revision Date** 8/21/2002

Title High Resolution Chopper Spectrometer (Document Control Only)

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Document Control Only

WBS Descriptor Form

WBS 1.07.15 **PCR** PCR IS 02 003 **Revision** 2 **Revision Date** 8/21/2002

Title Single Crystal Diffractometer (Document Control Only)

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Document Control Only

WBS Descriptor Form

WBS 1.07.16 **PCR** PCR IS 02 003 **Revision** 2 **Revision Date** 8/21/2002

Title Fundamental Physics (Document Control Only)

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Document Control Only

WBS Descriptor Form

WBS 1.07.17 **PCR** PCR IS 03 006 **Revision** 0 **Revision Date** 4/25/2003

Title Hybrid Spectrometer (Document Control Only)

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Document Control Only

WBS Descriptor Form

WBS 1.07.18 **PCR** PCR IS 03 006 **Revision** 0 **Revision Date** 4/25/2003

Title Neutron Spin Echo Spectrometer (Document Control Only)

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Document Control Only

WBS Descriptor Form

WBS 1.07.19 **PCR** PCR IS 03 006 **Revision** 0 **Revision Date** 4/25/2003

Title Chemical Spectrometer (Document Control Only)

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Document Control Only

WBS Descriptor Form

WBS 1.08 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999
Title Conventional Facilities

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

ORNL will construct the conventional buildings and structures that will house the SNS accelerator, ring and target hardware and all support buildings. The facilities will be designed to facilitate the construction and operation of the SNS. In addition to the basic building structures technical support facilities, office space, and general utilities will be provided to provide a complete facility to support neutron science.

Buildings include the Front End building; the Linac, HEBT, Ring and RTBT tunnels; the Klystron building; HEBT, Ring and RTBT support buildings; and other structures that include beam dumps, the Utility building, other site miscellaneous structures; and the Office and Technical Support buildings previously mentioned.

WBS Descriptor Form

WBS 1.08.01 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999

Title Technical Support

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS Descriptor Form

WBS 1.08.01.01 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001

Title AE Coordination (ORNL)

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

ORNL will provide technical oversight of the AE/CM and develop and manage interfaces between collaborating labs, ORNL, DOE and other State and Federal agencies. In addition to coordinating work with the collaborating laboratories the ORNL team will ensure that the design and construction of the SNS conforms to approved design and construction documents.

R0 WBS Title: AE Coordination

WBS Descriptor Form

WBS 1.08.01.02 **PCR** PCR SN 01 006 **Revision** 3 **Revision Date** 12/21/2001

Title ORNL Project Management

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

ORNL will provide overall project management and budget control of the CF portion of the project. This will include oversight of Knight/Jacobs' performance in their conduct of the design and construction effort, as determined by monitoring financial and activity completion against budget, schedule, and quality baselines. An ORNL team of management and cost control personnel will perform this effort.

Subcontract technical support is also included in this WBS.

R0 WBS Title: Project Support

WBS Descriptor Form

WBS 1.08.01.03 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001

Title AE/CM Project Management

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Knight/Jacobs will provide management of the design and construction effort, with responsibility to complete the project within budget and on schedule while achieving the required level of quality. A team of management, scheduling, estimating, and cost control personnel will accomplish this effort and provide detail oversight of all design and construction activities.

R0 WBS Title: Construction Management 1.8

WBS Descriptor Form

WBS 1.08.01.04 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001
Title Construction Management

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS element incorporates the cost for the CM oversight and construction management services during the construction process. Included are development and management of the construction interfaces with the construction team, the collaborating labs, ORNL, DOE, and other State and Federal agencies. This also includes oversight and review of all construction activities associated with the development and completion of the SNS.

WBS Descriptor Form

WBS 1.08.01.05 **PCR** PCR CF 01 016 **Revision** 0 **Revision Date** 10/10/2001

Title Title III Support

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This subtask shall provide the AE and CM Title III Services. Activities in this task include, but are not limited to:Resolution of deviations and non-conformancesReview and approve shop drawingsRespond to bidders questionsIncorporate design changes/revise design drawings as requiredEvaluation of alternates and "OR EQUAL" submittalsDesign for field changesProvide support in responses to request for informationAs build drawingsField observation and documentationThis task includes support from on-site and off-site resources.

WBS Descriptor Form

WBS 1.08.02 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999

Title Land Improvements and Constr Support

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS Descriptor Form

WBS 1.08.02.01 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001

Title Roadwork, walks, plazas, paved areas

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Deleted per PCR CF-00-004

Modification incorporated into R03, Issued October 2000

WBS Descriptor Form

WBS 1.08.02.02 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001
Title Site Characterization

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Site Characterization consists of the activities necessary for soil characterization and site analysis to explore and define surface and subsurface characteristics of the site. These will be used as the basis for overall site and building foundation design. These activities include investigating characteristics such as topography and locations of existing above and underground utilities; geology, slope stability, and soils as a basis for engineering; hydrology and groundwater; and natural hazards (i.e., seismic, wind, lightning, tornado, and flood). Borings and other appropriate and acceptable methods that adequately disclose the general engineering characteristics of the subsurface materials will be used.

WBS Descriptor Form

WBS 1.08.02.03 **PCR** _____ **Revision** 1 **Revision Date** 3/10/2000
Title Site Work

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Site Work activities include: 1) Roadwork, Walks, Plazas, and Paved Areas, 2) Site Preparation and Grading, 3) Storm Water Management, 4) the Groundwater Interceptor System, 5) Landscaping, 6) Fencing, and 7) Security Inspection Posts.

Roadwork, Walks, Plazas, and Paved Areas provides temporary and permanent access for vehicular and pedestrian traffic to, from, and throughout the site and its facilities. It includes roads, parking lots, and walkway and plaza areas connecting buildings to roads, parking, and other buildings.

Site Preparation and Grading includes demolition or removal of existing interferences to the grading operations; clearing and grubbing of existing vegetation, as well as protection of existing vegetation to remain in place; excavation and backfilling for building constructions, including stockpiling of reusable materials and disposal of excess and undesirable materials; finish grading in preparation for landscaping, walks, roads, etc., prior to facility occupancy; and provision of temporary erosion and sediment controls during construction. Excavations for specific building foundations or structural supports are not included here.

The Storm Water Management system collects surface runoff from the site and controls its discharge downstream into the infrastructure catchment area. This activity includes both surface and subgrade collection systems, as well as detention facilities for control against flooding and any monitoring as may be required by NPDES permitting.

The Groundwater Interceptor System includes membrane structures that divert groundwater away from potential contamination areas, such as the shielding area around the linac, HEBT, ring, and RTBT tunnels. A subsurface system collects incidental water that may elude stormwater management systems or that may penetrate diversion membranes into the shielding areas. This water is then conveyed to a holding area for monitoring and mitigation prior to release into the catchment area.

Landscaping includes trees and other plantings for visual screening, solar control, and noise control, as well as for the promotion of an overall "campus" atmosphere throughout the facility. Erosion control is also included in this activity.

Fencing will be utilized to provide a physical barrier that restricts access to restricted areas of the facility. Gates, locks, and other associated equipment other than electronic security devices are included.

The Security Inspection Posts are permanent structures for sheltering personnel and equipment required at strategic surveillance points.

R0 WBS Title: Site Prep and Grading

WBS Descriptor Form

WBS 1.08.02.04 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001

Title Stormwater Management

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Deleted per PCR CF-00-004

Modification incorporated into R03, Issued October 2000

WBS Descriptor Form

WBS 1.08.02.05 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001

Title Groundwater Interceptor Sys

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Deleted per PCR CF-00-004

Modification incorporated into R03, Issued October 2000

WBS Descriptor Form

WBS 1.08.02.06 **PCR** _____ **Revision** _____ **Revision Date** _____

Title Retaining Walls

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS Descriptor Form

WBS 1.08.02.07 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Landscaping

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Deleted

WBS Descriptor Form

WBS 1.08.02.08 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Fencing

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Deleted

WBS Descriptor Form

WBS 1.08.02.09 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Security Inspector Post

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Deleted

WBS Descriptor Form

WBS 1.08.02.10 **PCR** _____ **Revision** _____ **Revision Date** _____

Title Borrow areas

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS Descriptor Form

WBS 1.08.02.11 **PCR** _____ **Revision** _____ **Revision Date** _____

Title Excavation Disposal Areas

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS Descriptor Form

WBS 1.08.02.12 **PCR** PCR CF 02 005 **Revision** 2 **Revision Date** 2/5/2002
Title Construction Support

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Construction Support provides the material, equipment, services, and labor needed to cover those items and activities not furnished by fixed price construction subcontracts. Construction support includes the cost of installing temporary construction utilities (power, water, and sewer), construction access roads, construction parking areas, temporary site offices, and construction laydown and holding areas. Other material or services include telephones and other communication equipment, site security, construction badge and access system, safety items, general erosion control, general site maintenance, reproduction, construction vehicles, construction photography, and temporary fencing.

The Construction Manager is responsible for providing material, labor, equipment, and services to operate and maintain the large SNS construction site. The SNS Conventional Facilities team will approve procurements for this WBS. The Construction Manager will use a variety of methods to manage the construction site. They include subcontracts for services, construction subcontracts, and direct labor.

A building for temporary storage of equipment will be constructed at the site for use by the project. The 25,000sf metal building will be insulated, conditioned to prevent freezing and ventilated.

WBS Descriptor Form

WBS 1.08.03 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999

Title Buildings

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS Descriptor Form

WBS 1.08.03.01 **PCR** PCR SN 01 006 **Revision** 4 **Revision Date** 12/21/2001
Title Front End Buildings

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Front End Building is an above grade, steel frame structure of approximately 15,600 square feet of floor area with an interior clear height of approximately 12 feet. The FEB will house the accelerator ion source, low energy beam transport line (LEBT), radio frequency quadrupole (RFQ), the medium energy beam transport line (MEBT) and the first 30 feet of the Drift Tube Linac (DTL). Floor elevation is the same as the Linac Tunnel with a beam elevation of 50" above the floor. Personnel access and emergency egress from the Linac Tunnel is through the Front End Building. For proper smoke removal and ventilation of the linac confined area a wall will separate the linac from the FEB. All interior walls will be reinforced concrete block or gypsum board. The concrete floor slab will be constructed sufficiently flat to accommodate forklift traffic for moving equipment.

The exterior skin of the building will be insulated metal panels. The roof will be composite built-up roofing over metal deck.

Equipment access will be provided by means of one (1) overhead truck door. An access road and parking apron will be provided to allow for truck turnaround. Personnel access doors will also be provided as required by code.

Air conditioning will be provided throughout the building (except for the mechanical and electrical equipment rooms) by air conditioning units located on a 3,000 square feet equipment mezzanine using water from the chilled water system and the hot water heating system. The building utilities will include a deionized water, compressed air, tower water, water system, sanitary waste, and process waste systems. The building will be maintained at a slight positive pressure relative to ambient to prevent dust and dirt intrusion into the building.

WBS Descriptor Form

WBS 1.08.03.02 **PCR** PCR SN 01 006 **Revision** 3 **Revision Date** 12/21/2001
Title Linac Tunnel

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Linear Accelerator (Linac) Tunnel houses the majority of the linear accelerator components. These components consist of the remainder of the drift tube linac (DTL), the coupled-cavity linac (CCL), and medium and high beta cryomodules. The tunnel itself will be constructed entirely of steel reinforced concrete and will have approximately 14,700 square feet of floor area. With egresses the total area is 15,400 sf. Interior tunnel dimensions are estimated to be 14 feet wide and 10 feet high. The tunnel floor elevation will be the same as the Front End Building.

