PROJECT SUMMARY WBS DICTIONARY

FOR THE NLC PROJECT

Revision 5

May 1, 2000

1 NLC PROJECT

This is a Project Summary WBS for the NLC construction project during the time period from authorization (CD1) to completion (CD4). The Project Summary WBS defines the structure, scope and boundaries of the work required by the project to deliver the final product to the customer.

The WBS divides the project's scope into several major branches:

- 1.1 Conventional Facilities
- 1.2 Injector Systems
- 1.3 Main Linac Systems
- 1.4 Beam Delivery Systems
- 1.5 Control Systems
- 1.6 Technical Services
- 1.7 Administrative Services and Pre-operations
- 1.8 Experimental Detectors

Branches 1.1-1.5, and 1.8, contain the work required to deliver acceptance-tested systems (civil and technical), ready to be capitalized. That work includes conceptual design, R&D, preliminary and definitive design, sustaining engineering, construction, integration and testing.

Branch 1.6 was designed to cover the technical infrastructure supporting the other branches. It includes the one-time finishing or make-ready of some (but not all) facilities that support the work of the project.

Branch 1.7 was designed to cover the ongoing administrative and oversight expenses that support the project (and will evolve into a separately funded operating budget for the completed facility). It is the primary scope of work that will be allocated indirectly as general and administrative (G&A) expenses during execution.

Activities, assigned to the WBS terminal elements, will form the basis of a project schedule. Attributes assigned to the activities will form bases for analyzing the work by categories other than those explicit in the WBS (for example, by activities attributed to separate functional teams executing separate scopes of work). Estimated costs enter the WBS via resources assigned to the activities. (Definitions of activity and resource attributes follow this section of element definitions.)

This WBS summarizes a set of more detailed technical models that reside in the hands of system and subsystem managers. It facilitates the integration of these separate, detailed plans (of resource-loaded activities) into a total project cost and financial plan.

1.1 CONVENTIONAL FACILITIES

The Conventional Facilities for the Next Linear Collider will include development of the NLC site, beam line housings, campus buildings, all utility systems, roads, and parking. The scope of the Conventional Facilities elements includes the following major items: (1)

site preparation, including establishment of the network of survey monuments for site alignment; (2) tunnels to house the beam lines for the injectors, main linacs and the beam delivery systems, including associated cooling systems; (3) klystron gallery and support buildings to house the klystrons and associated electronics; (4) underground halls to house the detectors at the interaction points; (5) campus buildings and facilities; (6) fire protection systems; (7) utility systems, including waste disposal; and (8) roads, sidewalks, parking areas, landscaping, berms and fencing.

This branch of the WBS contains within its scope activities and resources needed to deliver completed conventional facilities to the project, acceptance tested and ready to be capitalized.

1.1.1 Conventional Facilities Systems Engineering & Administration

WBS 1.1.1 includes the costs of the NLC Conventional Facilities Group for staffing and M&S and the cost of contractor support for conceptual design and R&D studies. It includes management, administration, planning and documentation to support the conventional facilities portion of the project.

1.1.1.1 Conventional Facilities Systems Engineering & Administration

WBS 1.1.1.1 covers overall systems planning and documentation for the Conventional Facilities, including liaison with the centralized Project Management and Engineering Management Groups. It covers the development of facility requirements; and the management and integration of interfaces, such as those involving the Injectors, Main Linacs and Beam Delivery Areas. It also includes support of the personnel working ondedicated to Conventional Facilities taskssystems engineering and administration, including management and supervision of in-house staff, and direction of consulting contracts₇. An additional allocation will cover user fees for office support and consumables, computing support, telecommunications support, financial and personnel services as required.

1.1.1.2 Site Selection

Site selection includes the following tasks that will be accomplished by the Department of Energy: environmental impact studies, site selection studies, and land acquisition.

1.1.2 Site

Site Development includes on-site work needed to develop the site to support NLC facilities and operations, and any off-site work that must be charged to project funds, such as connections to the regional infrastructure of roads and utilities. This element includes the following major elements: (1) off-site work to connect to regional transportation and utility systems; (2) a network of monuments, both on-site and off-site, for survey work in support of the construction of facilities and the precision alignment of the beamlines; (3) construction support, such as contractor laydown areas, temporary utility systems for use during construction and spoil areas for disposal of tunnel muck and other excavation

materials; (4) site preparation, including clearing and grubbing, grading, landscaping, berms and fencing; (5) utility distribution systems, including electrical power, fuels, water and waste systems, and communications systems; and (6) roads, sidewalks and parking areas.

1.1.2.1 Site Off-Site Support

This element is intended to cover the cost of any off-site work that will be charged to project funding. For example, it may be necessary to develop off-site roads and utility systems to connect to the regional networks. The extent and nature of these needs will, of course, vary with the specific site selected. Also, some of these costs may be borne by outside entities, so that they do not become a project cost. The requirements under this element will have to be refined once a specific site has been selected.

1.1.2.2 Site Alignment Network

WBS 1.1.2.2 covers the cost of establishing the geodetic control networks. These survey networks will be used to establish horizontal and vertical control for use during the construction of the conventional facilities and during the alignment of the accelerator. (See discussion below concerning the precision tunnel networks and machine alignment.). The networks are implemented by determining the coordinates of survey monuments, which physically represent the surveying coordinate system. The work consists of three parts: the primary geodetic surface network, alignment transfer networks from the surface to tunnel elevation, and alignment tunnel construction networks on the floors and walls along the full length of the beam line tunnel and experimental halls.

Right of access to the lands adjacent to the site will be necessary during a period of approximately six months period for the initial survey work. Surveyors will need to occupy locations in a 500-meter grid pattern in an area approximately 4 km wide by 32 km long. The NLC site itself will be approximately 1 km wide by 32 km long, so this additional right of access will be needed in strips that are approximately 1500 meters wide on both sides of the NLC site.

To the extent possible, the alignment transfer network will take advantage of shafts and penetrations developed for other purposes. Any penetrations that are required solely for the purpose of tunnel alignment will be charged to WBS 1.1.2.2.

WBS 1.1.2.2 does not include the survey work needed for the implementation of the precision tunnel networks and the alignment of the beam lines and accelerators. These costs are included in the WBS elements for the machine.

1.1.2.3 Site Construction Support

This element covers the costs of providing contractor laydown areas for receipt and storage of the equipment, tools, and materials used by contractors during their construction of NLC facilities. It also covers the cost of providing temporary utility hookups of various types needed during construction, prior to completion of the permanent NLC

utility systems. For example, if tunnel boring machines (TBMs) commence operation prior to completion of the NLC electrical distribution system, temporary power would be needed. Because TBMs may require as much as 5 MW, this could be a significant expense. Finally, this WBS element covers the costs associated with disposal of excavation materials, including muck from boring the tunnels. This disposal may be on-site or off-site, depending on the specific site ultimately selected.

1.1.2.4 Site Preparation

WBS 1.1.2.4 covers the costs of preparing the site for construction activities, grading and final landscaping. It includes clearing and grubbing to remove unwanted vegetation and the removal and stockpiling of topsoil from construction sites for later use in landscaping. This element covers the cost of general grading to create suitable sites for individual facilities and to control drainage and the cost of landscaping to control erosion. Installation of fencing to control access or to provide security for selected areas is also part of this WBS element.

