Definitions of WBS Elements

1  NLC PROJECT

This is a Project Summary WBS for the NLC Construction Project during the time period from authorization (CD1) to project completion (CD4). The Project Summary WBS summarizes, for project management, a set of more detailed technical models that reside in the hands of the Level-2 system managers. Schedulable activities will be assigned to each terminal WBS element. Estimated costs enter the WBS via resources assigned to the activities.

The Project Summary WBS, the associated schedule of resource-loaded activities, this dictionary, and additional source documents all are part of a managed configuration of documentation that captures the state of the project plan at the time of the most recent controlled revision.

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.

1.1.1 Conventional Facilities Systems Engineering and 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 and Administration

See element 1.1.1.

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1 The additional source documents eventually will include (but not be limited to) the Project Management Plan, the Systems Engineering Management Plan, the Configuration Management Plan, cost estimating guidelines, and separate requirements documents for each WBS element.
1.1.2 Site Development

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 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 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 beamline 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 beamlines and accelerators. These costs are included in the WBS elements for the machine.

1.1.2.3 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 beamline housings in the WBS 113 series.

1.1.2.5 Electrical Distribution System

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 beamline and one approximately 13 km from the main campus along the positron beamline. 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 Fuel Distribution System
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 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, beamline tunnel or other facility that uses cooling water. Vibration isolation will be installed to minimize transmission of vibrations.

1.1.2.8 Communications Systems

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 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 beamline housing; and an adjacent space for electronic equipment racks. Vertical or horizontal penetrations will be provided between the klystron galleries and the beamline 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 beamline 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 beamline 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 beamline 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 beamline 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 beamline 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 and 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, beamline 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 beamlines.

1.1.3.3 Housings - Pre-Linacs

WBS 1.1.3.3 includes the positron and electron beamline 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 Linac

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

1.1.3.5 Housings - Collimation Sections

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 beamline housings for the end of linac diagnostics, the collimation sections and the IP switches.

1.1.3.6 Housings Interaction Region Transport Line One

WBS 1.1.3.6 includes the positron and electron beamlines 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 - Interaction Region Transport Line Two

WBS 1.1.3.8 includes the positron and electron beamlines 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. The campus facilities include the following:
* Central laboratory buildings, which contain laboratory, office and auditorium spaces;
* Shops and assembly buildings to support construction of equipment assemblies for the accelerator and the detectors;
One of the objectives in selecting a site for the NLC will be to locate sufficiently close to an
eexisting high energy physics laboratory that it would be possible to receive partial support,
thereby reducing the need for staff and facilities at the new NLC site. 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 therefore need to be refined following site selection, when the
degree of support that will be provided by another laboratory and by the community 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 Central Laboratory building

The central laboratory building will have a gross area of about 367,000 square feet and will
contain office spaces, laboratories for the development and testing of accelerator
components, computer facilities, conference rooms, a 1000-seat conference hall and a
cafeteria.

1.1.4.2 Heavy Assembly Buildings

There will be six heavy assembly buildings, four with 20,000 SF each and two with 43,000
SF each. The total floor area of the six buildings will be approximately 167,000 SF.

1.1.4.3 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 gun test lab, for
research, development and testing of the electron guns used in the sources of the
Injectors; 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. The total square footage of the three buildings is approximately
30,100 SF.

1.1.4.4 Support Buildings

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

1.1.4.5 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. The total area is about 30,000 SF.

1.2 INJECTOR SYSTEMS

The injectors include the electron and positron source areas, damping ring areas, and low-energy 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, definitive design, sustaining engineering, acquisition, installation, alignment, integration and testing for all technical systems, subsystems and components associated with the injectors.

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, and the rest of the project. It also includes support of the personnel working on Injector Systems tasks, including management supervision, office support and consumables, computing support, telecommunications support, financial and personnel services as required.

1.2.2 Sources Areas

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

1.2.2.1 Sources Areas Conceptual Design

This element collects the conceptual design activities for the parent element, commencing after CD1, and concluding 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.

1.2.2.2 Sources Areas R&D
This element collects the R&D activities in support of construction of the parent element at any time during the project, limited to demonstration of technical feasibility and engineering development of preproduction components, equipment, subsystems and systems. R&D 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 of 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 engineering support infrastructure is provided by Element 1.6.1.

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 II 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).

1.2.2.4 Sources Areas Sustaining Engineering

This element collects the post-design 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.

1.2.2.5 Sources Areas Acquisition

This element collects the acquisition activities for the technical systems, subsystems and components of the parent element such as purchasing (by subcontract) or manufacturing in-house (using direct labor and materials). These activities occur during the construction phase, starting after CD3.