Access to the tunnel for both personnel and heavy equipment will be through the Front End Building from the west and a large equipment plug and personnel door located to the east off the HEBT Tunnel. These accesses will be adequately shielded and located per the Interface Design Documents. Soil shielding is estimated to be a minimum of 17 feet deep around the Linac Tunnel and when combined with the fixed concrete shielding is sufficient to protect the surrounding buildings and its occupants. A drain system will be provided under the tunnel foundation to intercept ground water that might otherwise seep into the interior of the tunnel. A waterproof membrane will also be provided on the outside of the walls and roof of the tunnel to further mitigate water intrusion from the earth shielding.

Air conditioning in the tunnel will be provided by ceiling mounted air conditioning units. Cooling will be accomplished using water from the chilled water system. Heat will be provided by duct mounted electric coils. A separate smoke removal system utilizing grade mounted exhaust fans will also be provided. Services provided to the tunnel will be deionized water, compressed air, and the process waste removal system. Cable trays, power panels, and cables for conventional service loads (lighting, communications, the Personal Protection System, etc) shall be provided by Conventional Facilities.

Cable trays for technical equipment and power cable from the unit substations to the power panels and the power panels to supply technical equipment shall be designed, provided, and installed by other technical groups. Embedded conduit shall be provided by Conventional Facilities.

WBS Descriptor Form

WBS 1.08.03.03 **PCR** PCR SN 01 006 **Revision** 3 **Revision Date** 12/21/2001
Title Klystron Hall and HEBT Service Building

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Klystron Hall houses the RF power supplies, magent power supplies, cooling systems, and controls supporting the linac. The building is 15 feet 10 inches from the exterior face of the Linac Tunnel and parallel to it. The rear wall will be designed as a concrete retaining wall to support the earth shielding, which surrounds the Linac Tunnel. The retaining wall will extend approximately 17 feet above the level of the finish floor and will have waterproofing applied to the exterior face and a drain system under its foundation to remove ground water, which might otherwise seep into the building. The balance of the building will be a steel frame structure with an interior clear height of approximately 18 feet. It will have a floor area of approximately 45,500 square feet. Utility chases for routing of mechanical system piping, electrical cabling, and the RF wave guides will be provided between the Klystron and Linac. The elevation of these chases will be directly above the foundation. The Klystron Hall finished floor elevation will be 8 feet above the finished floor elevation of the Front End Building and Linac Tunnel. The HEBT Service Building houses the power supplies, cooling systems, and controls supporting the HEBT.

The HEBT Service Building is constructed in the same manner as the Klystron Hall. The building size is approximately 4,700 sf. Utility chases for routing of mechanical system piping and electrical cabling will be provided between the HEBT and the HEBT Service Building. The elevation of these chases will be directly above the foundation. The HEBT Service Building finished floor elevation will be 8 feet above the finished floor elevation of the Front End Building and Linac Tunnel.

The south face of the Klystron Building will be provided with several equipment access doors to accommodate delivery of equipment and forklifts. Adjacent to the access doors there will be a single personnel door. Localized deionized water will also be provided along the south face in outbuildings to the main klystron structure. These outbuildings will be sized large enough to accommodate the deionized water skids, HVAC units and electrical switchgear.

A 2 hour firewall across the width of the Klystron Hall will separate the building into two approximately equal segments. This is to limit the potential financial loss due to fire. The interior concrete floor slab will be constructed sufficiently flat to accommodate forklift traffic for moving equipment.

The exterior skins of the buildings will be insulated metal panels. The roof will be composite built-up roofing over metal deck.

Air conditioning will be provided throughout the buildings (except for the deionized water equipment rooms) by floor mounted air conditioning units using water from the chilled water system and the hot water heating system. The buildings will be provide with a deionized water system, a compressed air system, a potable water system, a sanitary waste system, and a process waste system. The buildings will be maintained at a slight positive pressure relative to ambient. Cable trays, power panels, and cables for conventional service loads (lighting, communications, the Personal Protection System, etc) shall be provided by Conventional Facilities.

Cable trays for technical equipment and power cable from the unit substations to the power panels and the power panels to supply technical equipment shall be designed, provided, and installed by other technical groups. Embedded conduit shall be provided by Conventional Facilities.

WBS Descriptor Form

WBS 1.08.03.04 **PCR** PCR SN 01 006 **Revision** 4 **Revision Date** 12/21/2001
Title HEBT Tunnel

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This below grade tunnel houses the HEBT beam line equipment (magnets, RF debuncher, collimators, etc.) and will be constructed entirely of concrete. Interior tunnel dimensions of 13 feet high by 17 feet wide accommodate the required beam height of approximately 50" above finish floor as well as accommodating necessary utilities and other equipment being routed overhead. The tunnel floor area will be approximately 9,800 square feet. With egresses the total area is 12,800 sf. The tunnel length is approximately 480 feet. Included in all sections of the tunnel is a monorail crane capable of lifting 25 tons for removing equipment.

Access to the tunnel will be through a large equipment plug door and adjacent personnel access-way. These accesses will be adequately shielded and located per the System Requirements Document. Soil shielding is estimated to be a minimum of 17 feet deep around the tunnels and when combined with the fixed concrete shielding is sufficient to protect the surrounding service buildings and its occupants. A drain system will be provided under the tunnel foundation to intercept ground water that might otherwise seep into the interior of the tunnel. A waterproof membrane will be provided on the outside of the walls and roof of the tunnel to further mitigate water intrusion from the earth shielding.

Air conditioning in the tunnel will be provided by grade mounted air conditioning units. Cooling will be accomplished using water from the chilled water system. Heat will be provided by duct mounted electric coils. A smoke removal system utilizing grade mounted exhaust fans will also be provided. The tunnel will be serviced by the deionized water system, the tower water system, the instrument air system, and the process waste system. Fire protection for the tunnel will be provided by a sprinkler system.

Cable trays, power panels, and cables for conventional service loads (lighting, communications, the Personal Protection System, etc) shall be provided by Conventional Facilities. Cable trays for technical equipment and power cable from the unit substations to the power panels and the power panels to supply technical equipment shall be designed, provided, and installed by other technical groups. Embedded conduit shall be provided by Conventional Facilities.

WBS Descriptor Form

WBS 1.08.03.05 **PCR** PCR SN 01 006 **Revision** 4 **Revision Date** 12/21/2001
Title Storage Ring Tunnel

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This below grade tunnel, which houses magnets, an RF debuncher, and collimators to accumulate beam pulses from the linac and bunch them for the target, will be constructed entirely of concrete and has a floor area of approximately 15,600 square feet. With egresses the area is approximately 18,200 sf. The circumference of the ring is approximately 816 feet. Interior tunnel dimensions of 17 feet wide by 13 feet high are based on the required beam height of approximately 48.2" above finish floor as well as accommodating necessary utilities and other equipment being routed overhead. Included in throughout the tunnel are two monorail cranes, capable of lifting 15 tons and 25 tons respectively.

Equipment and personnel access to the tunnel will be through a door and a lift south side of the ring. These will be adequately shielded and located per the System Requirements Document. Soil shielding is estimated to be a minimum of 17 feet deep around the tunnels and when combined with the concrete shielding is sufficient to protect the surrounding service buildings and its occupants. A drain system will be provided under the tunnel foundation to intercept ground water that might otherwise seep into the interior of the tunnel. A waterproof membrane will be provided on the outside of the walls and roof of the tunnel to further mitigate water intrusion from the earth shielding.

Air conditioning in the tunnel will be provided by grade mounted air conditioning units cooled by the chilled water system. Heat will be provided by duct mounted electric coils. A smoke removal system utilizing grade mounted exhaust fans will also be provided. The tunnel will be serviced by the deionized water system, the tower water system, the instrument air system, and the process waste system. Fire protection for the tunnel will be provided by a sprinkler system.

Cable trays, power panels, and cables for conventional service loads (lighting, communications, the Personal Protection System, etc) shall be provided by Conventional Facilities. Cable trays for technical equipment and power cable from the unit substations to the power panels and the power panels to supply technical equipment shall be designed, provided, and installed by other technical groups. Embedded conduit shall be provided by Conventional Facilities.

WBS Descriptor Form

WBS 1.08.03.06 **PCR** PCR SN 01 006 **Revision** 4 **Revision Date** 12/21/2001
Title RTBT Tunnel

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This below grade tunnel, which houses magnets and collimators to transfer the beam from the ring to the target, will be constructed entirely of concrete, has a floor area of approximately 6,100 square feet. With egresses the approximate area is 8,300 sf. The tunnel length is approximately 400 feet long. Interior tunnel dimensions of 17 feet wide by 13 feet high accommodate the required beam height of approximately 41" above finish floor as well as accommodating necessary utilities and other equipment being routed overhead. Included throughout the tunnel is a monorail crane capable of lifting 25 tons for equipment removal and maintenance.

Access to the tunnel will be through a large equipment plug door and adjacent personnel access-way. These accesses will be adequately shielded and located per the System Requirements Document. Soil shielding is estimated to be a minimum of 17 feet deep around the tunnels and when combined with the fixed concrete shielding is sufficient to protect the surrounding service buildings and its occupants. A drain system will be provided under the tunnel foundation to intercept ground water that might otherwise seep into the interior of the tunnel. A waterproof membrane will be provided on the outside of the walls and roof of the tunnel to further mitigate water intrusion from the earth shielding.

Air conditioning in the tunnel will be provided by grade mounted air conditioning units cooled by the chilled water system. Heat will be provided by duct mounted electric coils. A separate smoke removal system utilizing grade mounted exhaust fans will also be provided. The tunnel will be serviced by the deionized water system, the tower water system, the instrument air system, and the process waste system. Fire protection for the tunnel will be provided by a sprinkler system.

Cable trays, power panels, and cables for conventional service loads (lighting, communications, the Personal Protection System, etc) shall be provided by Conventional Facilities. Cable trays for technical equipment and power cable from the unit substations to the power panels and the power panels to supply technical equipment shall be designed, provided, and installed by other technical groups. Embedded conduit shall be provided by Conventional Facilities.

WBS Descriptor Form

WBS 1.08.03.07 **PCR** _____ **Revision** 2 **Revision Date** 2/22/2001
Title Target Building and Experiment Hall

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Target Station Building is a steel frame above ground structure with a partial basement. Interior clear height is approximately 30 feet in the Instrument Level to the hook of the 30-ton bridge crane. Building footprint is approximately 200 feet by 290 feet. Its intended uses are: to support the neutron scattering research programs by providing the experiment facilities for the scattering instruments; meeting their space and utility requirements; providing proton beam line shielding and a hot cell complex used for the target systems; and housing the electrical, cooling, waste, and HVAC systems used to support the proton target, neutron moderators, and experimental facilities in an appropriately shielded and serviceable environment. A Mezzanine Level will serve as a partial perimeter walkway connecting future Lab/Office module construction above the individual instruments. A Truss Level walkway and platform system will provide space for placement and servicing of air handling units to condition the facility.

Personnel access to the Target Station will be at the Basement Level through the east elevator/stair tower, at the Instrument Level through the east elevator/stair tower and from the west end of the building for bringing in nitrogen dewars. A personnel door will be provided on the north side of the building.

All interior walls will be reinforced, painted concrete block or reinforced cast-in-place concrete, with the exception of the plumbing wall at the restrooms which will be painted, non-reinforced concrete block. The concrete floor slab will be constructed sufficiently flat with a hard, smooth finish to accommodate forklift and air pallet traffic for moving equipment between the two main areas of the Instrument Level.

The exterior skin of the building will be insulated metal panels with moderate articulation in the form of reveals and profiles. Window systems will be prefinished, thermally broken, extruded aluminum with insulated glazing panels, located at the upper section of the Instrument Level wall. The roof will be a composite system.