The cost of creating berms to cover klystron galleries is included in the WBS elements for beam line housings in the WBS 113 series.

1.1.2.5 Site Electrical Distribution Systems

WBS 1.1.2.5 includes the on-site primary and secondary electrical distribution system down to the connection points for individual facilities at the five-foot line. The NLC will require approximately TBD MW capacity, delivered at 230 kV or greater, to three primary substations: one at the main campus, one approximately 13 km from the main campus along the electron beam line and one approximately 13 km from the main campus along the positron beam line. The primary substations will step down the voltage to 34.5 kV and will be interconnected in a three-way cross-tied ring bus. There will be approximately 90 unit substations that step down the voltage to 480 volts. Most of these will service the two linear accelerators; the main campus will also have several unit substations. The interface with the electrical system for individual facilities will occur at the five-foot line of each facility.

1.1.2.6 Site Fuel Distribution Systems

WBS 1.1.2.6 includes the on-site facilities needed for storage and distribution of fuels, such as natural gas and petroleum products. Fuels will be needed for heating, including domestic hot water, and, depending on the climate at the site ultimately selected, may be needed for humidity control. The requirements for these fuel storage and distribution systems will need to be refined once the site has been selected.

Propane will be used for powering forklifts and other vehicles, particularly those used in closed spaces, because of its clean-burning properties. A facility will be provided at the main campus under WBS 1.1.4 for storage and dispensing of propane. Gasoline and diesel storage and dispensing capability will be provided at vehicle service facilities, also under WBS 1.1.4.

1.1.2.7 Site Water and Waste Systems

WBS 1.1.2.7 includes the treatment, storage and distribution facilities for water used in cooling systems, for potable water, and for water needed for fire protection. This WBS element also includes waste systems, such as sewers and sewage treatment plants, and facilities needed for solid waste, such as holding and transfer facilities. The requirements for these waste and water systems will need to be refined once the site has been selected.

The facilities included in the cooling system under WBS 1.1.2.7 are the raw water systems, cooling towers, cooling ponds, distribution piping, chilled water systems and low conductivity water systems up to the five-foot line of the individual klystron gallery, support building, beam line tunnel or other facility that uses cooling water. Vibration isolation will be installed to minimize transmission of vibrations.

1.1.2.8 Site Communications

WBS 1.1.2.8 includes on-site cables, switches and other equipment for the administrative telephone system, the fire protection system and the supervisory control and data acquisition (SCADA) system for the control and monitoring of the conventional facilities (e.g., power, water, cooling and building HVAC systems). This WBS element does not include costs associated with the machine protection system, the personnel protection system and the beam protection system. For data transmission, these systems will rely upon the site-wide network developed primarily for the global controls.

1.1.2.9 Site Roads and Parking

WBS 1.1.2.9 includes the costs of on-site paving for roads, sidewalks and parking areas.

1.1.3 Housings

WBS 1.1.3 includes the tunnels, klystron galleries, detector halls and other facilities needed to house the electron and positron beam lines for the injectors, main linacs, beam delivery systems, interaction regions and beam dumps. To minimize repetition, many of the common housing elements will be defined here, and not repeated for each WBS element of the individual housings. The housings include the following elements:

* Klystron Galleries. These will be constructed at or near the surface, with minimum earth cover of one meter, or insulation, sufficient to isolate the interior from diurnal temperature variation. The klystron galleries will provide two separate spaces: a space for the klystrons, directly over or adjacent to the beam line housing; and an adjacent space for electronic equipment racks. Vertical or horizontal penetrations will be provided between the klystron galleries and the beam line housings for the RF waveguides and for cables.

* Support Buildings. These will be constructed at or near the surface to house electronic racks and power supply racks for the Injectors (positron target, damping rings, turn-arounds and pre-collimation sections) and for the Beam Delivery areas.

* Ramps or shafts from the surface to connect to the beam line housings below grade.

* Cooling Systems. The WBS 1.1.3 elements will connect to the cooling system supply and return lines provided under WBS 1.1.2.7 at the five-foot line of the individual klystron gallery or beam line housing. The WBS 1.1.3 elements include the cooling water supply and return lines and cooling system equipment within the klystron galleries, support buildings and beam line housings, as described below. (For an interface diagram, see attachment entitled "Conventional Facilities - Tunnel Cooling Interface Diagram.")

In the klystron galleries, cooling water for the electronic racks will be provided to a manifold mounted on the interior gallery wall. A flexible hose will be provided under WBS 1.1.2 to supply cooling water to the electronic racks and power supplies. (The WBS for technical system installation covers the cost of attaching this hose to the electronic rack.) For modulators and klystrons, which require a rigid connection, the piping provided under WBS 1.1.2 will terminate in a flange near the location of the klystron/modulator assembly. The WBS for technical system installation covers the cost of making the connection from this flange to the modulator/klystron assembly.

Within the beamline housings, LCW supply and return lines will be mounted on the tunnel wall. Flexible hoses will be provided to connect to the inlet and outlet flanges on the beamline girders, RF elbows and electro-magnets.

* Electrical Systems. WBS elements in the 1.1.3 series connect to the electrical distribution system under WBS element 1.1.2.5 at the five-foot line of the individual facility and bring the power to the main electrical panel within each facility. Downstream from this main electrical panel, WBS 1.1.3 will distribute electric power to secondary electrical panels in the vicinity of the technical system components. The WBS elements for the technical systems will cover the cost of the electrical connection from this secondary panel to the point of use. (For an interface diagram of the electrical system, see attachment entitled "Conventional Facilities - Electrical Interface Diagram.") WBS 1.1.3 will also install general area lighting and convenience outlets for 120-volt electric power.

* Ventilation Systems. The beamline enclosures will require ventilation systems for safe occupancy and for smoke removal in event of fire. Requirements will be defined by a Fire Hazard Analysis.

* HVAC Systems. Air handling and cooling systems will be required to control the room temperature in the klystron galleries, support buildings, detector halls and beam-line housings.

* Drainage Systems. The beamline enclosures will be provided with sumps to collect any groundwater inflow or liquid spills. Sumps will be pumped to collection tanks on the surface for analysis, prior to disposal in an environmentally conscious manner.

* Attachment Framework. The beam line housings will include a framework (e.g., Unistrut or equivalent) for attaching RF waveguides, conduits, cable racks and other systems. The

cost of attaching these systems to the framework is covered under the WBS elements for installation of technical systems. WBS 1.1.3 also does not include the cost of cable racks and cables, or the anchor bolts and base plates for the beam line pedestals.

* Exterior doors for personnel access and equipment access are provided under WBS 1.1.3 elements. Internal doors, partitions, fencing, and gates for control of access to radiation areas are provided under the WBS for the Personnel Protection System, as are the sensors, controls, indicators and other equipment needed for the Personnel Protection System.

* Shielding blocks are not part of WBS 1.1.3, but are provided under the WBS elements for the technical systems.

