

7	WBS AND MILESTONE DICTIONARY.....	7-1
7.1	CONSTRUCTION WBS DICTIONARY AT LEVELS 2 AND 3	7-1
7.2	R&D AND OPERATING WBS DICTIONARY AT LEVELS 2 AND 3	7-10
7.3	MILESTONE DICTIONARY.....	7-18

7 WBS and Milestone Dictionary

The NOvA Work Breakdown Structure (WBS) defines the total set of items to be developed and produced in order to accomplish the scientific goals set out in Chapter 3. The breakdown at Level 2 is shown in Table 7.1.

WBS elements at Level 2		Task Name
R&D	Construction	
1.0	2.0	Accelerator and NuMI Upgrades
1.1	2.1	Site and Building
1.2	2.2	Liquid Scintillator
1.3	2.3	Wavelength Shifting Fiber
1.4	2.4	PVC Extrusions
1.5	2.5	PVC Modules
1.6	2.6	Electronics Production
1.7	2.7	Data Acquisition Systems
1.8	2.8	Near Detector Assembly
	2.9	Far Detector Assembly
1.9	2.10	Project Management

Table 7.1 NOvA Level 2 WBS tasks. 1.x are the R&D tasks and 2.x are the construction project tasks.

7.1 Construction WBS Dictionary at Levels 2 and 3

This section defines the WBS tasks for the NOvA Construction Project through Level 3. WBS 2.X is for the design and construction of the NOvA Near and Far Detectors and the Far Detector Hall.

WBS 2.0 Accelerator and NuMI Upgrades

This Level 2 element includes the procurement, QA, construction and installation of components necessary for accelerator improvements in the Main Injector and Recycler and as well as for upgrades to the beamline and target hall at the NuMI facility.

- WBS 2.0.1 Recycler Upgrades
This summary task for the work to convert the Recycler Ring from an anti-proton storage ring to a proton pre-injector includes refurbishment of existing magnets, procurement and fabrication of new magnets, installation of injection and extraction lines, procurement, fabrication, and installation of a new 53 MHz RF system, and procurement, fabrication and installation of instrumentation upgrades.
- WBS 2.0.2 Main Injector Upgrades
This summary task covers the upgrades for the Main Injector. These include procurement and installation of equipment for upgrades to the existing vertical quad bus, communication infrastructure for two new service buildings and the procurement, fabrication, installation of two new RF stations as well as modifications to associated cooling systems.
- WBS 2.0.3 NuMI Upgrades
This summary task covers the procurement, fabrication and installation of equipment required for modification the NuMI Beamline to support 700kW operation for NOvA in the medium energy neutrino beam configuration. It includes the primary beam upgrades to support a shorter beam cycle time, upgrades to the cooling systems and electrical infrastructure to support the additional power needs. Also included are the medium energy target, baffle and carrier and an upgraded hadron monitor. Procurement, fabrication and installation of equipment in support of moving horn 2 and procurement, fabrication and assembly of the stripline, stripline block and chase temperature monitoring equipment are included.
- WBS 2.0.4 Project Management
This summary task details the management and administrative resources required by WBS 2.0. It includes administrative costs such as travel, computers, training and labor for reviews. It includes labor for the L2 manager, deputy, L3 and L4 managers, project engineers and an ESH professional.

WBS 2.1 Site and Building

This level 2 summary element covers the design and construction of the Site Preparation Package and the Far Detector Building

- WBS 2.1.1 Site Preparation Package
This WBS element contains the tasks necessary to build the access road, design and execute the site preparation work and perform wetlands mitigation in preparation for construction of the Far Detector Building.
- WBS 2.1.2 Far Detector Building
This summary task includes the design, construction and outfitting of the Far Detector Building in Northern Minnesota. The Far Detector

Building includes the detector enclosure, Assembly area and service building. Utilities and safety systems are also included.

WBS 2.1.3 Site and Building Security
This WBS element includes the design, procurement and installation of security systems for the Far Detector site and building.

WBS 2.1.4 Management
This WBS includes the tasks required to support and manage WBS 2.1 activities including quality assurance, value engineering, risk management, ES&H, monitoring of vendor performance and schedule, preparation of reports and related activities.

WBS 2.2 Liquid Scintillator

This level 2 summary element covers the procurement, storage and QA of the components required to make liquid scintillator. Blending, storage, QA and shipping of the liquid scintillator to the Near and Far Detectors are also included.

WBS 2.2.1 Mineral Oil
This WBS element provides for vendor selection, procurement, transport and QA of the mineral oil required for the liquid scintillator.

WBS 2.2.2 Pseudocumene
This WBS element provides for vendor selection, procurement, transport and QA of the pseudocumene required for the liquid scintillator.

WBS 2.2.3 Waveshifters and Stadis 425
This WBS element provides for vendor selection, procurement and QA of waveshifters for the liquid scintillator as well as for procurement of the anti-static agent Stadis 425.

WBS 2.2.4 Blending
This WBS element provides for selection of a vendor to blend the liquid scintillator. This task includes blending and QA of the fluor concentrate, blending of the fluor concentrate with the mineral oil and QA of the final scintillator blend.

WBS 2.2.5 Transport
This WBS element provides for truck transport of the blended liquid scintillator from the blending facility to the Near and Far Detector sites.

WBS 2.2.6 Management
This WBS element includes the tasks required to support and manage WBS 2.2 activities including quality assurance, value engineering, risk management, monitoring of vendor performance and schedule, preparation of reports and other related activities.