Equipment access will be provided by means of three (3) insulated steel overhead truck doors, one at the Basement Level and two at the Instrument Level. Personnel access doors will also be provided at all three over head doors, and as required by code. These doors and frames will be insulated hollow metal assemblies.

Air conditioning will be provided throughout the building by air conditioning units using water from the chilled water system and the hot water heating system. The building will have a deionized water system, a gaseous helium supply system, and a liquid nitrogen storage/transfer station and will be serviced by the compressed air system, the potable water system, the sanitary waste system, the process waste system, and the liquid low level waste system.

Confinement exhaust for the Target Building will consist of three separate exhaust systems. The hot-off-gas (HOG) system and the primary confinement exhaust (PCE) system will serve the hot cells and other nuclear portions of the facility. The secondary confinement exhaust (SCE) system will serve the lower hazard nuclear areas adjacent to the cells and certain areas in the basement.

WBS Descriptor Form

WBS 1.08.03.08 **PCR** _____ **Revision** 3 **Revision Date** 2/22/2001
Title Ring Service Building

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Ring Service Building is a steel frame structure with an interior clear height of approximately 18 feet above the main floor and a total floor area of approximately 14,100 square feet on or above grade. It will house the RF and instrument control rooms and a boiler room. The boiler room contains two gas fired, water tube boilers that provide hot water to the heating systems of several area structures. The building will have an exterior skin of insulated metal panels and composite roofing.

The basement of the Ring Service Building will contain the pumping and heat exchange equipment for the ring magnet, RF cavity, and power supply cooling water loops. The basement walls, floor, and floor/ceiling assembly will be of concrete. Equipment and personnel access will be through the Ring Service Building.

The Pulse Forming Network Building is attached to and shares a common wall with the Ring Service Building and houses the equipment to form proton pulses. It is a steel framed slab-on-grade building with metal panel walls and composite roofing.

Air conditioning will be provided throughout the building (except for the basement, mechanical rooms, and the Pulse Forming Network Building) by air conditioning units using water from the chilled water system and the hot water heating system. The basement, mechanical rooms, and the Pulse Forming Network Building will be heated and ventilated only. The building will contain equipment for the deionized water system and will be serviced by the compressed air system, the process water system, the potable water system, the sanitary waste system, and the process waste system. The building will be maintained at a slight positive pressure relative to ambient.

Soil and fixed shielding between the Ring Service Building and the adjacent tunnels will be sufficient to appropriately limit the radiation in the Ring Service Building. The conduit banks from the ring service building to the accumulator ring will be of a minimum and equal length to each other.

Equipment access will be provided by means of three overhead truck doors, one for the Ring Service Building and two for the Pulse Forming Network Building. Access roads and parking aprons will be provided to those locations sized sufficiently to allow for truck turnaround. Personnel access doors will also be provided as required by code.

Cable trays, power panels, and cables for conventional service loads (lighting, communications, the Personal Protection System, etc) shall be provided by Conventional Facilities. Cable trays for technical equipment and power cable from the unit substations to the power panels and the power panels to supply technical equipment shall be designed, provided, and installed by other technical groups. Embedded conduit shall be provided by Conventional Facilities.

R1 WBS Title: Ring Service Bldg and Pump Bldg

WBS Descriptor Form

WBS 1.08.03.09 **PCR** _____ **Revision** 3 **Revision Date** 2/22/2001
Title RTBT Service Building

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The RTBT Service Building is an above grade, steel frame structure with an interior clear height of approximately 18 feet and a total floor area of approximately 3,400 square feet. The exterior skin of the building will be insulated metal panels. The roof will be composite roofing. The building will contain electrical cabinets and equipment and the equipment for a deionized water cooling system.

Air conditioning will be provided throughout the building (except for cooling the deionized water equipment room, which will be heated and ventilated only) by floor mounted air conditioning units using water from the chilled water system and the hot water heating system. The building will contain equipment for the deionized water system and will be serviced by the deionized water system, the process water system, the compressed air system and the process waste system. The building will be maintained at a slight positive pressure relative to ambient.

Equipment access will be from an adjacent parking apron in front of the building. Personnel access doors will be provided as required by code and sized sufficiently to accommodate the movement of equipment within the building.

Cable trays, power panels, and cables for conventional service loads (lighting, communications, the Personal Protection System, etc) shall be provided by Conventional Facilities. Cable trays for technical equipment and power cable from the unit substations to the power panels and the power panels to supply technical equipment shall be designed, provided, and installed by other technical groups. Embedded conduit shall be provided by Conventional Facilities.

WBS Descriptor Form

WBS 1.08.03.10 **PCR** _____ **Revision** 2 **Revision Date** 2/22/2001
Title Dump Buildings

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Beam Dump Buildings are provided to house the Injection Dump beam stops' and shielding vaults' electrical, control, cooling, waste, supply, and HVAC systems, in an appropriate serviceable environment. These service areas are located on grade level, adjacent to the below grade dump pits. The Linac Dump and Extraction Dump are passive dump and the building houses the beam stop only.

The Injection Dump building has a floor area of approximately 2,500 square feet. The dump structure is made up of three structural elements: the beam stop enclosure, mechanical, control and electrical equipment room and the utility equipment vault.

The Linac Dump and Extraction Dump only have the beam stop vault.

The beam stop vaults will be below grade vaults constructed of reinforced cast-in-place concrete, surrounding the metal shielding of the dump target. The vaults will extend approximately 21 feet below finished grade. The Ring Injection Dump will have a 2 feet thick concrete ceiling on the pits, with a 4 feet by 4 feet access plug. This access plug aligns with the 8 feet by 8 feet roof hatch above.

In the Injection Dump, the enclosure walls of the utility vault and utility room will be cast-in-place architectural concrete for shielding. The concrete floor will be covered with a stainless steel liner that turns up 8 inches onto the base of the wall. An overhead service door, will provide access from the exterior. A 4 feet by 4 feet by 8 feet deep tank sump, with stainless steel lining, below this space will be accessed through a hatch. The mechanical/electrical room will have a concrete floor with a hard, smooth, liquid tight finish system. A pair of hollow metal doors and frame will lead into the adjacent utility room. The walls will be either cast-in place concrete, or precast concrete panels. The floor will be sloped to facilitate detection and clean up of spills, and have a hard, smooth, liquid tight finish system.

The Injection Beam Dump Building structure above grade will be constructed of steel frame covered by an insulated metal panel wall system. The roof will be a composite system. The exterior door into the mechanical/electrical room will be an insulated hollow metal door and frame assembly.

Units using water from the hot water heating system will provide injection Dump Building heating. Air conditioning will be provided using chilled water from the central system. The buildings will be serviced by the chilled water system, the compressed air system, the potable water system, and the central ventilation system.

WBS Descriptor Form

WBS 1.08.03.11 **PCR** _____ **Revision** 2 **Revision Date** 2/22/2001
Title Utility Buildings

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Central Utilities Building houses the chilled water system, the tower water pumps, and the compressed air system serving the site. The building consists of a structural steel frame on a reinforced concrete slab-on-grade floor and has a total floor area of approximately 14,800 square feet. The exterior walls will be insulated metal panel consistent with overall site design, and the roof will be composite roofing.

Air conditioning will be provided in the offices and restrooms by air conditioning units using water from the chilled water system and the hot water heating system. The buildings will be serviced by the potable water system, the sanitary waste system, and the process waste system. Power will be supplied from the site 13.8kV distribution system.

The building will also have a multiple zone refrigerant monitor to detect refrigerant leakage from the chillers and an automatic refrigerant spill exhaust system designed with opposing intake(s) and exhaust outlet(s) to sweep air across the activated spill zone at floor level.

Site Buildings and Structures includes such fixtures as the cooling tower basin, the water tower foundation, the pump building, the sewer lift station, the process waste storage station, the process waste segregation station, and the switchyard house as well as the foundations and pads for transformers, pumps, tanks, diesel generators, switchyards, etc.

WBS Descriptor Form

WBS 1.08.03.12 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001

Title Technical Service Buildings

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Deleted per PCR CF-00-004

Modification incorporated into R03, Issued October 2000

WBS Descriptor Form

WBS 1.08.03.13 **PCR** _____ **Revision** 1 **Revision Date** 3/15/2000

Title Central Control Building

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Canceled per PCR CF-00-004

Modification incorporated into R03, Issued October 2000

This WBS item deleted from the estimate. The function of the building has been incorporated into the Office Building space.

WBS Descriptor Form

WBS 1.08.03.14 **PCR** _____ **Revision** 2 **Revision Date** 2/22/2001
Title Central Lab & Office Building

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Central Laboratory and Office Building (CLO) is a mixed use facility providing the office, laboratory, conference, food service, and shop space necessary to operate the SNS facility. The building has approximately 217,100 square feet of floor space and is comprised of a six story, curved office "bar" connected to a four story shop and lab "block" by a three story circulation atrium.

There are two primary building entry points, the main, public entry to the west, on Level 1 and the main employee entry to the east on Level B1. A bank of two elevators, and toilet cores, serving all seven floors of the building, are located at each entry. The CLO service access, a triple bay truck dock, is located on level B1 at the north side of the shop and lab block. A freight elevator links the dock area with the three lab floors and mechanical penthouse.

All of the spaces intended for public use are organized around the Main Entry Lobby. The 315 person Auditorium is directly accessed from the Main Entry Lobby that provides break-out space for functions held in the Auditorium. The Seminar Room, Meeting Rooms, Coat Room and toilets for public use are accessed from the main circulation atrium, an extension of the Main Entry Lobby. An ornamental stair, at the Main Entry Lobby, provides a formal connection to the Cafeteria and Conference Gallery below on Level B1 and to Level 2, above. At level B1, outdoor terraces are provided adjacent to the Cafeteria Dining Room and Conference Gallery for outdoor dining and conference related functions. A level ground surface and other necessary provisions will be made to support a 500 person capacity temporary tent structure erected by SNS for conference functions.

While a small portion of offices are provided on Levels B1 and 1, primarily for the Support and Administrative Services, the majority of SNS staff offices are located in the curved office portion of the building on Levels 2, 3, and 4. The office and office support spaces are based on a standard 120 square foot module. In some cases, such as conference rooms and executive offices, several modules may be combined to create larger rooms. Except for Clerk and Designer Offices all offices are walled offices, each with glass side lites adjacent to the office doors. The User Offices, located in the shop and lab portion of the building on Levels 1 and 2, are based on a 160 square foot module. Each module provides space for two work stations. Office support spaces and conference rooms will be centrally located on each office floor within the interior office zone. The Library is located on Level 4 as is a "suite of offices" for the Office of the Director.

The plan and structural grid of the three story shop and lab "block" is based on a 20'x20', 400 square foot lab module. User offices are located along the perimeter for access to natural light and view. All of the heavy-duty Technical Support Shops and the Material Handling Area, which require truck access and a minimum ceiling height of 12'-0" are located on Level B1, the ground floor, of the shop and lab portion of the building. Other building service spaces requiring ground level access such as the Plant Shop are located on Level B1. Space on the sub-basement, Level B2, provides space for electrical and telecommunications functions. The large Technical Support Labs are located directly above the shops on Level 1. The Accelerator Control Room located on Level 1 shall have direct access to a small service vehicle parking area. The Target Control Room is adjacent to the Accelerator Control Room. The Control Room features a mezzanine overlook at Level 2 for public tour viewing.