The engineering and manufacturing support infrastructure is provided by 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 technical systems, subsystems and components of the parent element. Activities span the period from CD1 to CD4.

The installation support infrastructure is covered by Element 1.6.
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 systems engineering, conceptual design, R&D, definitive design, sustaining engineering, acquisition, installation, alignment, integration and testing for all technical systems, subsystems and components associated with the Damping Ring Areas.

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 Injector Linac Areas

The Injector Linac Areas include the electron booster linac, the drive linac (that accelerates a beam of electrons aimed at the positron target), the positron booster linac, the electron and positron “pre-linacs” (that accelerate the beams for injection into the Main Linac), several bunch and energy compressor linacs, and several arcs, chicanes and intermediate beam dumps. This WBS element covers systems engineering, conceptual design, R&D, definitive design, sustaining engineering, acquisition, installation, alignment, integration and testing for all technical systems, subsystems and components associated with the Injector Linac Areas.

1.2.4.1 Injector Linac Areas Conceptual Design
1.2.4.2 Injector Linac Areas R&D

Same definition as element 1.2.2.2.

1.2.4.3 Injector Linac Areas Design

Same definition as element 1.2.2.3.

1.2.4.4 Injector Linac Areas Sustaining Engineering

Same definition as element 1.2.2.4.

1.2.4.5 Injector Linac Areas Acquisition

Same definition as element 1.2.2.5.

1.2.4.6 Injector 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, definitive design, sustaining engineering, acquisition, installation, alignment, integration and testing for all technical systems, subsystems and components associated with the Main Linac Systems.

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 Management 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, and the rest of the project. It also includes support of the personnel working on Main Linac Systems tasks, including management supervision, 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, 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.

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, definitive design, sustaining engineering, and acquisition for all technical systems, subsystems and components associated with the Main Linac RF Systems.

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

1.3.4.6 Main Linac Installation, Integration and Testing

See 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

See element 1.3.5.

1.4 BEAM DELIVERY SYSTEMS

The Beam Delivery Systems transport the high-energy beams, accelerated by the Main Linacs, to collisions in the experimental detector(s) and dispose of them in beam dumps. This element covers systems engineering, conceptual design, R&D, definitive design, sustaining engineering, acquisition, installation, alignment, integration and testing for all technical systems, subsystems and components associated with the Beam Delivery Systems.

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 Management 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, and the rest of the project. It also includes support of the personnel working on Beam Delivery Systems tasks, including management supervision, office support and consumables, computing support, telecommunications support, financial and personnel services as required.
1.4.2 Beam Delivery Lines and Interaction Regions

This element covers systems engineering, conceptual design, R&D, definitive design, sustaining engineering, acquisition, installation, alignment, integration and testing for all technical systems, subsystems and components associated with the Beam Delivery Systems in the beam lines and interaction regions.

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.

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 Management 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, and the rest of the project. It also includes support of the personnel working on Control Systems tasks, including management supervision, 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 Embedded RCVR

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 Systems Engineering management and oversight for the entire project, engineering support services, manufacturing support services, and installation coordination and support services.

1.6.1 Systems Engineering
This element covers Systems Engineering management and oversight for the entire project.

1.6.1.1 Systems Engineering Management and Administration

Chief Systems Engineer and assistants.  
Configuration Manager and CM system.  
Administration and office support.  
Interface control.  
Integration planning.

1.6.1.2 Risk Management

This element covers analysis and management of risks threatening cost, schedule, or technical performance.

1.6.1.3 Quality Assurance

1.6.1.4 Integrated Safety Management

1.6.2 Engineering Support Services

This element covers centralized engineering design services and tool support for the entire project.

1.6.2.1 Engineering Support Management and Administration

1.6.2.2 Design Services

1.6.2.3 Engineering Tools

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 Management and Administration

1.6.3.2 Clean Assembly Facility

1.6.3.3 Cleaning and Plating Facility

1.6.3.4 Laser Assembly Facility

1.6.3.5 Mechanical Assembly Facility
1.6.3.? RF Assembly and Test Facility

1.6.3.? Quality Assurance Facility

1.6.3.? Machining Facility

1.6.3.? Vacuum Processing Facility

1.6.3.? Magnet Measurement Facility

1.6.3.? Equipment Maintenance Facility

1.6.3.? Cable Assembly Facility

1.6.3.? Electronics Rack Assembly Facility

The Electronics Rack Assembly Facility will support for the design, documentation, procurement, assembly, loading, and installation of equipment racks for the various technical systems. This facility serves numerous physical areas and accelerator technical systems. For baseline cost estimates a typical double width rack has been used to arrive at a generic cost unit that can be applied to a total rack count, either on an area basis, or smaller unit, to account for the above described costs. A count of 3000 double width rack units for the NLC project has been estimated at this time.