WBS 2.3 Wavelength Shifting Fiber

This level 2 summary element covers the procurement, QA, storage and shipping of wavelength shifting fiber.

- WBS 2.3.1 Procurement
This WBS element provides for vendor selection and procurement of WLS fiber as well as a QA, storage and shipping plan.
- WBS 2.3.2 Production
This WBS element provides for design and production of fiber QA testing equipment as well as the development of procedures, documentation and reporting requirements. Delivery of fiber spools to the module factory on a schedule consistent with the factory schedule and available storage must also be organized and managed.
- WBS 2.3.3 Management
This WBS element includes the tasks required to support and manage WBS 2.3 activities including quality assurance, value engineering, risk management, monitoring of vendor performance and schedule, preparation of reports and other related activities.

WBS 2.4 PVC Extrusions

This level 2 summary element covers vendor selection, procurement and QA of the custom PVC resin as well as the selection of a vendor to make the extrusions. Design and procurement of extrusion dies is included as well as pre-production runs to validate performance followed by full-scale extrusion production. QA and shipment of the PVC extrusions to the module factory is also included.

- WBS 2.4.1 Procurement
This WBS element includes developing a list of vendors capable of producing the NOvA PVC compound and extruders capable of producing the NOvA profiles. Preparation of bid packages, evaluation of vendor proposals and selection of vendors is included.
- WBS 2.4.2 Extrusion Pre-Production
This WBS element includes the fabrication of dies, tooling and other hardware needed for the pre-production and production of extrusions. Pre-production extrusions will be evaluated for adherence to mechanical tolerance, mechanical strength and reflectivity. Quality assurance methods for use in production as well as handling procedures will be finalized.
- WBS 2.4.3 Extrusion Production
This WBS element provides for production of the extrusions as well as supervision and quality assurance monitoring of PVC extrusion production.

WBS 2.4.4 Production Quality Assurance and Extrusion Evaluation
This WBS element provides for the procurement and setup of hardware for performing QA on the PVC extrusions as well as the necessary manpower.

WBS 2.4.5 Shipping & Handling
This WBS element provides for the development of a shipping and handling plan for delivering extrusions to the module factory, for supervising trucking schedules and for managing the equipment necessary for shipping and handling.

WBS 2.4.6 Management
This WBS element includes the tasks required to support and manage WBS 2.4 activities including quality assurance, value engineering, risk management, monitoring of vendor performance and schedule, preparation of reports and other related activities.

WBS 2.5 PVC Modules

This level 2 summary element provides for assembly and QA of the PVC modules for both the Near and Far Detectors, design and construction of the machines required for module assembly, acquisition and setup of the factory space and shipping of the completed and tested modules to their respective detector sites.

WBS 2.5.1 End Seals
This WBS element includes the production of the fiber manifolds that cover and seal the readout end of a PVC module and route the WLS fibers to the photodetector interface, and the production of the bottom plates that seal the other end of the PVC modules.

WBS 2.5.2 Optical Connector Production
This WBS element includes the final design, procurement and QA of the hardware necessary to connect the WLS fibers from the PVC modules to the APD modules.

WBS 2.5.3 Module Production
This WBS element covers the set up and operation of the module factory where sets of 16-cell PVC extrusions are glued into 32-cell objects, WLS fibers are inserted into each cell, the end seals are glued to the ends of the extrusions and the WLS fibers are potted into the optical connector. QA of the completed modules as well as the procurement and construction of the various machines necessary to assemble and test the modules is also included along with transport of the completed modules to the Near and Far Detector sites.

WBS 2.5.4 Management

This WBS element includes the tasks required to support and manage WBS 2.5 activities including quality assurance, value engineering, risk management, monitoring of factory performance and schedule, preparation of reports and other related activities.

WBS 2.6 Electronics Production

This level 2 summary element includes procurement of the Avalanche Photo Diode (APD) optical sensors, the thermo-electric (TE) coolers for cooling the APDs, the custom ASIC that amplifies and multiplexes the APD signals, the ADC that digitizes the signals and the FPGAs that zero suppress and time-stamps the data. The low-voltage system for the TE coolers and the front-end electronics, the high voltage system for the APDs and a cooling system to remove the heat from the TE coolers are included as well as system design, board layout and assembly and component testing.

WBS 2.6.1 APD Module Production

This WBS element includes procurement and QA of the APD chips, the APD carrier boards, the TE coolers and the APD housing hardware. This task includes managing the flow of components for assembly and development and execution of the QA plan.

WBS 2.6.2 Readout-Front-End Board (FEB)

This WBS element provides for delivery of the specified system to receive signals from the APD modules, digitize them and deliver them to the Data Acquisition (DAQ) system. This task includes managing the flow of components for assembly and development and execution of the QA plan.

WBS 2.6.3 Readout Infrastructure

This WBS element includes design, production and installation of the infrastructure required to deliver power and cooling to operate the FEBs and APDs.

WBS 2.6.4 Management

This WBS element includes the tasks required to support and manage WBS 2.6 activities including quality assurance, value engineering, risk management, monitoring of performance and schedule, preparation of reports and other related activities.

WBS 2.7 Data Acquisition System

This level 2 summary element includes the hardware and software to record the data to archival storage and to control and monitor both the Near and Far Detectors. It includes the fiber, cable, switches and memory necessary to move and buffer the data, a PC farm for online filtering, local disk storage, a system for moving data to permanent storage at Fermilab, software and testing.