R0 WBS Title: Central Lab Office

WBS Descriptor Form

WBS 1.08.03.15 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001

Title Site Buildings and Structures

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Deleted per PCR CF-00-004

Modification incorporated into R03, Issued October 2000

WBS Descriptor Form

WBS 1.08.03.16 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001
Title Central Helium Liquifier Building

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Central Helium Liquifier (CHL) Building is an on grade, steel frame structure with an interior clear height of approximately 30 feet. The building is located immediately adjacent to and shares a common wall with the Radio Frequency Building. The building will house the equipment for providing superfluid helium for use in the cryogenic systems. The helium equipment housed within the building are three (3) vacuum pumps, three (3) first stage compressors, three (3) second stage compressors, a helium refrigerator, a 4.5K cold box, a 2.0K cold box, and all the associated mechanical and electrical systems and equipment necessary to operate them. To accommodate these components and related support equipment a floor area of approximately 12,600 square feet is provided. The building will have a mezzanine of approximately 1,300 square feet that contains eating and changing facilities. The outside walls will have sound suppressing vents. All interior walls will be reinforced concrete block with the exception of the plumbing wall between restrooms. The concrete floor slab will be constructed sufficiently flat to accommodate forklift traffic for moving equipment.

Outside and immediately adjacent to the building will be eight (8) 30,000 gallon helium storage tanks with adsorber and purifier systems, a 10,000 gallon liquid helium dewar, a 20,000 gallon liquid nitrogen dewar, and parking and unloading areas for helium and liquid nitrogen trailers.

The exterior skin of the building will be insulated metal panels. The roof will be composite built-up roofing over metal deck.

Personnel and equipment access to the building will be through three (3) overhead truck doors. An access road and parking apron will be provided to these locations sized sufficiently to allow for truck turnaround. Personnel access doors will also be provided as required by code. The Compressor Room will have a 7½ ton overhead bridge crane.

Air conditioning will be provided in the control room. The remainder of the building will be heated and ventilated only. The building will have its own helium and nitrogen systems and will be serviced by the deionized water system, the compressed air system, the potable water system, the sanitary waste system, the tower water system, and the process water system. The building will be maintained at a slight positive pressure relative to ambient.

WBS Descriptor Form

WBS 1.08.03.17 **PCR** PCR SN 01 006 **Revision** 3 **Revision Date** 12/21/2001
Title Radio Frequency Building

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Radio Frequency (RF) Test Facility (also known as the RF or Klystron Shop) is and above grade, steel frame structure with an interior clear height of approximately 15 feet. The building is located to the east of, and immediately adjacent to and shares a common wall with the CHL Facility. Its intended use is to test 402.5 MHz and 805 MHz klystrons, RF power components, and warm accelerating structures. Major modulator repair can be performed in this area along with low level RF testing and development. To accomplish this mission the building will have 805 MHz test areas, a 402.5 MHz test area, an RF test lab, an electrical shop, an instrumentation shop, a parts storage area, a shielded test cave, and a cave support equipment area. There will be a transition area with a separate entrance where radiation confirmation surveys can be performed on components from the Linac Tunnel. To accommodate these facilities and related support equipment a building with approximately 12,200 square feet will be constructed. The building will have a mezzanine of 1,300 sf as well. The concrete floor slab will be constructed sufficiently flat to accommodate forklift and air pallet traffic for moving equipment.

The exterior skin of the building will be insulated metal panels. The roof will be a composite built-up roofing over metal deck. Equipment access to the building will be provided by means of two (2) overhead truck doors. An access road and parking apron will be provided to allow for truck turnaround. Personnel access doors will also be provided as required by code.

Air conditioning will be provided throughout the building (except for the mechanical and electrical equipment rooms) by floor mounted air conditioning units. The buildings will be serviced with deionized water, compressed air, potable water, and a process waste system. The building will be maintained at a slight positive pressure relative to ambient.

This reflects a building of reduced scope that once consisted of the SRF Building, scope which has been deferred, and the RF Building

R03 WBS Title: Radio Frequency Building

WBS Descriptor Form

WBS 1.08.04 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999

Title Utility Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS Descriptor Form

WBS 1.08.04.01 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Electrical Site Services

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Deleted

WBS Descriptor Form

WBS 1.08.04.02 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title HVAC Site Services

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Deleted

WBS Descriptor Form

WBS 1.08.04.03 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001
Title Site Utilities

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Site utilities includes all Electrical, HVAC and Mechanical, Waste and control Systems outside the building 5 foot line.

Electrical Site Services includes: 1) the SNS primary substation which transforms the 161kV utility supply to 13.8kV for on-site distribution; 2) the Site Electrical Distribution System, which routes electrical power via underground duct feeders from the SNS primary substation to the various facilities that constitute the SNS; 3) Telecommunications/Alarm Systems, which provide high-speed data communications systems, interplant data and voice communications, and the supervisory control and data acquisition system to the various facilities that constitute the SNS; and 4) Miscellaneous Electrical Utility Systems, which include cathodic protection systems, exterior area lighting, and aerial electrical system for the distribution of electrical power and telecommunications services on site.

HVAC Site Services includes: 1) aboveground and underground ductwork 5 ft. beyond the normal envelope for buildings; 2) the prefabricated stainless steel centralized exhaust stack; 3) confinement system exhaust fans located remotely from buildings and tying into the site main stack; and 4) associated miscellaneous controls and accessory devices.

Mechanical/Piping Utility Systems includes: 1) the Tower Cooling Water System, which provides coolant flow and pressure to remove heat from the chilled water and deionized cooling water systems and other water-cooled equipment throughout the facility; 2) the Chilled Water System, which provides chilled water flow, temperature, and pressure to remove heat from the HVAC air handling units, the activated and inactivated deionized chilled water systems, and other chilled water users; 3) the Building Heating Water System, which supplies adequate water flow, temperature, and pressure to hot water heating coils in air handling units and unit heaters throughout the facility; 4) the Process Water System, which provides nonpotable water to various systems requiring a clean source of makeup or process water; 5) the Sanitary Waste System, which collects sanitary waste from fixtures served by the potable water system and from floor drains in rest rooms and change rooms; 6) the Potable Water System, which provides clean water to the combined fire and domestic water supply system; 7) the Compressed Air System, which provides clean, dry, oil-free, pressurized air to instruments, pneumatic devices, and service air outlets through out the facility; and 8) the Natural Gas System, which provides a source of fuel for heating the building heating water system and various localized unit heaters.

Waste Systems includes the central functions of the waste systems that collect and process all generated wastes and discharge them to appropriate repositories. This includes portions of the process waste collection system, decontamination system the sampling/analysis system, the conventional liquid waste system, the conventional solid waste system, and the hazardous and mixed waste system.

Control Systems includes all the instrumentation and control backbone systems required to interface equipment controls to the CLO bulding andbetween buildings.

Other site buildings and structures include the cooling tower and basin, the water tower, the water pump building, the sewer lift station, the process waste storage and segregation station, the switchyard house and a multitude of foundations and pads for transformers, pumps, tanks, diesel generators, switchyards, etc.

WBS Descriptor Form

WBS 1.08.04.04 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Waste Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Deleted

WBS Descriptor Form

WBS 1.08.04.05 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001
Title Maintenance and General Purpose Equipment

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Maintenance and General Purpose Equipment provides the maintenance and shop equipment needed to support normal operations. Equipment includes Handling and Transportation Equipment, General P&E Maintenance Shop Equipment, Yards and Grounds Maintenance Facilities Equipment, and Material Control and Storage Facilities Equipment(if required).

Handling and Transportation Equipment provides: 1) mobile cranes, fork lifts, mobile platforms, dollies, air pads, and other equipment necessary to transport material, equipment, and supplies from one area of the plant to another; 2) mobile handling and transportation equipment as necessary for the repair, removal, relocation, and installation of equipment that cannot be serviced by installed equipment; 3) electrical and/or manual transportation equipment in areas where fueled equipment is not practical; and 4) mobile platforms and scaffolds for access to and maintenance of installed equipment only in areas where permanent platforms are not practical and access is infrequent.

General P&E Maintenance Shop Equipment includes: 1) the equipment and tools necessary for repairing, calibrating, inspecting, testing, maintaining, and general servicing of nonradioactive and uncontaminated mechanical, electrical, and instrument equipment; 2) OSHA-approved cabinets for the storage, control, and disposal of hazardous chemicals; 3) electrical tools, equipment, and work benches with nonconductive surfaces for troubleshooting, testing, repairing, and calibrating plant electrical systems and components; and 4) portable welding machines, equipment, tools, fume hood exhaust systems, and accessories to perform the following welding processes: shielded metal arc, tungsten inert gas, metal inert gas, oxyacetylene, and plasma cutting system.

Yards and Grounds Maintenance Facilities Equipment provides the equipment necessary for the proper care and maintenance of the SNS site, including lawn tractors.

WBS Descriptor Form

WBS 1.08.04.06 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001

Title Fire Protection

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS provides Fire Protection support during the design phase.

WBS Descriptor Form

WBS 1.08.05 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999

Title Conventional Facilites Local Controls

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS Descriptor Form

WBS 1.08.05.01 **PCR** _____ **Revision** 1 **Revision Date** 3/10/2000
Title Conventional Facilities Local Controls

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Control and system status of all Conventional Facilities systems and associated components will be provided by instrumentation systems. Both local control functions, located near each system or component, and remote control functions, located at a central control location (Conventional Facilities Central Control - CFCC) shall be provided. The instrumentation system shall be provided for the following major conventional facilities system:

- a. HVAC system
- b. mechanical system
- c. waste containment system
- d. power monitoring system
- e. plant security system

Remote control function for all of the Conventional Facilities equipment shall be provided via one stand alone HMI database system with a multi-screen display system for accessing various systems for control and status information.

The SNS Instrumentation System is divided into four sections to support five discrete systems associated with the facilities services and are as follows:

- The Electric Power Monitoring Instrumentation System shall provide for remote monitoring and trending and provide power quality information to the HMI database system. The installed system shall provide real-time monitoring at each major load point (substations and motor control center). The data collection system required to provide this information shall be provided by an Ethernet or equivalent high speed network system which shall be capable of assessing the individual Electric Power Monitoring system provided with each major power distribution point.
- HVAC Control is subdivided into two control functions. An embedded DDC controller supplied by the HVAC contractor under the WBS associated with the building will provide local control to each HVAC system. The second function, which will be provided by the Instrumentation System, is to provide a control system for accessing the DDC for control and monitoring of each HVAC system at the CFCC.
- Mechanical System Controls will provide local control at each Mechanical System major component location. These controls will allow for full operation of the component from the local control point. Each mechanical system control and status information shall be available at the remote CFCC location via the HMI/display system.
- Waste System Controls will provide local control at each Waste System major component location. These controls will allow for full operation of each waste system at field locations to be determined during Title I design. Each waste system control and information status shall be available at the remote CFCC location via the HMI/display system.
- The Plant Security System will provide video monitoring and badge reader systems for access control and area surveillance monitoring.

R0 WBS Title: Conventional Facilities Controls Integration

WBS Descriptor Form

WBS 1.08.05.02 **PCR** _____ **Revision** _____ **Revision Date** _____

Title Electrical Power and Communications Svcs

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS Descriptor Form

WBS 1.08.05.03 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title HVAC Services

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Deleted

WBS Descriptor Form

WBS 1.08.05.04 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Mechanical & Piping Services

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Deleted

WBS Descriptor Form

WBS 1.08.05.05 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001

Title Waste Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Deleted

WBS Descriptor Form

WBS 1.08.05.06 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001

Title Predictive Maintenance System

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Deleted per PCR CF-00-004

WBS Descriptor Form

WBS 1.08.05.07 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001

Title Plant Security System

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Deleted per PCR CF-00-004

Modification incorporated into R03, Issued October 2000

WBS Descriptor Form

WBS 1.08.06 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999

Title Safety and Computing Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS Descriptor Form

WBS 1.08.06.01 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999

Title Personal Protection System

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS items was transferred to WBS 1.9 in Jul 1999

WBS Descriptor Form

WBS 1.08.06.02 **PCR** _____ **Revision** _____ **Revision Date** _____

Title Business Computing Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS Descriptor Form

WBS 1.08.06.03 **PCR** _____ **Revision** _____ **Revision Date** _____

Title Emergency Response Facilities Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS Descriptor Form

WBS 1.09 **PCR** _____ **Revision** 1 **Revision Date** 3/10/2000
Title Integrated Control Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS 1.9 will implement an integrated, plant-wide control system to provide control, monitoring, and data acquisition services for SNS. This system is referred to as the "Integrated Control System", or ICS. High-level controls for all major SNS systems have been consolidated under this single WBS to promote both standardization and design efficiency.