1.1.3.1 Housings Sources & Boosters

WBS elements 1.1.3.1 through 1.1.3.3 comprise the Injector for the NLC. The first of these elements, WBS 1.1.3.1, Housings - Sources and Boosters, includes housings for the polarized electron and positron sources, beam line housings, klystron galleries, booster linacs and tuning dumps.

1.1.3.2 Housings Damping Rings

WBS 1.1.3.2 includes housings for a positron pre-damping ring; two damping rings, one for the electron beam and one for the positron beam; support buildings; and transport, bypass and dump lines for the positron and electron beam lines.

1.1.3.3 Housings Pre-linacs

WBS 1.1.3.3 includes the positron and electron beam line housings for the pre-linacs with their klystron galleries, beam abort dumps prior to the turn-arounds, the 180-degree compression arcs and the second bunch compressors. At the ends of the pre-linacs, there are housings for high-power beam abort dumps. These pre-linac housings extend from the flanges immediately following the bends to the damping ring tuning dumps to the flanges immediately following the bends to the high-power beam abort dumps. The latter flanges mark the interfaces with the housings for the main linacs (WBS 1.1.3.4).

1.1.3.4 Housings Main Linacs

WBS 1.1.3.4, the Main Linac, is the next major component of the accelerator. It contains the positron and electron beam lines from the Injector to the Beam Delivery System. WBS 1.1.3.4 includes the beam line housings for the main linacs and their associated klystron galleries.

1.1.3.5 Housings Collimation

The Beam Delivery System is the final major component of the accelerator. WBS element 1.1.3.5, Collimation and IP Switches, the first element of the Beam Delivery System,

contains the beam line housings for the end of linac diagnostics, the collimation sections and the IP switches.

1.1.3.6 Housings IR Transport Line One

WBS 1.1.3.6 includes the positron and electron beam lines for the big bends, the skew correction sections and the final focus sections in the Beam Delivery One area. These big bends direct the beams to Interaction Region One.

1.1.3.7 Housings Interaction Region One

WBS 1.1.3.7 includes the following items from the Beam Delivery One area: Interaction Hall One and its supporting facilities, the positron and electron housings for the dump lines, and the positron and electron high-powered final beam dumps.

1.1.3.8 Housings IR Transport Line Two

WBS 1.1.3.8 includes the positron and electron beam lines for the big bends, the skew correction sections and the final focus sections in the Beam Delivery Two area. These big bends direct the beams to Interaction Region Two.

1.1.3.9 Housings Interaction Region Two

WBS 1.1.3.9 includes the following items from the Beam Delivery Two area: Interaction Hall Two, the positron and electron housings for the dump lines, and the positron and electron high-powered beam dumps.

1.1.4 Campus Buildings

WBS 1.1.4 includes the buildings and facilities that will occupy the main campus of the NLC near the interaction points at the center of the accelerator site. Campus requirements have been based on the concept that maintenance and operations people will be at the NLC site, with minimal additional staff for management, supervision and support. Physicists and the balance of the staff working on the NLC will be located at the Stanford Linear Accelerator Center (SLAC), Fermi National Accelerator Laboratory (FNAL), Lawrence Livermore National Lab (LLNL), Lawrence Berkeley National Lab (LBNL) or another existing high energy physics lab. The campus facilities include the following: * Administrative space and a cafeteria;

* Shops and assembly buildings to support construction of equipment assemblies for the accelerator and the detectors;

* Support buildings of various types, such as warehousing, security and emergency services facilities, and vehicle servicing facilities; and

* Space for control rooms.

Some support may also be obtainable from an adjacent community, if the site is not located in a remote area. (For example, it would be possible to rely on a nearby service station and eliminate the fuel dispensing facility now included with the vehicle servicing building.)

The exact composition of the campus facilities will need to be refined following site selection, when the degree of external support has been determined.

See Table 1 in the attachment entitled "Conventional Facilities - Description of the Baseline Cost Model" for a listing of the campus facilities and their square footage.

1.1.4.1 Campus Central Laboratory Buildings

The central laboratory buildings will contain office spaces and a cafeteria.

1.1.4.2 Campus Heavy Assembly Buildings

Heavy assembly buildings will provide low bay and high bay industrial space, serviced by overhead cranes, for assembly of accelerator and detector components.

1.1.4.3 Campus Shop Buildings

There will be three shop buildings (Buildings G, H and J) to house various clean room spaces and shops. The clean room spaces in Building G include the optics maintenance facility, and clean room spaces for assembly of critical accelerator and detector components. Buildings H and J include shops such as cryogenic, vacuum, machine, welding, sheet metal, piping, and carpentry shops. Ten-ton or five-ton overhead cranes service buildings H and J.

1.1.4.4 Campus Support Buildings

WBS 1.1.4.4 includes support buildings for storage, security, emergency services, vehicle servicing and miscellaneous functions.

1.1.4.5 Campus Control Room Buildings

WBS 1.1.4.5 provides space for control rooms for the accelerator and detectors, adjacent space for control center functions and space for communications functions.

1.1.5 Buildings at Existing Laboratories

As noted in WBS 1.1.4, personnel located at the NLC site will be primarily those directly involved in maintenance and operations. Physicists and others working on the NLC will be located at SLAC, FNAL, LBNL, LLNL or another existing high energy physics laboratory. This WBS element will cover the cost of rehabilitation of buildings or construction of new space to house operations at existing laboratories in support of the NLC.

- 1.1.5.1 Buildings at SLAC
- 1.1.5.2 Buildings at FNAL

1.1.5.3 Buildings at LBNL

1.1.5.4 Buildings at LLNL

1.2 INJECTOR SYSTEMS

The injectors include the electron and positron source areas, damping ring areas, and lowenergy linac areas (including the electron and positron boosters, the drive linac for the positron target, energy and bunch compressors, and the "pre-linacs" that accelerate the beams to the injection energy for the Main Linacs).

This element covers systems engineering, conceptual design, R&D, preliminary and definitive design, sustaining engineering, acquisition, installation, alignment, integration and testing for all technical systems, subsystems and components associated with the injectors. It contains within its scope activities and resources needed to deliver completed injector systems to the project, acceptance tested and ready to be capitalized.

1.2.1 Injector Systems Engineering

Systems Engineering management and administration of the work on the Injector Systems.

1.2.1.1 Injector Systems Engineering and Administration

This element covers overall systems planning and documentation for the work on the Injector Systems, including liaison to the centralized Project Management and Engineering Management Groups. It covers the management and integration of interfaces, such as those involving the Sources Areas, the Damping Ring Areas, the Injector Linac Areas, the Control Systems, the Conventional Facilities, and the rest of the project. It also includes support of the personnel working ondedicated to Injector Systems tasks systems engineering and administration, including management and supervision of in-house tasks and direction of consulting contracts₇. An additional allocation will cover user fees for office support and consumables, computing support, telecommunications support, financial and personnel services as required.

1.2.2 Sources Areas

The Sources Areas include all beam lines and dumps of the electron sources, drive linac, positron source, electron and positron booster linacs, and Gun Test Lab.