- WBS 2.7.1 DAQ Software
This WBS element includes production and testing of software to run on buffering/triggering hardware for archival of data within selected time frames. Databases are also included in this WBS element.
- WBS 2.7.2 DAQ Hardware
This WBS element includes the design, QA and installation of the hardware for receiving signals from FEB, buffering and archival, and delivery of clock/timing signals.
- WBS 2.7.3 Integration
This WBS element includes the integration testing of DAQ and trigger electronics hardware and software.
- WBS 2.7.4 Detector Control System
This WBS element includes the controls required to receive and archive monitoring data as needed.
- WBS 2.7.5 Management
This WBS element includes the tasks required to support and manage WBS 2.7 activities including quality assurance, value engineering, risk management, monitoring of performance and schedule, preparation of reports and other related activities.

WBS 2.8 Near Detector Assembly

This WBS element provides for site preparation of the region to contain the Near Detector, mechanical assembly and installation of the detector itself, assembly and utilization of a liquid scintillator filling system extending from the MINOS service building to underground, and oversight of the outfitting of the detector. The site preparation consists of tasks necessary to reposition MINOS cabling and infrastructure, and to construct a new cavern at the appropriate off axis angle.

- WBS 2.8.1 Near Detector Site Preparation
Complete the engineering design, procurement, fabrication and installation of the utilities and infrastructure required to install and operate the Near Detector in its underground tunnel location. These systems include excavation, lighting, HVAC, electrical power, fire protection, chilled water and liquid scintillator containment. This task covers the technical and ES&H reviews and approvals of equipment and assembly procedures.
- WBS 2.8.2 Mechanical Construction and Installation
Complete the engineering design, procurement and fabrication of the Near Detector muon steel segment, the detector support structure and the systems for moving the detector subassemblies underground and to different positions along the MINOS access tunnel. This task includes

any shipping and moving costs and the final optimization, review and approval of equipment and assembly procedures.

WBS 2.8.3 Liquid Scintillator Filling Equipment

Complete the engineering design, procurement and fabrication of the Near Detector liquid scintillator supply system, the filling machine and the plumbing that connects these together and to the detector modules. Secondary containment of the liquid scintillator is included in this task as well as any shipping and moving costs and the final optimization, review and approval of equipment and assembly procedures.

WBS 2.8.4 Installation Coordination

This WBS element includes installing readout electronics, cabling, plumbing, filling with liquid scintillator, final component QA tests, detector alignment, the implementation of safety systems, the review and approval of equipment and installation procedures, and the documentation and initial commissioning of the assembled detector and its moving system.

WBS 2.8.5 Management

This WBS element includes the tasks required to support and manage WBS 2.8 activities including quality assurance, value engineering, risk management, schedule monitoring, preparation of reports and other related activities.

WBS 2.9 Far Detector Assembly

This task provides for the engineering design of the mechanical systems and tooling needed to install the NOvA Far Detector. Fabrication of the necessary tooling, installation and commissioning of the detector in the detector building in northern Minnesota is also included. This task requires close coordination with the WBS 2.1 (far site and buildings), WBS 2.2 (scintillator), WBS 2.5 (PVC modules), and WBS 2.6/2.7 (electronics and DAQ).

WBS 2.9.1 Mechanical Systems

This WBS element includes the engineering design, procurement and fabrication of the Far Detector support structure and machines for moving materials and equipment into and within the detector building. This task includes any shipping and moving costs and the final optimization, review and approval of associated equipment and assembly procedures.

WBS 2.9.2 Detector Infrastructure

This WBS element includes the infrastructure necessary to support detector construction. This includes installation of the electrical infrastructure necessary for the detector assembly and scintillator filling equipment and the design and fabrication of the North and South bookends

This WBS element includes the engineering design, procurement and fabrication of the block raiser, the 31-plane block assembly fixtures, the

adhesive dispensing system and the detector alignment systems. This task includes any shipping and moving costs and the final optimization, review and approval of associated equipment and assembly procedures.

WBS 2.9.3 Liquid Scintillator Filling Equipment

This WBS element includes the engineering design, procurement and fabrication of the Far Detector liquid scintillator transfer and filling equipment, the associated distribution controls, the plumbing that connects the transfer equipment to the filling machines and detector modules and the vapor recovery system. This task includes any shipping and moving costs and the final optimization, review and approval of equipment and assembly procedures.

WBS 2.9.4 Block Assembly and Installation

This WBS element includes the design and construction of the block pivoter, procurement and installation of the adhesive dispenser, design and procurement of the block pallets that form the base of each block, procurement of the adhesive required for block assembly and the scintillator expansion tanks required prior to filling the assembled blocks with liquid scintillator. This task also includes the assembly and erection of blocks, installation of readout electronics, cabling and plumbing, filling the blocks with liquid scintillator, final component QA tests, detector alignment, the implementation of safety systems, the review and approval of equipment and installation procedures, and the documentation and initial commissioning of the assembled detector.

WBS 2.9.5 Management

This WBS element includes the tasks required to support and manage WBS 2.9 activities including quality assurance, value engineering, risk management, schedule monitoring, preparation of reports and other related activities.