ICS subsystems can be divided into two broad categories:

- global systems and tools which provide common services across the facility (WBS 1.9.1 - 1.9.2), and
- distributed, local systems (WBS 1.9.3-1.9.10) which provide the specific control, monitoring, and data acquisition services required by individual SNS systems.

Implementation of the ICS will be a truly collaborative effort, with responsibilities assigned to personnel from five labs. ICS subsystems include:

WBS	Subsystem	Team leader from:
1.1.9	ICS R&D	(Collaborative)
1.9.1	Integration	(Collaborative)
1.9.2	Global Systems	(Collaborative)
1.9.3	Front End Controls	LBL
1.9.4	Linac Controls	LANL
1.9.5	Ring Controls	BNL
1.9.6	Target Controls	ORNL
1.9.7	Experiment Control Systems	ANL
1.9.8	Conventional Facilities Controls Interface	ORNL
1.9.9	Personnel Protection System (PPS)	ORNL
1.9.10	CHL, Cryomodule Controls	ORNL

See the SNS109000000-SR0001 SRD for WBS 1.9 Integrated Control Systems and the corresponding third-level WBS descriptor forms for more detailed information.

The "Experimental Physics and Industrial Control System" (EPICS), a distributed control system developed by DOE accelerator laboratories, has been chosen as the framework for the ICS.

Portions of the Personnel Protection System (WBS 1.9.9) are safety significant. Special quality assurance requirements will apply in these cases.

WBS Descriptor Form

WBS 1.09.01 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999

Title ICS Integration

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers integration and management of all of WBS 1.9. It includes a senior team leader and lead engineer for the duration of the project (level of effort), as well as part time for a database administrator, a system administrator and project controls support. Travel is also covered in this WBS.

WBS Descriptor Form

WBS 1.09.01.01 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999

Title Project Management

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS Descriptor Form

WBS 1.09.01.02 **PCR** _____ **Revision** 0 **Revision Date** 2/1/2000

Title Cable Coordination

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS provides appropriate standardization, integration, and coordination of cabling requirements, design, installation, and documentation for power and signal cables to conventional facilities equipment, technical systems equipment, and all other cabling for which the AE/CM will need design requirements.

WBS Descriptor Form

WBS 1.09.01.03 **PCR** PCR CO 02 005 **Revision** 0 **Revision Date** 2/5/2002
Title Linac Installation, Testing, and Startup Support

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

LANL is designing and fabricating most of the hardware and is generating nearly all of the software needed for Linac controls. This WBS is a "level-of-effort" task providing funding for ORNL controls personnel to serve as task leaders that will receive LANL hardware and software and insure that it is properly integrated into SNS systems at the site.

Basically, the work is to bring into operation the controls hardware and software for the RCCS, Vacuum, High Power RF, Low Power RF, and Magnet Power Supply systems for the DTL, CCL, SCL, and D-Plate.

Functions include:

- 1) Insure acceptable locations exist for IOC"s, PLC"s, MPS, network and other controls equipment (system block diagrams and the Derrick spreadsheet)
 - 2) Insure that AC power and Global Controls network services are provided as needed
 - 3) Insure acceptable rack designs are received
 - 4) Coordinate rack fabrication and installation (including installation of Global Controls equipment in racks)
 - 5) Insure that software requirements exist, have been reviewed by system engineers, are clearly documented, and have been communicated to software designers (the FSD)
 - 6) Insure that software is properly tested, checked into the project CVS repository and follows the proper Application Development Environment (ADE) configuration.
- Note: LANL personnel will generate all software (including recurring software) and check it into CVS as tasks under WBS 1.9.4. This task is to review, receive, and understand how to use it.
- 7) Coordinate installation and termination of AC Power, Global Controls network, and field cabling
 - 8) Review, receive, and enter hardware and software documentation into project document management systems
 - 9) Install software at the site (with LANL assistance)
 - 10) Perform loop testing
 - 11) Perform system operational testing
 - 12) Assist operations in startup

WBS Descriptor Form

WBS 1.09.02 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999
Title Global Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers all of the global control systems i.e. the systems that are common to all or many of the principle SNS subsystems. Specifically, these systems are:

1. WBS 1.9.2.1 Control System Network
2. WBS 1.9.2.2 Timing and Synchronization System
3. WBS 1.9.2.3 Equipment Protection System
4. WBS 1.9.2.4 Control Room and Computers
5. WBS 1.9.2.5 Global Software Development
6. WBS 1.9.2.6 Controls Group Laboratories

These systems are described in more detail in the appropriate level 4 WBS descriptor forms.

WBS Descriptor Form

WBS 1.09.02.01 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999

Title ICS Network

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the control system communication network only. The design and cost estimate is based upon the Megabit switched Ethernet backbone, with 100Kbit copper or fiber to individual IOCs. This WBS contains fiber and copper, Ethernet switches, racks, a sniffer terminal servers as well as installation costs and some training.

Networks and connectivity for SNS offices and labs and connectivity to the external internet are not included.

WBS Descriptor Form

WBS 1.09.02.02 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999
Title Timing System

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS includes the engineering, fabrication, installation and testing of the SNS global timing and synchronization system. This system synchronizes all aspects of accelerator operation – including neutron and proton choppers, linac and ring rf systems, and ring injection and extraction systems. Distributed slave modules produce interrupts or triggers to initiate synchronized data taking or other activities.

The cost estimate and design are based upon the design for similar functionality from RHIC. A master timer distributes “events” to slave modules distributed in IOCs. The carrier frequency is 19MHz, the 16th harmonic of the Ring frequency. The master, distribution system and 100 slave modules are included in this WBS item, as well as software development for “programming” the events.

WBS Descriptor Form

WBS 1.09.02.03 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999
Title Equipment Protection Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the engineering, construction, installation and testing of the global equipment protection systems. It does NOT include personnel safety systems, which are covered in WBS 1.9.9. Functionality includes:

1. Fast Protect – turns off beam and aborts beam in machine within 10usec when certain conditions are met or exceeded.
2. Beam Pulse Enable – allows each macropulse to be initiated provided all accelerator systems are in an appropriate state.
3. Run Permit – allows beam operation only when all accelerator systems are operating normally in the correct mode.

Some intersystem interlocks may be included in this WBS. Interlocks within a subsystem (eg DTL vacuum interlocks) are not included; nor are specific equipment interlocks.

The cost estimate is based upon the RHIC design for similar functionality. A carrier is interrupted at distributed slave modules when anomalous conditions are detected. First fault is latched, and can be read on the IOC backplane.

The cost estimate includes the master, carrier distribution system and 100 slave modules, and software development for status display and mode selection.

WBS Descriptor Form

WBS 1.09.02.04 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999
Title Computing Equipment (C.R. Servers,etc.)

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS includes the design, installation and checkout of the console and servers for the main SNS control room. The design and estimate is based upon the APS control room. It assumes 12 "two-headed" consoles in a circular arrangement.

A gateway, an EPICS server, and a model server are all included.

WBS Descriptor Form

WBS 1.09.02.05 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999
Title Software (System & Application)

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS is a “level-of-effort” task providing 9 FTEs for “Application Software” and 4 FTEs for EPICS system software. Additional applications effort is in WBS 1.9.4 and 1.9.5. Effort in those WBS elements will focus on the linac and ring respectively, and their instrumentation.

The global applications application software task will be focused on providing tools and an environment for the development of physics applications by the commissioning team applications group.

The system software task will be focused on contributing to EPICS improvements required by SNS and supported by the international EPICS community.

This WBS also includes software licenses and maintenance fees.

WBS Descriptor Form

WBS 1.09.02.06 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999

Title Software Development System

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS is to equip a light electronics and software laboratory for controls group use. It includes instruments and test equipment, as well as workstations for software development and lab support. The WBS also includes an electronics technician to man this lab.

WBS Descriptor Form

WBS 1.09.02.07 **PCR** PCR CO 02 003 **Revision** 0 **Revision Date** 1/31/2002
Title Diagnostics Software Support

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS activity will develop software for beam diagnostic systems. Software will be developed primarily in the Windows environment, and include the use of LabView, MatLab and other tools.

This WBS is a “level-of-effort” task providing 3 FTEs for “Diagnostics Application Software” and interfaces between the Diagnostic Network Attached Devices (NADs) and the Control System.

Work will be assigned by the Diagnostics Group Leader.

WBS Descriptor Form

WBS 1.09.03 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999
Title Front End Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Front End controls integrates the control and monitoring functionality of the on Source/LEBT (1.9.3.2), the RFQ (1.9.3.4), the MEBT (1.9.3.5), and Vacuum/Cooling (1.9.3.6) hardware. The scope of Front End controls is bounded on the hardware side by the cables leading to/from actuators and sensors, or to/from embedded equipment such as PLCs supplied by vendors; and by connection to the global timing and beam-permit signals. Special diagnostic hardware is outside the scope of Front End controls (it is supplied within the scope 1.3.1-3) but a suitable hardware/software interface to such equipment will be provided. On the software side, Front End communicates with the Global system and other systems (Linac, Ring, Target), and provides suitable environment in which Front End physicists, engineers, and operators can implement modeling, sequencing, and feed-back algorithms. Front End controls will provision all low-level and high-level hardware needed to design, implement, test, document and maintain its portion of the ICS.

WBS Descriptor Form

WBS 1.09.03.01 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999
Title Front End Control System Integration

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Integration part of the Front End controls includes travel and management in support of:

- maintaining practices that are conformant with, and contribute to SNS-wide standards;
- continuing effort required for design, budget, cost performance, and schedule review and reporting activities;
- overall engineering supervision of controls software engineers and technicians, including relevant LBNL institutional duties;
- liaison with Front End electrical engineering and operational personnel to ensure that interface between equipment and control system is correct, and that required control system functionality is available when needed for operation, particularly when hardwired, manual controls are not being built.

WBS Descriptor Form

WBS 1.09.03.02 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999
Title Ion Source Controls

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Ion Source and LEPT part of the Front End controls will address the power supplies, RF, timing, cooling and vacuum devices specific to this hardware. (Shared vacuum and cooling devices will be considered in 1.9.3.6.) General scope definitions from 1.9.3 otherwise apply. Some automatic sequencing for turn-on or fault recovery is required, and some closed-loop control for maintaining operating conditions. Detailed requirements will come from the physicists and engineers.

WBS Descriptor Form

WBS 1.09.03.03 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999

Title LEBT Controls

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

WBS element is not used.

WBS Descriptor Form

WBS 1.09.03.04 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999

Title RFQ Controls

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The RFQ part of the Front End controls will address the power supplies, RF, timing, beam pickup, cooling and vacuum devices specific to this hardware. (Shared vacuum and cooling devices will be considered in 1.9.3.6.) General scope definitions from 1.9.3 otherwise apply. Only basic support for diagnostic devices is provided.

WBS Descriptor Form

WBS 1.09.03.05 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999

Title MEBT Controls

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The MEBT part of the Front End controls will address the power supplies, timing, cooling and vacuum devices specific to this hardware. (Shared vacuum and cooling devices will be considered in 1.9.3.6.) General scope definitions from 1.9.3 otherwise apply. Only basic support for diagnostic devices is provided.