This element covers conceptual design, R&D, preliminary and definitive design, sustaining engineering, acquisition, installation, alignment, integration and testing for all technical systems, subsystems and components associated with the Sources Areas.

The work elements described below (at level 4) shall apply to technical systems, subsystems and components including such ancillary items as: electronics enclosures (racks, cabinets or frames) with utility services; electrical and electronic cables; and distribution of utilities as needed from the Conventional Facilities interfaces described in WBS element 1.1.3.

The work elements described below (at level 4) shall NOT apply to: the Central Control and Timing System backbone services and software, or to the protection systems provided

by element 1.5; nor to the technical services provided by element 1.6; nor to the administrative services provided by element 1.7.

1.2.2.1 Sources Areas Conceptual Design

This element collects conceptual design activities pertaining to the parent element, commencing after CD1, and concluding with satisfactory completion of the project Conceptual Design Report and Review, just prior to CD2. Conceptual design includes systems analysis of requirements, interfaces, manufacturability, reliability, maintainability, cost and schedule, etc.

The systems engineering support infrastructure is provided by Element 1.6.1. The functional engineering support infrastructure is provided by Element 1.6.2.

1.2.2.2 Sources Areas R&D

This element collects R&D activities in support of construction, pertaining to the parent element, at any time during the project. R&D is limited (by law) to demonstration of technical feasibility and engineering development of pre-production components, equipment, subsystems and systems; it does not include the development of working prototypes or components that will be installed in the NLC.

1.2.2.3 Sources Areas Design

This element collects the engineering design activities for the systems, subsystems and components pertaining to the parent element. Engineering design shall include appropriate systems engineering (such as requirements analyses, systems integration planning, design for manufacturability, reliability, availability, maintainability, etc.) and documentation including procurement plans and cost and schedule estimates. Design also includes the development of working prototypes that will be installed in the NLC.

The systems engineering, and functional engineering, support infrastructures are in Elements 1.6.1 and 1.6.2, respectively.

The design activities covered by this element occur only during the formal design phase of the project, between CD2 and CD3. Two significant parts of the design phase are: "preliminary design" (Title I) activities, and "definitive design" (Title II) activities. The ultimate deliverable of the design phase is the documented definitive design and acquisition plan for all systems, subsystems and components of the parent element, validated by a definitive design review (a prerequisite to actual construction). Definitive design reviews may be completed separately for different beam lines.

1.2.2.4 Sources Areas Sustaining Engineering

This element collects the post-design (construction phase) engineering changes, inspections, construction management, systems integration (Title III) activities for all

systems, subsystems and components pertaining to the parent element. Sustaining Engineering includes both office support and field services.

Pre-operational maintenance or improvement is NOT within the scope of this element.

1.2.2.5 Sources Areas Acquisition

This element collects the acquisition activities for the technical components pertaining to the parent element, such as management and execution of purchasing subcontracts, or direct labor and materials used for in-house manufacturing. These activities occur during the construction phase, starting after CD3.

The engineering and manufacturing support infrastructure is in Element 1.6.

1.2.2.6 Sources Areas Installation, Integration and Testing

This element collects the activities for planning and carrying out the installation, integration and testing of the components, subsystems, and systems of the parent element. This element covers conditioning and full-systems acceptance testing (sometimes called commissioning), as specified by formal acceptance test requirements and plans (yet to be developed). The activities span the period from CD1 to CD4.

The installation support infrastructure is in Element 1.6.4. The pre-operations support infrastructure is in Element 1.7.5.

(*** Need to define where pre-operational utilities and replacements are covered. ***)

1.2.3 Damping Ring Areas

Damping Ring Areas are part of both the electron and positron injectors. The electron injector contains a main damping ring, an injection line and an extraction line. The positron injector contains a pre-damping ring (PDR), a main damping ring (MDR), a linac-to-PDR injection line, a PDR-to-MDR transfer line, and an MDR-to-linac extraction line.

This element covers conceptual design, R&D, preliminary and definitive design, sustaining engineering, acquisition, installation, alignment, integration and testing for all technical systems, subsystems and components associated with the Damping Ring Areas.

The work elements described below (at level 4) shall apply to technical systems, subsystems and components including such ancillary items as: electronics enclosures (racks, cabinets or frames) with utility services; electrical and electronic cables; and distribution of utilities as needed from the Conventional Facilities interfaces described in WBS element 1.1.3.

The work elements described below (at level 4) shall NOT apply to: the Central Control and Timing System backbone services and software, or to the protection systems provided

by element 1.5; nor to the technical services provided by element 1.6; nor to the administrative services provided by element 1.7.

1.2.3.1 Damping Ring Areas Conceptual Design

Same definition as element 1.2.2.1.

1.2.3.2 Damping Ring Areas R&D

Same definition as element 1.2.2.2.

1.2.3.3 Damping Ring Areas Design

Same definition as element 1.2.2.3.

1.2.3.4 Damping Ring Areas Sustaining Engineering

Same definition as element 1.2.2.4.

1.2.3.5 Damping Ring Areas Acquisition

Same definition as element 1.2.2.5.

1.2.3.6 Damping Ring Areas Installation, Integration and Testing

Same definition as element 1.2.2.6.

1.2.4 Pre-linac Areas

The Pre-linac Areas include the electron and positron "pre-linacs" (that accelerate the beams for injection into the Main Linac), the bunch compressors (BC2), and associated beam dumps. This WBS element covers conceptual design, R&D, preliminary and definitive design, sustaining engineering, acquisition, installation, alignment, integration and testing for all technical systems, subsystems and components associated with the Injector Linac Areas.

The work elements described below (at level 4) shall apply to technical systems, subsystems and components including such ancillary items as: electronics enclosures (racks, cabinets or frames) with utility services; electrical and electronic cables; and distribution of utilities as needed from the Conventional Facilities interfaces described in WBS element 1.1.3.

The work elements described below (at level 4) shall NOT apply to: the Central Control and Timing System backbone services and software, or to the protection systems provided by element 1.5; nor to the technical services provided by element 1.6; nor to the administrative services provided by element 1.7.

- 1.2.4.1 Pre-linac Areas Conceptual Design Same definition as element 1.2.2.1.
- 1.2.4.2 Pre-linac Areas R&D

Same definition as element 1.2.2.2.

- 1.2.4.3 Pre-linac Areas Design Same definition as element 1.2.2.3.
- 1.2.4.4 Pre-linac Areas Sustaining Engineering Same definition as element 1.2.2.4.
- 1.2.4.5 Pre-linac Areas Acquisition Same definition as element 1.2.2.5.
- 1.2.4.6 Pre-linac Areas Installation, Integration and Testing Same definition as element 1.2.2.6.

1.3 MAIN LINAC SYSTEMS

The Main Linacs are two very high-energy linear accelerators, one for electrons and another for positrons.

This element covers systems engineering, conceptual design, R&D, preliminary and definitive design, sustaining engineering, acquisition, installation, alignment, integration and testing for all technical systems, subsystems and components associated with the Main Linac Systems. It contains within its scope activities and resources needed to deliver completed Main Linac systems to the project, acceptance tested and ready to be capitalized.