WBS 2.10 Project Management

This Level 2 summary element consists of reviews, reports, site visits, local supervision, running technical board meetings, standards preparation, tracking and analysis, schedule preparation tracking and analysis and change control. It also includes procurement of relevant software and computers, the cost of running the project office and the salaries of non-scientists working on the project. WBS 2.10 is broken down into L3 subsystems corresponding to fiscal years.

WBS 2.10.2 FY08 Project Management

WBS 2.10.3 FY09 Project Management

WBS 2.10.4 FY10 Project Management

WBS 2.10.5 FY11 Project Management

WBS 2.10.6 FY12 Project Management

WBS 2.10.7 FY13 Project Management

7.2 *R&D and Operating WBS Dictionary at Levels 2 and 3*

This section defines the WBS tasks for the NOvA R&D Project through Level 3. WBS 1.X is for the research and development of the NOvA Near and Far Detectors and the Far Detector Hall.

WBS 1.0 Accelerator and NuMI Planning, Engineering and Design

WBS 1.0.1 Recycler Upgrades

This summary task for the work to convert the Recycler Ring from an anti-proton storage ring to a proton pre-injector includes planning for removing anti-proton specific devices in the Recycler, design of new injection and extraction lines, design of new injection, extraction, and abort kickers, design of a new 53 MHz RF system, and engineering to upgrade the instrumentation.

WBS 1.0.2 Main Injector Upgrades

This summary task covers the modifications to low-level RF systems and associated machine timing modifications. It also includes planning for and removal of existing magnets and cavities no longer required. It also covers engineering for upgrades to existing LCW and RF cooling systems. Also included is the engineering and design for two extra MI RF stations.

WBS 1.0.3 NuMI Upgrades

This summary task covers the design and planning for modifications to NuMI Beamline to support 700kW NOvA operation in the medium energy neutrino beam configuration. It includes the primary beam upgrades to support a shorter beam cycle time, upgrades to the cooling systems and electrical infrastructure to support the additional power needs. Also included are the planning, engineering and design for a medium energy target, baffle and carrier and an upgraded hadron monitor. Planning for the movement of horn 2 to the medium energy position and the design of the stripline to connect to it in the new position are included.

WBS 1.0.4 Beam Physics

This summary task is to evaluate the efficacy the ANU project, to perform preparative beam physics measurements, calculations, and

simulations of the eventual ANU operation, and to establish and maintain a method of extrapolation to estimate future ANU proton production.

- WBS 1.0.5 Management R&D Phase
This WBS details the management and administrative resources required for ANU R&D. It includes labor for the L2 manager, deputy manager, L3 and L4 managers, project engineers and an ES&H professional.

WBS 1.1 Site and Building

This Level 2 element covers the design, planning and value engineering for the far detector hall as well as the site evaluation and environmental assessment.

- WBS 1.1.1 Site Conditions Investigation
This WBS element includes the investigations required to provide a comprehensive understanding of the conditions at the far detector site. This is a necessary prerequisite for designing the far detector hall.
- WBS 1.1.2 Title 1 Preparation
This WBS element provides for preparation of Title 1 documents for the far detector hall.
- WBS 1.1.3 Site Logistics
This WBS element consists of an investigation of the site support activities that will be necessary during the construction phase of the project.
- WBS 1.1.4 Management R&D Phase
This WBS element includes the management required for planning, controlling and reporting efforts for WBS 1.1. This includes the identification and execution of value management task as well as appropriate external reviews.

WBS 1.2 Liquid Scintillator R&D

This level 2 summary element covers the development and documentation of the specifications for the liquid scintillator required for both the near and far detectors. This includes the studies, simulations and measurements required to define these requirements.

- WBS 1.2.1 Requirements
This WBS element provides for development of a document detailing the experimental requirements for the liquid scintillator.
- WBS 1.2.2 Scintillator Composition Studies
This WBS element provides for scintillator composition studies. These include studies of light yield, optimization of component concentrations, simulations and measurements of attenuation length.
- WBS 1.2.3 Accelerated Aging Studies

This WBS task provides for accelerated studies of aging that results from the interaction of scintillator with various components and materials used in the detector.

- WBS 1.2.4 Scintillator Production Method Studies
This WBS element provides for development of the plan for blending of liquid scintillator.
- WBS 1.2.5 Development of QC Methods
This WBS element includes the tasks required to develop methods, procedures and plans for reliable and accurate QC testing procedures for the individual liquid scintillator components and the blended liquid scintillator.
- WBS 1.2.6 Scintillator Transportation Studies
This WBS element includes the tasks required to develop methods, procedures and plans for delivering the liquid scintillator components to the blending site and for delivering the blended scintillator to the detector sites.
- WBS 1.2.7 Blending Investigations
This WBS element includes the tasks required to develop, assess, and verify the ability of vendors to produce and QC liquid scintillator to meet our specifications.
- WBS 1.2.8 Component Acquisition Investigations
This WBS element includes the tasks required to investigate the options available for acquiring the various components required to blend liquid scintillator.
- WBS 1.2.9 Integration Prototype Detector Scintillator Production
This WBS element includes the tasks necessary to blend liquid scintillator at Fermilab for the integration prototype near detector.
- WBS 1.2.10 Production Scintillator Specifications
This WBS element provides for development of the technical specifications documents for production quantities of liquid scintillator.
- WBS 1.2.11 Management R&D Phase
This WBS includes the tasks required to support and manage WBS 1.2 activities including subproject activities and management for the liquid scintillator R&D phase.

WBS 1.3 Wavelength Shifting Fiber R&D

This level 2 summary element covers the development and documentation of the requirements for procurement, QA, storage and shipping of the wavelength shifting fiber.