1.6.3.? Preinstallation Assembly Facility

1.6.3.? Materials Storage and Handling

This element covers warehouse facilities and materials handling and tracking systems.

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 from the receiving dock, or warehouse, into position for installation.

1.6.4.1 Management and Administration

This element covers planning, documentation, and infrastructure development for installation, including liaison to the centralized Project Management and 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 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.

1.6.4.3 Installation Conveyances

This element covers the design, acquisition, operation and maintenance of a system of conveyances that deliver each piece of material from a storage or receiving facility to its point of installation.

1.7 PROJECT MANAGEMENT AND PRE-OPERATIONS

1.7.1 Project Management

Project management covers those services provided to the DOE on a specific project, beginning at the start of design and continuing through the completion of construction, for planning, organizing, directing, controlling, and reporting on the status of the project. It includes developing and maintaining the project management plan, quality assurance plan, configuration management plan, managing project resources, establishing and implementing management systems including performance measurement systems, and approving and implementing changes to project baselines.

1.7.1.1 Management & Administration

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

1.7.1.2 Project Planning & Controls

This element covers the activities of planning, controlling, and reporting on the status of the project.

1.7.1.3 ES&H

Environmental protection and restoration, waste management, personal safety and health, fire and emergency protection systems.

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

1.7.2 Project Administration
Project administration includes those activities that are required for the overall direction and oversight of the business aspect of the project.

1.7.2.1 Management & Administration

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

1.7.2.2 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.

1.7.2.3 Public Affairs

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

1.7.2.4 Internal Audit and Compliance

This element 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.

1.7.2.5 Affirmative Action

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

1.7.3 Project Business Services

Project business services include

1.7.3.1 Project Business Services Management & Administration

This element covers the support of the personnel working on Project Business Services tasks, including management supervision, office support and consumables, computing support, telecommunications support, financial and personnel services as required.

1.7.3.2 Legal and Risk Management Services

This element includes the resources to coordinate legal services in the areas of personnel issues, contracting issues, technology transfer, and union relations. The activities to manage risk and obtain coverage/provide self-insurance for property loss, liability, and workers compensation are also included here.
1.7.3.3 Financial Services

This element includes the management and processing of payments to vendors and employees, management of the letter of credit and banking relationships, and maintenance of the general ledger and property accounting databases. Reporting of financial activities to internal customers and DOE is included here. This element also includes the activities to manage fiscal year budgeting, funds control and coordination of the annual budget submission to DOE.

1.7.3.4 Procurement Services

This element includes the activities of purchasing, shipping and receiving, maintenance of inventories. Reporting of procurement activities to internal customers and DOE is included here. This element also includes subcontracting activities such as negotiation, oversight, cost analysis and compliance.

1.7.3.5 Human Resources Services

This element includes the activities of recruiting resources, compensation management, negotiation and administration of benefits programs, maintenance of personnel data and records, wellness/medical services and training. Reporting of personnel activities to internal customers and DOE is included here. This element also includes providing services for travel, relocation, housing and international issues.

1.7.3.6 Computing Services

This element includes the resources to provide hardware and software support for desktop and administrative computing systems.

1.7.3.7 Facilities Services

This element covers 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, cafeteria service, utilities costs, and the maintenance of site vehicles. Initial building finish-out, ongoing improvements and interim space lease costs are included here. This element covers the acquisition and support costs to provide occupied spaces with furniture, copiers, and other equipment as required.

1.7.4 Accelerator Physics

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 beam-line area design teams and technical systems engineering teams to ensure that design and construction will support achievement of the physics goals of the project.

1.7.4.1 Accelerator Physics Management and Administration
1.7.4.2 Accelerator Physics Design

1.7.5 Accelerator Pre-operations

Accelerator pre-operations include operations planning, development and training of the operations group, conduct of an Accelerator Readiness Review, and Commissioning. This element covers 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.

1.7.5.1 Accelerator Pre-operations Management and Administration

This element covers 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.

1.7.5.2 Accelerator Operations Planning

This element covers planning, process and procedure development, training and other preparations for accelerator operations.

1.7.5.3 Accelerator Readiness Review

This element covers preparations for and conduct of the Accelerator Readiness Review(s) needed to certify readiness of the equipment, people and procedures for accelerator operation, prior to the start of full-systems commissioning.

1.7.5.4 Accelerator Commissioning

This element covers the pre-operational commissioning of all accelerator areas by a centralized operations team.

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