1.3.1 Main Linac Systems Engineering

Systems Engineering management and administration of the work on the Main Linac Systems.

1.3.1.1 Main Linac Systems Engineering and Administration

This element covers overall systems planning and documentation for the work on the Main Linac Systems, including liaison to the centralized Project Management and Engineering Management Groups. It covers the management and integration of interfaces between the Main Linac Beam Line Systems, the Main Linac RF Systems, the Control Systems, the Conventional Facilities, and the rest of the project. It also includes support of the personnel working ondedicated to Main Linac Systems tasksengineering and administration, including management and supervision of in-house staff and direction of consulting contracts₇. An additional allocation will cover user fees for office support and consumables, computing support, telecommunications support, financial and personnel services as required.

1.3.2 Main Linac Beam Line Systems

The Main Linac beam lines include the Main Linac for electrons and the Main Linac for positrons.

This element covers systems engineering, conceptual design, R&D, preliminary and definitive design, sustaining engineering, and acquisition for all technical systems, subsystems and components associated with the Main Linac beam lines including the high-gradient accelerator structures, excluding the RF power sources, controls and distribution systems.

The work elements described below (at level 4) shall apply to technical systems, subsystems and components including such ancillary items as: electronics enclosures (racks, cabinets or frames) with utility services; electrical and electronic cables; and distribution of utilities as needed from the Conventional Facilities interfaces described in WBS element 1.1.3.

The work elements described below (at level 4) shall NOT apply to: the Central Control and Timing System backbone services and software, or to the protection systems provided by element 1.5; nor to the technical services provided by element 1.6; nor to the administrative services provided by element 1.7.

1.3.2.1 Main Linac Beam Line Systems Conceptual Design

Same definition as element 1.2.2.1.

1.3.2.2 Main Linac Beam Line Systems R&D

Same definition as element 1.2.2.2.

1.3.2.3 Main Linac Beam Line Systems Design

Same definition as element 1.2.2.3.

1.3.2.4 Main Linac Beam Line Systems Sustaining Engineering

Same definition as element 1.2.2.4.

1.3.2.5 Main Linac Beam Line Systems Acquisition

Same definition as element 1.2.2.5.

1.3.3 Main Linac RF Systems

The Main Linac RF Systems includes the RF power sources, controls, and distribution system for both Main Linacs.

This element covers systems engineering, conceptual design, R&D, preliminary and definitive design, sustaining engineering, and acquisition for all technical systems, subsystems and components associated with the Main Linac RF Systems.

The work elements described below (at level 4) shall apply to technical systems, subsystems and components including such ancillary items as: electronics enclosures (racks, cabinets or frames) with utility services; electrical and electronic cables; and distribution of utilities as needed from the Conventional Facilities interfaces described in WBS element 1.1.3.

The work elements described below (at level 4) shall NOT apply to: the Central Control and Timing System backbone services and software, or to the protection systems provided by element 1.5; nor to the technical services provided by element 1.6; nor to the administrative services provided by element 1.7.

1.3.3.1 Main Linac RF Systems Conceptual Design

Same definition as element 1.2.2.1.

1.3.3.2 Main Linac RF Systems R&D

Same definition as element 1.2.2.2.

1.3.3.3 Main Linac RF Systems Design

Same definition as element 1.2.2.3.

1.3.3.4 Main Linac RF Systems Sustaining Engineering

Same definition as element 1.2.2.4.

1.3.3.5 Main Linac RF Systems Acquisition

Same definition as element 1.2.2.5.

- 1.3.4 Main Linac Installation, Integration and Testing
- 1.3.4.1 Main Linac Installation, Integration and Testing

Same definition as element 1.2.2.6.

1.3.5 Main Linac Systems Integration Test

This element covers the incremental costs (in addition to elements 1.3.2 and 1.3.3) for development and utilization of a systems integration test for the Main Linac beam line and RF system components. (Activities span the period from CD1 to CD4.)

1.3.5.1 Main Linac Systems Integration Test

(More definition needed.)

1.4 BEAM DELIVERY SYSTEMS

The Beam Delivery Systems transport the high-energy beams from the Main Linacs to collisions, observed by experimental detectors, in the interaction region(s) and dispose of them in beam dumps.

This element covers systems engineering, conceptual design, R&D, preliminary and definitive design, sustaining engineering, acquisition, installation, alignment, integration and testing for all technical systems, subsystems and components associated with the Beam Delivery Systems. It contains within its scope activities and resources needed to deliver completed Beam Delivery systems to the project, acceptance tested and ready to be capitalized.

1.4.1 Beam Delivery Systems Engineering

Systems Engineering management and administration of the work on the Beam Delivery Systems.

1.4.1.1 Beam Delivery Systems Engineering and Administration

This element covers overall systems planning and documentation for the work on the Beam Delivery Systems, including liaison to the centralized Project Management and Engineering Management Groups. It covers the management and integration of interfaces, such as those involving different Beam Delivery subsystems, the experimental detectors, the Control Systems, the Conventional Facilities, and the rest of the project. It also includes support of the personnel working ondedicated to Beam Delivery Systems tasksengineering and administration, including management and supervision of in-house staff and direction of consulting contracts_T. An additional allocation will cover user fees for office support and consumables, computing support, telecommunications support, financial and personnel services as required.

1.4.2 Beam Delivery Lines and Interaction Regions

The beam delivery lines include collimation beam lines (downstream from the Main Linacs) for electrons and positrons, a pair of Interaction Region Transport (IRT) lines from the electron and positron Main Linacs to IR1, and another pair of IRT lines from the electron and positron Main Linacs to IR2.

This element covers conceptual design, R&D, preliminary and definitive design, sustaining engineering, acquisition, installation, alignment, integration and testing for all technical systems, subsystems and components associated with both collimation beam lines, four IRT lines, and both interaction regions.

The work elements described below (at level 4) shall apply to technical systems, subsystems and components including such ancillary items as: electronics enclosures (racks, cabinets or frames) with utility services; electrical and electronic cables; and

distribution of utilities as needed from the Conventional Facilities interfaces described in WBS element 1.1.3.

The work elements described below (at level 4) shall NOT apply to: the Central Control and Timing System backbone services and software, or to the protection systems provided by element 1.5; nor to the technical services provided by element 1.6; nor to the administrative services provided by element 1.7.

1.4.2.1 Beam Delivery Systems Conceptual Design

Same definition as element 1.2.2.1.

1.4.2.2 Beam Delivery Systems R&D

Same definition as element 1.2.2.2.

1.4.2.3 Beam Delivery Systems Design

Same definition as element 1.2.2.3.

1.4.2.4 Beam Delivery Systems Sustaining Engineering

Same definition as element 1.2.2.4.

1.4.2.5 Beam Delivery Systems Acquisition

Same definition as element 1.2.2.5.

1.4.2.6 Beam Delivery Systems Installation, Integration and Testing

Same definition as element 1.2.2.6.

1.5 CONTROL SYSTEMS

The Control Systems include the central control system and control room for the accelerator complex, the site-wide accelerator control system network, the accelerator timing control and distribution system, and the protection systems.