- WBS 1.3.1 Requirements

This WBS element provides for development of a document detailing the specifications for the wavelength shifting fiber.

- WBS 1.3.2 Vendor Investigations
This WBS element includes the tasks required to develop, assess, and verify the ability of vendors to produce and QC wavelength shifting fiber to meet our specifications.
- WBS 1.3.3 WLS Fiber Optimization Studies
This WBS task provides for studies of wavelength shifting fiber to optimize the performance for our specific application.
- WBS 1.3.4 Development of QA Methods
This WBS element provides for development of the methods and procedures for QA testing of the wavelength shifting fiber.
- WBS 1.3.5 Integration Prototype Detector Fiber Production
This WBS element provides for delivery and QA of fiber for the integration prototype near detector.
- WBS 1.3.6 Production WLS Fiber Specification
This WBS element includes the tasks required to produce the technical specification documents for procurement of production quantities of wavelength shifting fiber.
- WBS 1.3.7 Management R&D Phase
This WBS includes the tasks required to support and manage WBS 1.3 activities including subproject activities and management for the wavelength shifting fiber R&D phase.

WBS 1.4 PVC Extrusions R&D

This level 2 summary element includes studies of various PVC materials and their properties, production of prototype extrusions as well as the development and documentation of QA and shipping plans for the PVC extrusions.

- WBS 1.4.1 Physical Properties Determination and Test Method Development
This WBS element includes measuring the optical and mechanical properties of various PVC compounds and extrusions.
- WBS 1.4.2 Raw Materials
This WBS element includes the studies required to develop an appropriate custom PVC resin for prototype extrusion production.
- WBS 1.4.3 Extrusions
This WBS element identifies vendors capable of producing extrusions to meet the NOvA specifications and produces extrusions for the Integration Prototype Near Detector. The task will also develop methods for assuring the quality of extruded products.

- WBS 1.4.4 Shipping & Handling
This WBS element includes tasks to develop a shipping and handling plan for delivery of extrusions.
- WBS 1.4.5 Quality Assurance Hardware Modifications
This WBS element provides for the modification of prototype QA hardware to be used for QA of preproduction extrusions.
- WBS 1.4.6 Management R&D Phase
This WBS includes the tasks required to support and manage WBS 1.4 activities including subproject activities and management for the PVC extrusion R&D phase.

WBS 1.5 PVC Modules R&D

This level 2 summary element provides for development and documentation of the procedures for assembly of the PVC modules and the design of the fiber manifolds, end seals and the various machines and fixtures necessary for module construction. Development of QA and shipping plans is also included.

- WBS 1.5.1 Requirements
This WBS element provides for development of requirements documents for module assembly, manifolds and end seals. QA requirements for the completed modules are also included.
- WBS 1.5.2 End Seal R&D
This WBS element includes the design and development of the manifolds and end seals as well as specification of QA procedures.
- WBS 1.5.3 Photo Detector Interface R&D
This WBS element includes the design and development of the photodetector interface as well specification of QA procedures.
- WBS 1.5.4 Module Factory R&D
This WBS element includes the development of assembly methods for the PVC modules as well as the design of machines, tooling and moving fixtures.
- WBS 1.5.5 Quality Assurance and Quality Control Methods Development
This WBS task provides for the development of a QA plan for PVC module production. Construction of the required testing equipment is also included.
- WBS 1.5.6 Module Shipping and Storage R&D
This WBS element provides for the development of a plan for shipping and handling of extrusion modules between the module factory and the Detector sites and for managing the equipment necessary for shipping and handling.
- WBS 1.5.7 Integration Prototype Detector Modules

This WBS element provides for production of the PVC modules for the integration near detector prototype.

- WBS 1.5.8 Initial Production Module Specifications
This WBS element provides for the development of the initial production module specifications.
- WBS 1.5.9 Initial Factory Tooling Specifications
This WBS element provides for the development of the initial factory tooling specifications.
- WBS 1.5.10 Management R&D Phase
This WBS includes the tasks required to support and manage WBS 1.5 activities including subproject activities and management for the PVC module R&D phase.

WBS 1.6 Electronics R&D

This level 2 summary element includes the design, development and testing of the front end electronics and infrastructure.

- WBS 1.6.1 APD Modules
This WBS element includes development and procurement of prototype APD chips, APD carrier boards, TE coolers, optical connectors and the associated hardware that comprise the APD modules. Development of specifications for fiber alignment, power consumption, cooling and QA are also included. APD modules for the Integration Prototype Near Detector are included here.
- WBS 1.6.2 Front End Board
This WBS element includes design of the front-end boards as well as the development of testing and installation procedures. Front-end boards for the Integration Prototype Near Detector are included here.
- WBS 1.6.3 Power Distribution
This WBS element includes the design and specification of the low voltage, high voltage, cooling and power distribution for the NOvA electronics. Power distribution for the Integration Prototype Near Detector is included here.
- WBS 1.6.4 Management R&D Phase
This WBS element includes the tasks required to support and manage WBS 1.6 management activities for the Electronics subproject during R&D phase.
- WBS 1.6.5 Vertical Slice Tests
This WBS element provides for a small-scale test facility for evaluating various configurations of prototype PVC extrusions, liquid scintillator

and WLS fiber using cosmic ray muons, APDs and prototype versions of the front-end board.