WBS Descriptor Form

WBS 1.09.03.06 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999

Title Cooling and Vacuum Controls

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

The Vacuum and Cooling part of the Front End controls will address the shared cooling and vacuum devices. General scope definitions from 1.9.3 otherwise apply.

WBS Descriptor Form

WBS 1.09.04 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001
Title Linac Control Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers linac control systems. Subsystems include:

1. WBS 1.9.4.1 Linac Controls Integration and Management
2. WBS 1.9.4.2 Control Systems for Linac DTL
3. WBS 1.9.4.3 Deleted
4. WBS 1.9.4.4 Control Systems for Linac CCL
5. WBS 1.9.4.5 Control Systems for MEBT Chopper and Linac Diagnostics
6. WBS 1.9.4.6 Control Systems for Warm Linac RF Systems
7. WBS 1.9.4.7 Non-Recurring (Title I) Design for Warm Linac Vacuum, Cooling, Diagnostics and Power Supply Subsystems
8. WBS 1.9.4.8 Not used
9. WBS 1.9.4.9 Control Systems for Cold Linac Linac Vacuum, Diagnostics, and Power Supply Subsystems
10. WBS 1.9.4.10 Not used
11. WBS 1.9.4.11 Controls Systems for Cold Linac RF Systems

Standard designs will be used as a means of reducing cost. This is reflected in the WBS structure by the division of design costs into "non-recurring" and "recurring" tasks. Non-recurring design costs are contained in WBS 1.9.4.7. Because of the interactions through various flavors of RF, 1.9.4.6 and 1.9.4.11 have separate level 4 workpackages for non-recurring and recurring as well.

Linac subsystems are described in more detail in the appropriate level 4 WBS descriptor forms.

WBS Descriptor Form

WBS 1.09.04.01 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001
Title Linac Control Systems Integration

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers four specific items:

- i) Management and Support services, including the Linac level 3 team leader and system and database support for WBS 1.9.4.
- ii) Travel for the level 3 team leader, design engineers and eventually in support of installation and testing.
- iii) Application Programming for Linac integration. This is for "client-side" high-level programming in support of the linac. This effort will be divided between provision of tools for linac physicists, and application support for beam instrumentation.
- iv) Control laboratory. This provides a part-time technician, as well as instruments and consumables for a controls laboratory in support of linac control system development.

WBS Descriptor Form

WBS 1.09.04.02 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001
Title DTL Control Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the overall system design for the Linac DTL, as well as the implementation, installation and testing of both hardware (IOCs) and software for the DTL vacuum, cooling and power supply control systems.

This WBS has:

- 1 System and 492 Channels in DTL Vacuum (IOC)
- 1 System and 576 Channels in DTL Cooling (ICO)
- 1 System and 720 Channels in DTL Power (IOC)
- 6 System and 576 Channels in DTL Cooling (PLC)

WBS Descriptor Form

WBS 1.09.04.03 **PCR** _____ **Revision** 0 **Revision Date** 3/10/2000

Title CCDTL Control Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Closed per PCR LI-00-0007

This WBS covers the overall system design for the Linac CCDTL, as well as the implementation, installation and testing of both hardware (IOCs) and software for the CCDTL vacuum, cooling and power supply control systems.

WBS Descriptor Form

WBS 1.09.04.04 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001
Title CCL Control Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the overall system design for the Linac CCL, as well as the implementation, installation and testing of both hardware (IOCs) and software for the CCL vacuum, cooling and power supply control systems.

This WBS has:

- 1 System and 600 Channels in CCL Vacuum (IOC)
- 2 Systems and 630 Channels in CCL Cooling (IOC)
- 2 Systems and 1880 Channels in CCL Power (IOC)
- 4 Systems and 628 Channels in CCL Cooling (PLC)

WBS Descriptor Form

WBS 1.09.04.05 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001

Title Other Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the overall system design for integrated control system interface to the MEBT Chopper and Linac Diagnostics Systems. Both hardware and software are included, as well as the implementation, installation and testing of hardware and software for these interfaces.

This WBS has:
15 Systems and 750 Channels in the Diagnostics System

R0 Title: Control Systems for Other Systems

WBS Descriptor Form

WBS 1.09.04.06 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001
Title RF Power

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the overall system design for the integrated control system interface to the warm Linac Low Level RF (LLRF) and High Power RF (HPRF) Subsystems. Both hardware and software are included, as well as the implementation, installation and testing of hardware and software for these interfaces.

Because of the interactions through various flavors of RF, 1.9.4.6 and 1.9.4.11 have separate level 4 workpackages for non-recurring and recurring as well.

This WBS has:

- 11 Systems and 1650 Channels in the LLRF
- 3 Systems and 2400 Channels in the HPRF
- 2 Systems and 300 Channels in the Warm LLRF
- 2 Systems and 600 Channels in the Warm HPRF

R0 Title: Control Sys for Linac RF Power Sys

WBS Descriptor Form

WBS 1.09.04.07 **PCR** PCR SN 01 006 **Revision** 2 **Revision Date** 12/21/2001
Title Standard System Design

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the Title I design for the distributed parts (IOCs) of the vacuum, cooling and power supply subsystems for the warm Linac DTL and CCL. This includes development, implementation, testing and iteration of EPICS databases, drivers, sequences and engineering screens on a prototypical test bed in prototypical IOCs for each of these subsystems, to the point where these IOCs, databases and associated software can be replicated automatically for the actual systems.

This WBS has:

- 1 System and 100 Channels in Standard Vacuum (IOC)
- 1 System and 100 Channels in Standard Cooling (IOC)
- 1 System and 100 Channels in Standard Power (IOC)
- 3 Systems and 100 Channels in Standard Diagnostics (IOC)
- 1 System and 180 Channels in Standard Vacuum (PLC)
- 1 System and 100 Channels in Standard Cooling (PLC)

R0 Title: Standard System Design

WBS Descriptor Form

WBS 1.09.04.08 **PCR** _____ **Revision** 0 **Revision Date** 3/10/2000

Title Super Conducting Controls

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS element is not used.

WBS Descriptor Form

WBS 1.09.04.09 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001
Title Recurring Design for Cold Linac Vacuum, Cooling and Power Supply

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the design, procurement, installation, and testing for the distributed parts (IOCs) of the vacuum, cooling and power supply subsystems for the cold Linac. This includes development, implementation, testing and iteration of EPICS databases, drivers, sequences and engineering screens on a prototypical test bed in prototypical IOCs for each of these subsystems, to the point where these IOCs, databases and associated software can be replicated automatically for the actual systems.

This WBS covers the design, procurement, installation, and testing for the distributed parts (IOCs) of the vacuum, cooling and power supply subsystems for the cold Linac. This includes development, implementation, testing and iteration of EPICS databases, drivers, sequences and engineering screens on a prototypical test bed in prototypical IOCs for each of these subsystems, to the point where these IOCs, databases and associated software can be replicated automatically for the actual systems.

This WBS has:

- 1 System and 1448 Channels in Vacuum (IOC)
- 15 Systems and 1065 Channels in Diagnostics (IOC)
- 8 Systems and 1400 Channels in Power System Magnets (IOC)
- 8 Systems and 1448 Channels in Vacuum (PLC)

WBS Descriptor Form

WBS 1.09.04.11 **PCR** PCR SN 01 006 **Revision** 1 **Revision Date** 12/21/2001
Title Controls Systems for the Cold Linac RF Subsystem

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS covers the overall system design for the interface to the integrated control system for the cold Linac Low Level RF (LLRF) and High Power RF (HPRF) Subsystems, both hardware and software, as well as the implementation, installation and testing of both hardware (IOCs) and software for these systems.

Because of the interactions through various flavors of RF, 1.9.4.6 and 1.9.4.11 have separate level 4 workpackages for non-recurring and recurring as well.

This WBS has:

- 1 System and 1053 Channels in RF Interface (IOC)
- 2 Systems and 600 Channels in HPRF NR (IOC)
- 22 Systems and 13200 Channels in LLRF (IOC)
- 8 Systems and 2400 Channels in HPRF (IOC)

WBS Descriptor Form

WBS 1.09.05 **PCR** _____ **Revision** 1 **Revision Date** 8/2/2000
Title Ring Controls

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS element covers all aspects of design, construction, installation and testing of the distributed part of the SNS Control System for the Ring, HEBT and RTBT control systems. Tasks include:

1. WBS 1.9.5.1 Integration. Included are implementation of development systems (required for support of WBS 1.9.5 activities), travel, and project management.
2. WBS 1.9.5.2 Power Supply Controls
3. WBS 1.9.5.3 Diagnostics
4. WBS 1.9.5.4 Vacuum Controls
5. WBS 1.9.5.5 Application Programming
6. WBS 1.9.5.6 RF Controls

WBS Descriptor Form

WBS 1.09.05.01 **PCR** _____ **Revision** 1 **Revision Date** 8/2/2000

Title Ring ICS Integration Activities

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

In general, all activities associated with this WBS take place at BNL.

WBS Descriptor Form

WBS 1.09.05.02 **PCR** _____ **Revision** 1 **Revision Date** 8/2/2000
Title Power Supply Controls

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS provides manpower and hardware for implementation of power supply control systems. Included are IOC hardware and software, as well as needed engineering application programs for diagnostic and other devices.

Method of accomplishment is as follows:

Design by BNL

Procurement by BNL

Fabrication by BNL (e.g. completed racks shipped to SNS)

Some testing of fabricated equipment at BNL

Installation by CM

Checkout / start-up by mix of both BNL and SNS personnel

Rev. 0 Title: HEBT Controls, Modified via PCR CO-00-003

WBS Descriptor Form

WBS 1.09.05.03 PCR _____ Revision 1 Revision Date 8/2/2000

Title Diagnostics

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This work will include preliminary design for all the Diagnostic systems for the HEFT, Ring and RTBT

Method of accomplishment is as follows:

Design by BNL

Procurement by BNL

Fabrication by BNL (e.g. completed racks shipped to SNS)

Some testing of fabricated equipment at BNL

Installation by CM

Checkout / start-up by mix of both BNL and SNS personnel

Rev. 0 Title: Ring Controls, Modified via PCR CO-00-003

WBS Descriptor Form

WBS 1.09.05.04 **PCR** _____ **Revision** 1 **Revision Date** 8/2/2000
Title Vacuum Controls

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS provides manpower and hardware required to implement vacuum control systems. Included are IOC hardware and software, as well as needed engineering application programs for diagnostic and other devices.

Method of accomplishment is as follows:

Design by BNL

Procurement by BNL

Fabrication by BNL (e.g. completed racks shipped to SNS)

Some testing of fabricated equipment at BNL

Installation by CM

Checkout / start-up by mix of both BNL and SNS personnel

Rev. 0 Title: RTBT Controls, Modified via PCR CO-00-003

WBS Descriptor Form

WBS 1.09.05.05 **PCR** _____ **Revision** 1 **Revision Date** 8/2/2000

Title Application Programming

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS includes all the manpower required for application programming and database design. It also includes procurement of commercial software packages needed to support the application programming effort.

In general these activities will be performed by BNL.

Rev. 0 Title: Application Software, Modified via PCR CO-00-003

WBS Descriptor Form

WBS 1.09.05.06 **PCR** _____ **Revision** 0 **Revision Date** 8/2/2000
Title RF Controls

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS provides manpower and hardware required to implement RF control systems. Included are IOC hardware and software, as well as needed engineering application programs for diagnostic and other devices.