This element covers hardware and software development that serves all physical areas and accelerator technical systems. It includes general computer resources, networks, operating systems, control software and database development. It contains within its scope activities and resources needed to deliver completed control systems to the project, acceptance tested and ready to be capitalized.

A boundary exists between the control systems covered by this element, and the other technical systems in the project: this element includes the application software, networking, and interface crate(s) and controller(s). However, it excludes crate-based electronics modules and associated firmware, channel-specific scalable software work (such as database entries), and system-specific hardware (such as chassis, power supplies, cables, and beam line components).

1.5.1 Control Systems Systems Engineering

Systems Engineering management and administration of the work on the Control Systems.

1.5.1.1 Control Systems Systems Engineering and Administration

This element covers overall Systems Engineering planning and documentation of the work on the Control Systems, including liaison to the centralized Project Management and Engineering Management Groups. It covers the management and integration of interfaces, such as those involving the central control system, the timing control and distribution system, the protection systems, the Conventional Facilities, and the rest of the project. It also includes support of the personnel working ondedicated to Control Systems taskssystems engineering and administration, including management and supervision of in-house staff and direction of consulting contracts₇. An additional allocation will cover user fees for office support and consumables, computing support, telecommunications support, financial and personnel services as required.

1.5.2 Central Control and Timing System

The central control system will control the operation of the accelerator complex. It consists of a central control room, computers, networks, interfaces and software that will send commands and monitor performance. A central timing system will create and distribute the clock pulses that synchronize all accelerator monitoring and control operations.

1.5.2.1 Computers

The Global Systems Computers include all the system processors and servers serving databases, processing applications, generating displays, providing user interfaces to the

control system. At a lower level, there are servers for booting IOCs, database transfers, data archiving, file servers and web servers. A third category includes a server farm to support software development and maintenance.

1.5.2.2 Networking

Networking includes the fiber optic control system backbone and the associated routers, repeaters, switches and network diagnostic systems. This includes all the real time and data acquisition infrastructure with the exception of the hardware timing system. Also included are all the protection systems with the exception of the Personnel Protection System, which has its own dedicated fiber plant.

1.5.2.3 Software

This element includes all the software necessary to operate and diagnose the accelerator control system. This category includes: system software for data acquisition and control, low level device control software, high-level applications software, control system tools and utilities, parameter control and feedback systems, low level firmware embedded in controller modules.

1.5.2.4 Control Rooms

This element includes the layout, the networking, workstations, status and operational displays and supporting infrastructure.

1.5.2.5 Timing System

This element covers hardware and software development that serves numerous physical areas and accelerator technical systems requiring precise timing synchronization. It includes the Master Timing Oscillator, timing signal fiber optic distribution, and local area hub distribution systems. For detailed descriptions of the baseline cost estimates see the following documents:

NLC Timing Top Sheet NLC Component Catalog - Master Oscillator NLC Component Catalog - Optical Fan-out NLC Component Catalog - Stable Fiber Optic Transmitter NLC Component Catalog - Trench Temperature Control NLC Component Catalog - Stable Fiber Optic Receiver NLC Component Catalog - Stable Fiber Optic Receiver

1.5.2.6 Control System Interface

The control system interface is a network of input-output control (IOC) crates and standard modules. This element covers the hardware that serves numerous physical areas and accelerator technical systems requiring control system functions. It includes the hardware required to support the IOC functions and a standard module set to support the common

needs of the various users in each physical area. The control system interface includes all the crates that branch off the main backbone, to be populated by all subsystem users.

1.5.3 Protection Systems

The protection systems include the Personnel Protection System (PPS), the Beam Containment System (BCS), and the Machine Protection System (MPS). This element covers hardware and software developments that serve numerous physical areas and accelerator technical systems.

1.5.3.1 Personnel Protection System (PPS)

This element covers all PPS related Engineering, Design, Inspection, Building, and Hardware necessary to support the NLC PPS requirements throughout the project. For detailed descriptions please see the following attachments:

NLC PPS Area Listing - enumerates the segmentation for each beamline area.

NLC PPS Definition - contains top level descriptions of the definition, design functions and geographical PPS zones that comprise the scope of the PPS.

The functional requirements for the PPS are: (1) to operate as an access control system with access states, access controls for personnel and equipment, and personnel identification. (2) contain logic for normal accesses as well as responses to abnormal access conditions. (3) control PPS hazard permits that are inputs to the hazard power source interlocks. (4) control PPS permits to beam stoppers.

1.5.3.2 Beam Containment System (BCS)

This element covers all BCS related Engineering, Design, Inspection, Building, and Hardware necessary to support the NLC BCS requirements throughout the project. For detailed descriptions please see the following attachments:

NLC BCS Requirements - describes the basic overall project requirements for the BCS system.

NLC BCS Model - contains the description of the current cost model design for the BCS system.

NLC BCS Status & Control - describes the overall status and control approaches used for the BCS current cost model.

NLC BCS Diagnostic Requirements - reflects the current self-checking and diagnostic capabilities desired for the system.

1.5.3.3 Machine Protection System (MPS)

This element covers all MPS related engineering, design, inspection, building, and hardware necessary to support the NLC MPS requirements throughout the project. For detailed descriptions please see the following attachments.

NLC MPS Requirements - describes the basic overall project requirements for the MPS system.

NLC MPS Model - contains the description of the current cost model design for the MPS system.

NLC MPS Status & Control - describes the overall status and control approaches used for the MPS current cost model.

NLC MPS Diagnostic Requirements - reflects the current self-checking and diagnostic capabilities desired for the system.

1.6 TECHNICAL SERVICES

This element covers management and coordination of Systems Engineering for the entire project, management and coordination of functional engineering teams, engineering support services, manufacturing support services, and installation coordination and support services.

1.6.1 Project Systems Engineering

This element covers management and coordination of Systems Engineering for the entire project under the direction of the Chief Systems Engineer and staff.

It includes analysis and management of risks threatening cost, schedule, or technical performance.

It includes project-wide implementation and management of engineering standards and systems to assure uniform quality of technical design and implementation. Inspection, measurement, and failure analysis are included.

It includes integrated safety management includes setting policies and implementing procedures for the construction project.

1.6.1.1 Systems Engineering Management and Administration

This element covers systems engineering management, coordination, planning and documentation for the project, including liaison to the centralized Project Management and Engineering Management Groups. It covers the management and integration of interfaces, such as those involving the Injector Systems, the Main Linac Systems, the Beam Delivery systems, the experimental detectors, the Control Systems, the Conventional Facilities, and the rest of the project. It includes support of the personnel working ondedicated to project systems engineering tasks-and administation, including management and supervision of in-house staff and direction of consulting contracts, that are not allocable to any of the other branches unless they are allocated to another branch of this WBS. An additional allocation will cover user fees for office support and consumables, computing support, telecommunications support, financial and personnel services as required.

1.6.2 Engineering Support Services

This element covers management and coordination of functional engineering teams, centralized engineering design services and engineering tool support for the entire project.

1.6.2.1 Functional Engineering Team Management and Administration

This element covers management and coordination of functional engineering teams.