WBS 1.7 DAQ System R&D

This level 2 summary element includes the development of specifications and design of the hardware and software necessary to acquire and record data to archival storage and to control and monitor both the Near and Far Detectors.

WBS 1.7.1 DAQ Software

This WBS element includes the development of specifications and the design of the DAQ software.

WBS 1.7.2 DAQ Hardware

This WBS element includes the development of specifications and the design of hardware for receiving signals from the FEBs, buffering and archival of data and distribution of clock/timing signals.

WBS 1.7.3 Integration

This WBS element includes the development of specifications and requirements for integration of the DAQ hardware and software.

WBS 1.7.4 Detector Control Systems

This WBS element includes the development of specifications and requirements for the detector control system.

WBS 1.7.5 Management R&D

This WBS element includes the tasks required to support and manage WBS 1.7 management activities for the DAQ System R&D phase.

WBS 1.7.5 Operate IPND

This WBS element accounts for the resources required to operate the IPND in the NuMI surface building.

WBS 1.8 Detector Assembly R&D

This level 2 summary includes R&D work to validate and optimize the mechanical designs and installation procedures for the NOvA Near and Far Detectors. This includes structural engineering calculations of the fully and partially assembled detectors, the mechanical design and prototyping of detector assembly mechanical systems and tooling, and the construction and testing of prototypes of both Near and Far Detectors.

WBS 1.8.1 Plane Assembly Adhesives R&D

This WBS element includes the tasks required to choose an adhesive that is suitable for bonding the extrusion modules together for the Far and Near detector.

WBS 1.8.2 Structural Design and Validation

This WBS element includes the tasks required to develop and optimize the structural design of the far detector.

- WBS 1.8.3 Liquid Scintillator Filling and Handling R&D
This WBS element includes the tasks required to develop techniques and semi-automatic equipment for filling the Integration Prototype as well as the Near and Far detectors.
- WBS 1.8.4 Near Detector Assembly R&D
This WBS element includes the tasks required to develop the procedures, equipment and assembly plan for the near detector. The task also includes the design of an assembly facility and associated procedures and equipment for assembling extrusion modules. Finally, this task will design the steel-plate muon-catcher segment of the near detector, along with associated support structures and assembly equipment.
- WBS 1.8.5 Integration Prototype Near Detector
This WBS element includes the tasks required to design, fabricate and install the Integration Prototype Near Detector.
- WBS 1.8.6 Far Detector Assembly Engineering
This WBS element includes the tasks required to specify and design the equipment needed to assemble and install the far detector.
- WBS 1.8.7 Far Detector Installation Procedures
This WBS element includes the tasks required to develop the far detector installation procedures, schedules and labor requirements.
- WBS 1.8.8 Far Detector Prototypes
This WBS element includes the tasks required to test and optimize the procedures and equipment designs developed in WBS 1.8. This task will lead to the final optimization of the designs for assembly tooling and materials handling equipment.
- WBS 1.8.9 Management R&D Phase
This WBS element includes the tasks required to support and manage WBS 1.8 activities for the Detector Assembly R&D phase.

WBS 1.9 Project Management R&D

This Level 2 summary element provides for internal project reviews, report preparation, site visits, local supervision, standards preparation, tracking and analysis, schedule preparation tracking and analysis and change control. It also includes procurement of relevant software and computers, the cost of running the project office and the salaries of non-scientists working on the project.

7.3 Milestone Dictionary

The following table contains the milestone definitions for all NOvA milestones from Level 0 through Level 5. The milestones are ordered by WBS number. In many cases the definition is self explanatory and in others more explanation is required. In all cases it should be apparent what constitutes completion of the milestone.