Method of accomplishment is as follows:

Design by BNL

Procurement by BNL

Fabrication by BNL (e.g. completed racks shipped to SNS)

Some testing of fabricated equipment at BNL

Installation by CM

Checkout / start-up by mix of both BNL and SNS personnel

WBS Descriptor Form

WBS 1.09.06 **PCR** _____ **Revision** 1 **Revision Date** 8/2/2000
Title Target Global Controls

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Integrate the target control system into EPICS using IOCs and PLCs to control the target systems. Design and develop the IOC and PLC hardware and the EPICS and PLC software to control the target systems. Provide an interface to the Equipment Protection System. Interface to the target systems safety and control systems for integrated display of the target process. Install the IOC and PLC hardware and perform control system checkout and testing.

ORNL will specify, design, and test the EPICS and PLC hardware and software for target systems. Contractors will design and fabricate controls for the target utilities. Contractors will be used to fabricate the cabinets and install the cabinets. ORNL engineers and technicians will support checkout and startup testing of the WBS 1.6.x systems.

WBS Descriptor Form

WBS 1.09.06.01 **PCR** _____ **Revision** 1 **Revision Date** 8/2/2000

Title Target Controls Integration

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Provide for training of engineers to write the EPICS and PLC software for target control systems. Support travel to vendors, conferences, Integrated Controls Working Group (ICWG) meetings, and collaboration and equipment interface meetings with other laboratories. Provide integration support for the duration of the project.

WBS Descriptor Form

WBS 1.09.06.02 **PCR** _____ **Revision** 1 **Revision Date** 8/2/2000

Title Target Systems Controls

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Develop the IOC interface hardware and software and the PLC control system hardware and software for control and monitoring of the target control systems and for monitoring the Target Protection System.

ORNL engineers will design the hardware and software, a contractor will install the equipment in cabinets, and a contractor will install the cabinets. After installation, the ORNL engineers will test the hardware and software. The IOC will interface to the PLC for integration, but the PLC will perform control and interlock logic. Provide connections to the equipment protection system to shut down the beam as required to protect the target equipment. The IOC will have few or no process input modules.

Rev. 0 Title: Target Systems, Modified via PCR CO-00-003

WBS Descriptor Form

WBS 1.09.06.03 **PCR** _____ **Revision** 1 **Revision Date** 8/2/2000

Title Target Utilities Controls

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Contractors will design and fabricate controls for the target utility systems. This includes PLCs and an IOC that connects the utility PLCs to the ICS network. The contractor will also design and install cables for the target utility control system. The utility controls will be implemented using project standard hardware and software by the contractor. The contractor will provide inputs to the equipment protection system provided by WBS 1.9. Oversight will be provided by target controls engineers.

Rev. 0 Title: Moderator Systems, Modified via PCR CO-00-003

WBS Descriptor Form

WBS 1.09.06.04 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999

Title Reflector Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Develop the IOC interface hardware and software for control and monitoring of the reflector systems.

ORNL engineers will design the hardware and software, a contractor will install the equipment in cabinets, and a contractor will install the cabinets. After installation, the ORNL engineers will test the hardware and software. The IOC will perform control and interlock logic for the reflector systems. Provide connections to the equipment protection system to shut down the beam as required to protect the target equipment

WBS Descriptor Form

WBS 1.09.06.05 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999

Title Vessel Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Develop the IOC interface hardware and software for control and monitoring of the vessel systems. ORNL engineers will design the hardware and software, a contractor will install the equipment in cabinets, and a contractor will install the cabinets. After installation, the ORNL engineers will test the hardware and software. The IOC will perform control and interlock logic for the vessel systems. Provide connections to the equipment protection system to shut down the beam as required to protect the target equipment

WBS Descriptor Form

WBS 1.09.06.06 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999

Title Shielding Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Develop the IOC interface hardware and software for control and monitoring of the shielding systems. ORNL engineers will design the hardware and software, a contractor will install the equipment in cabinets, and a contractor will install the cabinets. After installation, the ORNL engineers will test the hardware and software. The IOC will perform control and interlock logic for the shielding systems. Provide connections to the equipment protection system to shut down the beam as required to protect the target equipment

WBS Descriptor Form

WBS 1.09.06.07 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999

Title Target Utility Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Develop the IOC interface hardware and software and the PLC control system hardware and software for control and monitoring of the target utility systems. ORNL engineers will design the hardware and software, a contractor will install the equipment in cabinets, and a contractor will install the cabinets. After installation, the ORNL engineers will test the hardware and software. The IOC will interface to the PLC for integration, but the PLC will perform control and interlock logic. The IOC will have few or no process input modules. Provide connections to the equipment protection system to shut down the beam as required to protect the target equipment

WBS Descriptor Form

WBS 1.09.06.08 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999

Title Remote Handling System Interface

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Provide an IOC to connect the remote handling controls to the ICS. The remote handling control system will be developed as part of WBS 1.6.2, but WBS 1.9.6.3 will provide the EPICS software and the IOC hardware to connect the remote handling control system to the global control system.

WBS Descriptor Form

WBS 1.09.06.09 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999
Title Beam Dump Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Develop the IOC interface hardware and software and the PLC control system hardware and software for control and monitoring of the beam dump systems. ORNL engineers will design the hardware and software, a contractor will install the equipment in cabinets, and a contractor will install the cabinets. After installation, the ORNL engineers will test the hardware and software. The IOC will interface to the PLC for integration, but the PLC will perform control and interlock logic. The IOC will have few or no process input modules. Provide connections to the equipment protection system to shut down the beam as required to protect the target equipment

WBS Descriptor Form

WBS 1.09.07 **PCR** _____ **Revision** 1 **Revision Date** 9/2/2000

Title Control Systems

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Closed per PCR CO-00-003

This WBS item covers effort for control system liaison between SNS collaborators and for control system equipment provided by Experiment Systems.

WBS Descriptor Form

WBS 1.09.07.01 **PCR** _____ **Revision** 1 **Revision Date** 8/2/2000

Title Instrument Support Facilities Controls

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Closed per PCR CO-00-003

There are currently no funds budgeted for this task.

WBS Descriptor Form

WBS 1.09.07.02 **PCR** _____ **Revision** 1 **Revision Date** 8/2/2000

Title System Integration

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Closed per PCR CO-00-003

Provide management level support for integrating the Experiment Systems (WBS 1.7) controls with the Global Control System (WBS 1.9).

WBS Descriptor Form

WBS 1.09.07.03 **PCR** _____ **Revision** 1 **Revision Date** 8/2/2000

Title POW3 Controls

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Closed per PCR CO-00-003

Provide standard control hardware for the reference instrument POW3. This covers the purchase of one standard IOC for sample environment controls and two standard IOCs for chopper controls.

WBS Descriptor Form

WBS 1.09.07.04 **PCR** _____ **Revision** 1 **Revision Date** 8/2/2000

Title INEL2 Controls

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Closed per PCR CO-00-003

Provide standard control hardware for the reference instrument INEL2. This covers the purchase of one standard IOC for sample environment controls and two standard IOCs for chopper controls.

WBS Descriptor Form

WBS 1.09.07.05 **PCR** _____ **Revision** 1 **Revision Date** 8/2/2000

Title SCD1 Controls

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Closed per PCR CO-00-003

Provide standard control hardware for the reference instrument SCD1. This covers the purchase of one standard IOC for sample environment controls and one IOC for chopper controls.

WBS Descriptor Form

WBS 1.09.07.06 **PCR** _____ **Revision** 1 **Revision Date** 8/2/2000

Title POW7 Controls

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Closed per PCR CO-00-003

Provide standard control hardware for the reference instrument POW7. This covers the purchase of one standard IOC for sample environment controls and one IOC for chopper controls.

WBS Descriptor Form

WBS 1.09.07.07 **PCR** _____ **Revision** 1 **Revision Date** 8/2/2000

Title INEL4 Controls

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Closed per PCR CO-00-003

Provide standard control hardware for the reference instrument INEL4. This covers the purchase of one standard IOC for sample environment controls and one IOC for chopper controls.

WBS Descriptor Form

WBS 1.09.07.08 **PCR** _____ **Revision** 1 **Revision Date** 8/2/2000

Title INEL1 Controls

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Closed per PCR CO-00-003

Provide standard control hardware for the reference instrument INEL1. This covers the purchase of one standard IOC for sample environment controls and two standard IOCs for chopper controls.

WBS Descriptor Form

WBS 1.09.07.09 **PCR** _____ **Revision** 1 **Revision Date** 8/2/2000

Title SANS2 Cotrols

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Closed per PCR CO-00-003

Provide standard control hardware for the reference instrument SANS2. This covers the purchase of one standard IOC for sample environment controls and two standard IOCs for chopper controls.

WBS Descriptor Form

WBS 1.09.07.10 **PCR** _____ **Revision** 1 **Revision Date** 8/2/2000

Title REF1 Controls

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Closed per PCR CO-00-003

Provide standard control hardware for the reference instrument REF1. This covers the purchase of one standard IOC for sample environment controls and two standard IOCs for chopper controls.

WBS Descriptor Form

WBS 1.09.07.11 **PCR** _____ **Revision** 1 **Revision Date** 8/2/2000

Title POW6 Controls

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Closed per PCR CO-00-003

Provide standard control hardware for the reference instrument POW6. This covers the purchase of one standard IOC for sample environment controls and two standard IOCs for chopper controls.

WBS Descriptor Form

WBS 1.09.07.12 **PCR** _____ **Revision** 1 **Revision Date** 8/2/2000

Title INEL5 Controls

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Closed per PCR CO-00-003

Provide standard control hardware for the reference instrument INEL5. This covers the purchase of one standard IOC for sample environment controls and two standard IOCs for chopper controls.

WBS Descriptor Form

WBS 1.09.08 **PCR** _____ **Revision** 1 **Revision Date** 8/2/2000
Title Conventional Facilities ICS Interface

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS will interface the integrated control system (ICS) with conventional facilities control systems.

Conventional facilities control systems will be implemented by WBS 1.8.6 Conventional Facilities Controls. These controls will likely be implemented via commercial distributed control systems (DCSs) and/or programmable logic controllers (PLCs). These control systems will have data that is important to accelerator operators, and will therefore be interfaced with the Integrated Control System. This will allow operators to be informed of conventional facilities operating status and to correlate accelerator phenomena with facility parameters.

Conventional Facilities Interface includes the following subtasks:

WBS 1.9.8.1 Integration Activities

WBS 1.9.8.2 Systems and Equipment

The design for this WBS will be performed by ORNL / SNS. Procurement of materials and equipment will be by ORNL / SNS. Installation of components will be performed by the construction manager craft labor and ORNL craft labor. Checkout will be performed by ORNL / SNS.

Rev. 0 Title: Conventional Facilities Global Controls. Modified via PCR C0-00-003.

WBS Descriptor Form

WBS 1.09.08.01 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999
Title Integration Activities

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS handles setting up the infrastructure and personnel to support conventional facilities interface activities. Integration Activities include:

- Implementation of a software development system to enable the software design in other WBS 1.9.8 tasks.
- Participation in the SNS "Integrated Controls Working Group" (ICWG) activities. (This working group develops standards for SNS control systems).
- EPICS Training for WBS 1.9.8 design personnel
- Project controls and design review support
- System maintenance, for support the software development system and other design tools.

The design for this WBS will be performed by ORNL/ SNS. Procurement of materials and equipment will be by ORNL/ SNS. Installation of components will be performed by ORNL craft labor.

WBS Descriptor Form

WBS 1.09.08.02 **PCR** _____ **Revision** 1 **Revision Date** 8/2/2000
Title Systems and Equipment

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS activity will implement an interface between the ICS and Conventional Facilities controls systems.

Subtasks include:

- Work with AE design personnel to ensure that all systems have a suitable interface.
- Procure and install I/O Controllers (IOC)
- Develop a software driver to allow communications between the ICS and CF systems.
- Configure the EPICS continuous control database
- Develop EPICS display graphics.
- Title I, II, and III design.
- Test the interface to verify it functions properly.