1.6.2.2 Central Design Services

The design services covered here cannot be (or have not been) allocated to other branches of this WBS. They may include, but are not limited to: engineering effort; designer effort; personnel supervision; design of specialized engineering equipment, fixtures or tooling; design of generic prototypes, jury rigs or mock-ups; generic failure analyses, manufacturing analyses; experimental machining; vendor evaluation and certification; manufacturing problem resolution; process engineering; industrial engineering; Taguchi analysis; reliability and maintainability analysis; test planning; development of acceptance criteria; life-cycle cost analysis; value engineering; design for manufacturability; and design for assembly.

1.6.2.3 Engineering Tools

The engineering tools covered here cannot be (or have not been) allocated to other branches of this WBS. They may include, but are not limited to: PDM support; CAD support and training; document checking; engineering software licensing and training; CAD station procurement; engineering standards; engineering network installation; BOM preparation; change order control; drawing distribution; and design reviews.

1.6.3 Manufacturing Support Services

This element covers the shared infrastructure and supervisory overhead for manufacturing, assembly, materials storage and handling. The infrastructure includes management, facilities, equipment, consumables and logistics support systems.

1.6.3.1 Manufacturing Support Services Management and Administration

1.6.3.2 Manufacturing Services

This element covers the supervisory and equipment overheads for manufacturing services managed by the project. These services include machining, cleaning, plating, bonding, and materials processing.

1.6.3.3 Assembly and Testing Services

This element covers the costs of designing, outfitting and supervising assembly and testing services that will be managed and operated by the NLC project. These include assembly, testing, metrology and quality control services for electrical, mechanical, and microwave components such as electromagnets, permanent magnets, vacuum systems, RF sources, electronics enclosures (racks, cabinets or frames), electrical and electronic cables, precision components, optics and lasers, etc.

1.6.3.4 Manufacturing Logistics Support

This element covers supervision and maintenance of Technical Services equipment for manufacturing, material handling, and transportation. It includes warehouse operations and inventory control, replacement of consumable tools and fuels, and the cost of maintaining the vehicle pool that supports manufacturing and installation services.

1.6.4 Installation Support Services

This element covers the shared infrastructure and management overheads that support installation site-wide. The shared infrastructure includes management, facilities, equipment (including vehicles) and logistical support systems needed to plan, oversee and coordinate the installation process, and to move the technical components into position for installation.

1.6.4.1 Installation Systems Engineering and Administration

This element covers planning, documentation, and infrastructure development for installation including liaison to the centralized Project Management and Systems Engineering Management Groups. It covers the management and integration of interfaces. It also includes support of the personnel working on installation tasks, including management supervision, office support and consumables, computing support, telecommunications support, financial and personnel services as required.

1.6.4.2 Installation Logistics Support

This element covers logistics support and conveyances for installation. The installation process will be supported by a network of teams, equipment, vehicles, staging areas, and portable services that move with the teams.

This element covers the design, acquisition, operation and maintenance of a system of conveyances that deliver each piece of material from storage or receiving facility to its point of installation. It includes a system for conveying parts in the accelerator housings.

1.6.4.3 Interface Integration and Testing

Integration and testing of system interfaces not allocated to any other branch of this WBS.

1.6.5 Project Infrastructure Finish-out

This element includes the finish-out of the project infrastructure required to make ready for occupancy and utility. It includes furnishings, fixtures and equipment.

1.6.5.1 Project Infrastructure Finish-out

(Needs more definition.)

1.7 ADMINISTRATIVE SERVICES AND PRE-OPERATIONS

This branch contains ongoing administration and oversight expenses that support the project (and will evolve into a separately funded operating budget for the completed facility). It is the primary scope of work that will be allocated indirectly as general and administrative (G&A) expenses during execution.

It DOES NOT in general cover initial building finish-out, ongoing improvements and interim space lease costs, nor the acquisition costs to provide occupied spaces with furnishings, fixtures or equipment.

1.7.1 Project Direction

This element covers the direction and oversight of the project, and the interface to external stakeholders. It includes the Director's Office, Public Affairs, Internal Audit and Compliance, and Affirmative Action.

The Director's Office includes the Project Director (or Manager), Associate Directors, Assistant Directors, and administrative staff.

Public Affairs includes the control of official internal and external communications, events coordination and the administration of the education program.

Internal Audit includes the resources to conduct audits and compliance reviews of project activities and data as directed. These resources also interface with external agencies and regulators in response to inquiries, investigations and reviews.

Affirmative Action includes the resources to ensure that affirmative action goals are achieved throughout the business activities of the project.

1.7.1.1 Project Directorate & Administration

This element covers the support of the personnel dedicated to project direction, administration and oversight, including management and supervision of in-house staff and direction of consulting contracts. An additional allocation will cover user fees for office support and consumables, computing support, telecommunications support, financial and personnel services as required.

1.7.2 Project Administration

This element covers project planning and controls, project business services, and the fee paid to the Management and Operating contractor.

1.7.2.1 Project Planning & Controls

This element covers the administrative aspects of the project management services provided to DOE for planning, organizing, controlling, and reporting on the status of the

project. It includes developing and maintaining the project management plan, configuration management plan, managing project resources, establishing and implementing management systems including performance measurement systems, and approving and implementing changes to project baselines.

1.7.2.2 Project Business Services

Project business services include legal and risk management services, financial services, procurement services, human resources services, desktop and administrative computing services, communications services and facilities services.

Legal and risk management services include the resources to coordinate legal services in the areas of personnel issues, contracting issues, technology transfer, and union relations, and to manage risk and obtain coverage/provide self-insurance for property loss, liability, and workers compensation.

Financial Services include the management and processing of payments to vendors and employees, management of the letter of credit and banking relationships, maintenance of the general ledger and property accounting databases, reporting of financial activities to internal customers and DOE, management of fiscal year budgeting, control of funds and coordination of the annual budget submission to DOE.

Procurement Services include the activities of purchasing, shipping and receiving, maintenance of inventories, reporting of procurement activities to internal customers and DOE, and subcontracting activities such as negotiation, oversight, cost analysis and compliance.

Human Resources Services include the activities of recruiting resources, compensation management, negotiation and administration of benefits programs, and maintenance of personnel data and records, reporting of personnel activities to internal customers and DOE, and providing services for travel, relocation, housing and international issues.

Computing Services include the resources to provide hardware and software support for desktop and administrative computing systems.

Communications Services include site-wide telecommunications services such as voicemail, paging, faxing, videoconferencing, and wireless (radio) communications, as well as dedicated, external communications links to other sites.

Facilities Services cover the activities required to maintain the project site in an acceptable manner for occupancy such as maintenance and janitorial services, site security, property control, mail service, reprographics services, records management, cafeteria service, utilities costs, maintenance of site vehicles, and transportation between the Laboratory and remote sites.

This element covers the support of the personnel working on the above project business services tasks, including management supervision, office support and consumables,

computing support, telecommunications support, financial and personnel services as required.

1.7.2.3 Management & Operating Contract Fee

This element covers the fee paid to the prime contractor from contract funds for the management and operation of the project.