WBS	Milestone	Milestone Definition
1.0.1.1.6.1	Recycler Ring (RR); All 3 ADC Magnets Found	Location of 3 ADC magnets in the Recycler Ring have been identified and documented.
1.0.1.1.6.2	RR; Lattice Designs Complete	Recycler Ring beamline design lattices completed and documented. This includes the 3d drawings to check for interferences.
1.0.1.1.6.3	RR; 53 MHz RF Design Review Complete	53 MHz RF design review complete and the committee report has been transmitted to the L2 manager.
1.0.1.1.6.4	RR; Decision on Vacuum Window Removal Finalized	The beam abort line contains a vacuum window. The decision is whether to eliminate the window and have the beam abort line vacuum integrated with the circulating beam vacuum, or to leave it as a separate vacuum system with its own vacuum pumping and instrumentation. This Milestone is complete when the L3 and L4 managers finalize the decision.
1.0.1.1.6.5	RR; Beamline Modifications Design Review Complete	A design review of the proposed beamline modifications in the Recycler Ring is complete and the committee report has been submitted to the L2 manager.
1.0.1.1.6.6	RR; Mirror Magnet Design Finalized	PDD Mirror magnet for the injection line design is complete and signed off by AD and the L2 manager.
1.0.1.2.7.1	RR; Injection & Gap Clearing Pulsar Cables Finalized	Existing cables are measured for impedance vs. frequency to determine the pulse response for fall time and droop in voltage. The decision is whether to accept them for the new kicker system or buy new cables with a more desirable impedance. This Milestone is complete when the L4 manager makes this decision.
1.0.1.2.7.2	RR; External/MI Injection Pulsar Cables Finalized	Existing cables are measured for impedance vs. frequency, to determine the pulse response for fall time and droop in voltage. The decision is whether to accept them for the new kicker system or buy new cables with a more desirable impedance. This Milestone is complete when the L4 manager makes the decision.
1.0.1.2.7.4	RR; Extraction MI Injection Kicker Prototype Pulsar System Complete	After testing and iterating the design of the prototype pulser with a test magnet, the design is ready for procurement of production parts. This Milestone is complete when the L4 manager makes the decision to move forward on procurement based on successful prototyping.
1.0.1.2.7.5	RR; Injection Line Prototype Kicker Complete	This Milestone is complete when the L4 manager makes the decision to accept the kicker design for production and move forward on procurement of parts for two pre-production magnets based on successful prototyping.
1.0.1.2.7.6	RR; Ferrite Procurement or Re-design Finalized	This Milestone is complete when the L4 manager chooses the most acceptable of the ferrite designs for production in order to move forward on procurement.
1.0.1.4.3.1	RR; Shielding Assessment Complete	This milestone is defined as the point at which the RR shielding assessment issues for NOvA operation have been addressed in the MI Shielding Assessment.
1.0.2.1.6.1	Main Injector (MI); 2.5 MHz Cavities Removal Complete	The removal of the 6 coalescing cavities (2.5,5.0MHz) from MI is complete.
1.0.2.1.6.2	MI; Decommissioning of A1 Extraction Line Complete	The removal of the 3 Lambertson magnets and the 2 kickers used for the anti-proton extraction from the MI is complete.
1.0.2.1.6.3	MI; Machine Timing Complete	All the modifications to the MI and RR low level RF systems required for slip stacking in the RR are complete and documented.
1.0.2.2.4.1	MI; Cavity Pre-install Testing Complete	The testing of the two MI RF cavities is complete. This milestone is satisfied when the results of the testing have been transmitted to the L2 manager.
1.0.2.3.2.1	MI; Shielding Assessment Complete	This milestone is defined as the point at which the MI Shielding Assessment has been updated/appended for NOvA operation and is ready to start the Lab approval process.
1.0.3.1.5.1	NuMI; Charging PS Upgrade Design Complete	A review of the NuMI Charging PS Upgrade Design has been completed and a report on their findings.

1.0.3.1.5.2	NuMI; Profile Monitor Conceptual Design Review Complete	A review of the technical design for the NuMI Primary Beamline Profile Monitors has been completed and the committee report has been submitted to the L2 manager. The modifications to the Profile Monitor design have been determined and agreed to by the L3 and L4 managers.
1.0.3.1.5.3	NuMI; Profile Monitor Technical Design Review Complete	A review of the technical design for the NuMI Profile Monitors has been completed and the review committee has written a report on their findings and submitted it to the L2 manager.
1.0.3.2.5.1	NuMI; Target, Baffle & Carrier Initial Design Review Complete	A review of the conceptual designs for the NuMI Target, Baffle, & Carrier has been completed and the review committee has submitted a written report to the L2 manager.
1.0.3.2.5.3	NuMI; Final Design of Target Carrier Complete	This final design of the target carrier has been completed. The drawings for the carrier have been completed, and the procurement and fabrication of the carrier can begin.
1.0.3.2.5.9	NuMI; Hadron Monitor Initial Re-design Complete	An analysis of the Hadron Monitor performance under ANU operating conditions has been completed. The modifications to the Hadron Monitor design has been determined and agreed to by the L3 and L4 managers.
1.0.3.3.5.1	NuMI; Analyze Predicted Block Temperatures Effect on Chase Components Complete	This milestone is the completion of the finite element analysis (FEA) to calculate the amount of radiation heat transfer that takes place from the chase blocks to sensitive components (such as target, horn, & stripline assembly), with the results documented in a posted engineering note.
1.0.3.3.5.2	NuMI; Shielding Assessment Complete	A review of the technical design for the NuMI Primary Beamline Profile Monitors has been completed and the committee report has been submitted to the L2 manager. The modifications to the Profile Monitor design has been determined and agreed to by the L3 and L4 managers.
1.0.3.3.5.3	NuMI; Target Chase Cooling Design Complete	This milestone is the completion of the engineering analysis, design, and drafting of the Target Chase Air Cooling upgrades. It includes completion of the following tasks: 1) Design of new chiller cooling coils including modifications to the existing coil box, with a final drawing package that includes piping layout details, valve and instrumentation specifications, control wiring diagrams, and updating of the existing controls. After this milestone, the design is ready for review and procurement of parts.
1.0.3.3.5.11	NuMI; FEM 3-D Thermal Analysis Complete	This milestone is the completion of the 3-D thermal Finite Element Analysis (FEA) of the target chase region, with results documented in an engineering note.
1.0.4.4.1	Estimate Limits of Proton Plan Performance	Complete an analysis of the achieved Proton Plan performance and extrapolate its ultimate performance. In particular, several major items of the Proton Plan are evaluated in terms of the anticipated usage in ANU. This is an interim analysis that occurs after all the Proton Plan improvements have been implemented, but before all of their gains have been realized. Therefore, a certain amount of extrapolation may be necessary to evaluate them for ANU. This milestone is complete when a report is generated and posted that documents the Proton Plan performance and the ANU extrapolation.
1.0.4.4.2	Beam Physics Preparative Analysis Complete	All of the general beam physics studies for ANU are completed and documented. The preparative analyses are studies needed to facilitate commissioning and operation of ANU; they involve experimental characterization of the accelerators, optimization and detailing of the ANU stacking scheme, and simulation of intense beam dynamics. One or more reports are generated to document the studies.
1.1.1.1.7	Purchase order released for topographic study	The purchase order has been issued to conduct a topographic study of the Far Detector Hall site in Ash River Minnesota.
1.1.1.1.10	Topographic survey complete	The topographic survey of the Far Detector Hall site has been completed and the results documented by the L2 manager.
1.1.1.2.11	Subsurface investigation completed	This milestone is complete when the subsurface borings have been completed and the investigation report has been completed and transmitted to the L2 manager.