The design and software development for this WBS will be performed by ORNL/ SNS. Procurement of materials and equipment will be by ORNL/ SNS. Installation of components will be performed by the construction manager craft labor and ORNL craft labor. Testing will be by ORNL / SNS.

Rev. 0 Title: Electrical Power and Communications Interface, Modified by PCR C0-00-003.

WBS Descriptor Form

WBS 1.09.08.03 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999
Title HVAC System Interface

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS activity will implement an interface between the ICS and the SNS HVAC systems. (The HVAC systems provided under WBS 1.8 divide into two broad categories: standard temperature control applications, and pressure-control systems for confinement of contamination and activated air. Temperature control will be performed by a commercial distributed control system (DCS). Pressure control will be performed either by a distributed control system or by programmable logic controllers).

Subtasks include:

- Work with WBS 1.8 design personnel to ensure that HVAC control systems have a suitable interface.
- Procure and install I/O Controllers (IOC)
- Develop any software drivers required to implement communications between the ICS and HVAC DCS.
- Configure the EPICS continuous control database for HVAC I/O channels.
- Develop EPICS display graphics.
- Title I, II, and III design.
- Test the interface to verify it functions properly.

The design and software development for this WBS will be performed by ORNL/ SNS. Procurement of materials and equipment will be by ORNL/ SNS. Installation of components will be performed by the construction manager craft labor and ORNL craft labor. Testing will be by ORNL / SNS.

WBS Descriptor Form

WBS 1.09.08.04 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999
Title Mechanical & Piping Systems Interface

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS activity will implement an interface between the ICS and the SNS mechanical and piping system controls provided under WBS 1.8. Examples of systems that will be interfaced with include control systems for cooling water systems, cryogen plants, and gas distribution systems. Control systems interfaced with will be in the form of a commercial distributed control system or programmable logic controllers.

Subtasks include:

- Work with WBS 1.8 design personnel to ensure that control systems provided have an appropriate interface.
- Procure and install I/O Controller (IOC)
- Develop any software drivers required to implement communications between the ICS and the mechanical/piping control systems.
- Configure the EPICS continuous control database.
- Develop EPICS display graphics.
- Title I, II, and III design.
- Test the interfaces to verify they function properly.

The design and software development for this WBS will be performed by ORNL/ SNS. Procurement of materials and equipment will be by ORNL/ SNS. Installation of components will be performed by the construction manager craft labor and ORNL craft labor. Testing will be by ORNL / SNS.

WBS Descriptor Form

WBS 1.09.08.05 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999
Title Waste Processing Systems Interface

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS activity will implement an interface between the ICS and the SNS waste processing systems provided under WBS 1.8. Examples of systems that will be interfaced with include control systems for liquid waste storage and transfer, hot off-gas processing, and gas hold-up for de-activation. Control systems interfaced with will be in the form of a commercial distributed control system or programmable logic controllers.

Subtasks include:

- Work with WBS 1.8 design personnel to ensure that control systems provided have an appropriate interface.
- Procure and install I/O Controller (IOC)
- Develop any software drivers required to implement communications between the ICS and the waste processing systems.
- Configure the EPICS continuous control database.
- Develop EPICS display graphics.
- Title I, II, and III design.
- Test the interfaces to verify they function properly.

The design and software development for this WBS will be performed by ORNL/ SNS. Procurement of materials and equipment will be by ORNL/ SNS. Installation of components will be performed by the construction manager craft labor and ORNL craft labor. Testing will be by ORNL / SNS.

WBS Descriptor Form

WBS 1.09.08.06 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999
Title ORNL Emergency Response Facility Interface

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS activity will implement a status display at the ORNL emergency response facility. Current plans are to install an EPICS operator interface (OPI) at the facility. It is assumed that the existing ORNL communications network infrastructure will provide the connection to the SNS ICS.

Subtasks include:

- Work with ORNL emergency response personnel to optimize the system provided.
- Procure and install EPICS operator interface (OPI) workstation (for placement at emergency response facility).
- Configure a basic set of EPICS displays graphics.
- Title I, II, and III design.
- Test the interface to verify they function properly.

The design and software development for this WBS will be performed by ORNL/ SNS. Procurement of materials and equipment will be by ORNL/ SNS. Installation of components will be performed by the construction manager craft labor and ORNL craft labor. Testing will be by ORNL / SNS.

WBS Descriptor Form

WBS 1.09.09 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999
Title Personnel Protection

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Personnel Protection Systems (PPS) include systems provided to protect personnel from radiation hazards and radioactive contamination from accelerator operations. This WBS element consists of 3 sub-elements:

1. WBS 1.9.9.1 Accelerator Personnel Protection. This WBS includes equipment to protect workers from prompt radiation from accelerator operations.
2. WBS 1.9.9.2 Target Facility Personnel Protection. This WBS includes equipment located in the target facility to protect workers from prompt radiation from a mis-configured or malfunctioning mercury target or from prompt radiation from the neutron beam lines.
3. WBS 1.9.9.3 Radiation and NESHAPS Monitoring Equipment. This WBS has two components:
 - Portable and fixed contamination monitoring equipment to support Health Physics operations
 - Isokinetic stack sampling equipment as required by the SNS air discharge permit

The design for this WBS will be performed by ORNL/SNS personnel. Procurement of materials and equipment will be by ORNL/SNS. Installation of components will be performed by the construction manager craft labor and ORNL craft labor.

The systems provided by WBS 1.9.9.1 and 1.9.9.2 are safety significant. Special quality assurance requirements apply to these systems.

WBS Descriptor Form

WBS 1.09.09.01 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999
Title Accelerator Personnel Protection

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Accelerator Personnel Protection Systems includes systems provided to protect personnel from radiation hazards associated with prompt radiation hazards from accelerator operations.

Systems and associated software are provided to:

- Control personnel access to accelerator tunnels prior to operation
- Enforce searching in tunnels prior to operation
- Automatically shut off the accelerator if access control is violated
- Control accelerator equipment (magnets, beam stops) to allow personnel to work in an accelerator tunnel while an upstream segment of the accelerator is operating
- Monitor radiation levels
- Allow monitoring of these systems by the integrated control system (ICS)

The systems provided by WBS 1.9.9.1 and 1.9.9.2 are safety significant. Special quality assurance requirements apply to these systems.

WBS Descriptor Form

WBS 1.09.09.02 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999
Title Target Facility Personnel Protection

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

Target Facilities Personnel Protection Systems includes systems provided to protect personnel from radiation hazards associated with prompt radiation hazards from target facility operations.

Systems and associated software are provided to:

- Control personnel access to areas where high radiation levels are possible during accelerator operation
- Enforce searching prior to operation in areas where high radiation levels are possible during operation
- Automatically shut off the accelerator if access control is violated
- Control shielding and experimental access for beam lines to prevent opening beam line shutter if shielding or experimental equipment are not properly configured
- Monitor radiation levels
- Allow monitoring of these systems by the integrated control system (ICS)

The systems provided by WBS 1.9.9.1 and 1.9.9.2 are safety significant. Special quality assurance requirements apply to these systems.

WBS Descriptor Form

WBS 1.09.09.03 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999
Title Health Physics Instruments and Stack Mont.

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS has two components:

- Portable and fixed contamination monitoring equipment to support Health Physics operations
- Isokinetic stack sampling equipment as required by the SNS air discharge permit

The design for this WBS will be performed by ORNL/SNS personnel. Procurement of materials and equipment will be by ORNL/SNS. Installation of components will be performed by the construction manager craft labor and ORNL craft labor.

WBS Descriptor Form

WBS 1.09.09.04 **PCR** _____ **Revision** 0 **Revision Date** 7/13/1999
Title ODH Alarm System

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS will provide supervisory control and interface the integrated control system (ICS) with Central Helium Liquefier (CHL) and cryomodule control systems.

Central Helium Liquefier (CHL) and cryomodule supervisory control systems will likely be implemented by using programmable logic controllers (PLCs) and EPICS.

Central Helium Liquefier (CHL) and Cryomodule Interface includes the following subtasks:

WBS 1.9.10.1 Integration Activities

WBS 1.9.10.2 CHL Controls

WBS 1.9.10.3 Cryomodule Controls

The design for this WBS will be performed by ORNL / SNS. Procurement of materials and equipment will be by ORNL / SNS. Installation of components will be performed by the construction manager craft labor and ORNL craft labor. Checkout will be performed by ORNL / SNS.

WBS Descriptor Form

WBS 1.09.10 **PCR** _____ **Revision** 0 **Revision Date** 3/10/2000
Title CHL & Cryomodule Supervisory Controls

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS will provide supervisory control and interface the integrated control system (ICS) with Central Helium Liquefier (CHL) and cryomodule control systems.

Central Helium Liquefier (CHL) and cryomodule supervisory control systems will likely be implemented by using programmable logic controllers (PLCs) and EPICS.

Central Helium Liquefier (CHL) and Cryomodule Interface includes the following subtasks:

WBS 1.9.10.1 Integration Activities

WBS 1.9.10.2 CHL Controls

WBS 1.9.10.3 Cryomodule Controls

The design for this WBS will be performed by ORNL / SNS. Procurement of materials and equipment will be by ORNL / SNS. Installation of components will be performed by the construction manager craft labor and ORNL craft labor. Checkout will be performed by ORNL / SNS.

WBS Descriptor Form

WBS 1.09.10.01 **PCR** _____ **Revision** 0 **Revision Date** 3/10/2000
Title Integration Activities

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS handles setting up the infrastructure and personnel to support Central Helium Liquefier (CHL) and cryomodule interface activities. Integration Activities include:

- Participation in the SNS "Integrated Controls Working Group" (ICWG) activities. (This working group develops standards for SNS control systems).
- EPICS Training for design personnel
- Project controls and design review support
- Funding support for JLAB personnel to provide consulting services.
- Travel and relocation costs

The design for this WBS will be performed by ORNL/ SNS. Procurement of materials and equipment will be by ORNL/ SNS. Installation of components will be performed by ORNL craft labor.

WBS Descriptor Form

WBS 1.09.10.02 **PCR** _____ **Revision** 0 **Revision Date** 3/10/2000
Title CHL Controls

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS activity will implement supervisory controls for the Central Helium Liquefier (CHL) controls systems.

Subtasks include:

- Work with JLAB design personnel to define supervisory control requirements.
- Procure and install controller equipment (IOC, PLCs, etc.)
- Software development (EPICS databases, PLC ladder logic, etc.)
- Develop EPICS display graphics.
- Title I, II, and III design.
- Test the supervisory control to verify it functions properly.

The design and software development for this WBS will be performed by ORNL/ SNS. Procurement of materials and equipment will be by ORNL/ SNS. Installation of components will be performed by the construction manager craft labor and ORNL craft labor. Testing will be by ORNL / SNS.

WBS Descriptor Form

WBS 1.09.10.03 **PCR** _____ **Revision** 0 **Revision Date** 3/10/2000
Title Cryomodule Controls

Description (Scope, Number of Items, Method of Accomplishments, and Special Requirements)

This WBS activity will implement supervisory controls for the cryomodule controls systems.

Subtasks include:

- Work with JLAB design personnel to define supervisory control requirements.
- Procure and install controller equipment (IOC, PLCs, etc.)
- Software development (EPICS databases, PLC ladder logic, etc.)
- Develop EPICS display graphics.
- Title I, II, and III design.
- Test the supervisory control to verify it functions properly.

The design and software development for this WBS will be performed by ORNL/ SNS. Procurement of materials and equipment will be by ORNL/ SNS. Installation of components will be performed by the construction manager craft labor and ORNL craft labor. Testing will be by ORNL / SNS.