1.7.3 Project ES&H

This element covers ES&H activities of the construction project, including environmental protection and restoration, waste management, personal safety and health, medical and wellness services and training, fire protection, and emergency services.

This element covers coordination and preparation of the Preliminary and Final Safety Analyses.

1.7.4 Accelerator Physics Support

This element covers accelerator physics support during execution of the project for evaluation of requirements and trade-offs. The accelerator physics group works with the systems engineering teams to ensure that the design and construction will support achievement of the physics goals of the project.

1.7.4.1 Accelerator Physics Support

The element covers the work and supervision of accelerator physics support.

1.7.5 Accelerator Pre-operations

Accelerator pre-operations include operations planning, development of operating procedures and training of the operations group, conduct of an Accelerator Readiness Review needed to certify readiness of the equipment, people and procedures for accelerator operation, and the conduct of pre-operational acceptance tests.

1.7.5.1 Accelerator Pre-operations

This element covers Accelerator Pre-operations and the support of the personnel working on Accelerator Pre-operations tasks, including management supervision, office support and consumables, computing support, telecommunications support, financial and personnel services as required.

1.8 EXPERIMENTAL DETECTORS

Management, administration, design, engineering, construction and installation of experimental detectors for performing high-energy physics research at the NLC.

- 1.8.1 Experimental Detectors
- 1.8.1.1 Experimental Detectors

Definitions of Activity Attributes (Work in Progress)

Activities shall be defined with sufficient resolution so that each may be coded (tagged) uniquely by one and only one attribute from each of the following sets.

(1) To facilitate requesting funds on an annual basis, the funding for each activity shall be identified as either (a) construction funds or (b) operating (R&D and equipment) funds.

Construction funds shall be used for all engineering design costs (after conceptual design), facility construction costs, and other costs specifically related to those construction efforts. These are typically capitalized. Construction funding will include, but not be limited to: project and construction management during Titles I, II, and III; design and construction management and reporting during design and construction; contingency and economic escalation for construction-funded elements; ED&I during Titles I, II, and III; contractor support directly related to design and construction; and equipment and refurbishing equipment.

Operating funds shall be used for all other costs related to the project that are not funded by construction funds, such as supporting research and development, pre-authorization costs prior to start of Title-I design, plant support costs during construction, activation, and startup. Operating funding will include, but not be limited to,: research and development; NEPA documentation; project data sheets (PDSs); CDR; short form project data sheets; surveying for siting; conceptual design plan; and evaluation of RCRA/EPA/State permit requiements.

(2) To facilitate comparisons with benchmarks from other projects, the nature of each activity shall be identified as either (a) EDI&A or (b) B&H.

EDI&A activities involve tasks of engineering, design, inspection or administration and may utilize labor, material and service resources. (See Resource Definitions, below.)

B&H activities involve tasks of 'building and handling' and may utilize labor, material and service resources. (See Resource Definitions, below.)

(3) To facilitate comparisons with benchmarks from other projects, the nature of each activity shall be identified as contributing to the work of either:

(a) Conceptual Design activities. Conceptual design activities commence after CD1, and conclude with completion of the Conceptual Design Report and Review, just prior to CD2. Conceptual design includes systems analysis of requirements, interfaces, manufacturability, reliability, maintainability, cost and schedule, etc.

(b) R&D in support of construction. R&D activities, which may be scheduled at any time during the project, are limited to demonstration of technical feasibility and engineering development of pre-production components, equipment, subsystems and systems. R&D does not include the development of working prototypes or components that will be installed in the NLC.

(c) Design Activities. Design activities include engineering design for systems, subsystems and components. Engineering design shall include appropriate systems engineering (such as requirements analyses, systems integration planning, design for manufacturability, reliability, availability, maintainability, etc.) and documentation including procurement plans and cost and schedule estimates. Design also includes the development of working prototypes that will be installed in the NLC.

The design activities covered by this element occur only during the formal design phase of the project, between CD2 and CD3. Two significant parts of the design phase include: "Preliminary Design" activities (Title I EDI&A), and "Definitive Design" activities (Title I EDI&A). The ultimate deliverable of the design phase is the Definitive Design and acquisition plan for all systems, subsystems and components of the parent element, fully documented and validated by a Definitive Design Review (a prerequisite for CD3).

(d) Sustaining Engineering activities. Sustaining Engineering activities include the postdesign phase (after CD3) engineering, inspection, construction management, systems integration, and pre-operational maintenance activities (Title III EDI&A) for all systems, subsystems and components of the parent element. Sustaining Engineering includes both office support and field services.

(e) Acquisition activities. Acquisition activities include the purchasing (by subcontract) or manufacturing in-house (using direct labor and materials) of systems, subsystems or components. These activities occur during the construction phase, starting after CD3.

(f) Installation, Integration, and Testing activities. Installation, Integration and Testing activities include the planning and carrying out of the installation, integration and testing of technical systems, subsystems and components of the parent element. These activities span the period from CD1 to CD4.

(4) To facilitate reporting of EDI&A costs, each activity shall be identified as either:

- (a) Title I EDI&A,
- (b) Title II EDI&A,
- (c) Title III EDI&A,
- (d) EDI&A of undefined Title,
- (e) Not EDI&A.

(5) To facilitate scheduling by milestones, each activity shall be identified with one of the following major phases of the project:

- (a) Preconceptual phase (Prior to CD1)
- (b) Conceptual Design phase (CD1-CD2),
- (c) Formal Design phase (CD2-CD3),
- (d) Construction phase (CD3-CD4).

(6) To facilitate analysis of the budgets and schedules of functional teams (which are not directly represented by the WBS), each activity shall be identified with one and only one of the following functional team designations: (List under development!)

- (a) System Engineering Teams. (These include the separate teams dedicated to Conventional Facilities, Injector Systems, Main Linac Systems, Beam Delivery Systems, Control Systems, Technical Services, and Project Management. They are distinguished by the branch of the WBS to which their activities are assigned.
- (b) Vacuum Team (Chambers and controls)
- (c) Magnets Team (Electromagnets and Permanent Magnets)
- (d) Power Conversion Team
- (e) Kickers Team
- (f) Supports and Movers Team
- (g) Cable Group
- (h) RF controls Team
- (i) Modulators Team
- (j) RF Sources Team
- (k) BPMs Team (hardware and controls)
- (I) Collimators, Dumps and Optical Anchors Team
- (m) Special Instrumentation Team (hardware and controls)
- (n) Optics and Lasers Team (hardware and controls)
- (o) Manufacturing Support Team
- (p) Operations Group
- (q) Controls Hardware Team
- (r) Controls Software Team

Definitions of Resource Attributes (Work in Progress)

Labor resources hired and managed by the project (not by service contract) shall be represented as hours.

Labor resources may be assigned both to EDI&A activities and to B&H activities. (See definitions of activity attributes, EDI&A and B&H.)

Materials and services (M&S) purchased by the project shall be represented as FY2000 dollars.

M&S resources may be assigned both to EDI&A activities and to B&H activities. (See definitions of activity attributes, EDI&A and B&H.)