1.1.1.2.7	Purchase order released for subsurface borings.	The purchase order has been issued to perform subsurface borings at the Far Detector Hall site.
1.1.1.3.10	Wetland delineation completed	This milestone is complete when the wetland delineation report has been completed and delivered to the L2 manager.
1.1.1.3.7	Purchase order released for wetland delineation	The purchase order has been issued for wetland delineation at the Far Detector Hall site.
1.1.1.4.15	Environmental Assessment Worksheet (EAW) process completed	This milestone marks the point where the State of Minnesota Environmental Assessment Worksheet process is complete including publication, public comment and responses.
1.1.1.4.8	EAW revisions completed	This milestone is satisfied when revisions to the State of Minnesota Environmental Assessment Worksheet, required due to changes in the Project, have been completed and the final report has been received by the L2 manager.
1.1.2.1.21	Site preparation ACD completed	The advanced conceptual design of the Far Detector Hall site has been completed and the report has been received by the L2 manager.
1.1.2.2.7	PO Released for Building Design Modifications	The purchase order has been issued to incorporate building design modifications into the initial design of the Far Detector Hall.
1.1.2.2.11.5	Value engineering completed for Far Detector Hall.	This milestone marks the conclusion of the value engineering process for the design of the Far detector Hall. This includes investigation, review and documentation alternatives.
1.1.2.2.12.6	Document revisions completed.	This milestone marks the completion of revisions to design documents resulting from the building design modifications process.
1.1.2.2.13	Building design modifications completed	This milestone marks the completion of revisions to design documents resulting from the building design modifications process.
1.1.2.3	Title 1 preparation complete	This milestone is satisfied when the Title I design of the Far Detector Building is complete, value engineering has been completed and the documentation has been fully completed and reviewed.
1.1.4.1.1.7	Purchase order issued for initial independent cost estimate.	The purchase order has been issued for an initial independent estimate of the cost to prepare the site and construct the Far Detector Hall.
1.1.4.1.1.19	ICE review completed	The initial independent cost estimate has been reviewed and documented by the L2 manager.
1.1.4.1.2.4	Cost estimate update completed	An update to the initial independent cost estimate for the Far Detector Hall, capturing changes to the design since the initial estimate, is completed and the report has been received by the L2 manager.
1.1.4.1.3.1.5	Burns and McDonnell Cost Estimate Complete	This milestone is satisfied when Burns and McDonnell has completed their independent cost estimate for the Far Detector Hall and the report has been received by the L2 manager.
1.1.4.1.3.2.7	PO Release for J.E. Dunn North Central for cost estimate	The purchase order has been issued to J.E. Dunn for an independent cost estimate of the Far Detector Hall, site and road package.
1.1.4.1.3.2.14	JE Dunn North Central Cost Estimate Complete	This milestone is satisfied when J.E. Dunn has completed their independent cost estimate for the Far Detector Hall and the report has been received by the L2 manager.
1.1.4.1.3.3.7	PO Issued for Constructive Ideas cost estimate	The purchase order has been issued to Constructive Ideas for an independent cost estimate of the Far Detector Hall, site and road package.
1.1.4.1.3.3.14	Constructive Ideas cost estimate complete	This milestone is satisfied when Constructive Ideas has completed their independent cost estimate for the Far Detector Hall and the report has been received by the L2 manager.
1.1.4.2.7	Purchase order issued for secondary containment study.	The purchase order has been issued to commission a study of secondary containment options for liquid scintillator in the Far Detector Hall.
1.1.4.2.13	Secondary containment study completed	The study of options for secondary containment of liquid scintillator at the Far Detector Hall has been completed and the results documented by the L2 manager.

1.1.4.3.4	Overburden study completed	This milestone is complete when the study of options, methods and materials for an overburden covering the top and sides of the Far Detector Hall to attenuate cosmic rays has been completed and the report has been received by the L2 manager.
1.1.4.5.9	Risk management Assessment for the site and building complete.	This milestone is complete when the risk management assessment for WBS 1.1 and WBS 2.1 has been completed, the risks have been entered into the risk registry and the high risk items have been document in a risk assessment form that has been posted in the document database.
1.2.7.4	Baseline blending option selected	This milestone is satisfied once a decision is made and documents regarding the mode of blending the liquid scintillator. The options are to blend it ourselves at Fermilab or to contract with an outside firm, a toll blender, to do the work for us.
1.2.9.1.3	PO issued for ISO tanks	PO issued for ISO tanks for storage of mineral oil and scintillator blending for the IPND.
1.2.9.2.6	Prototype blending system facility completed	The blending system that will be used to blend liquid scintillator in ISO tanks at Fermilab for the IPND has been completed and is ready for blending.
1.2.9.3.4	Mineral oil PO issued	The purchase order for IPND mineral oil has been issued to the vendor.
1.2.9.3.6	Mineral oil batch 1 for IPND delivered	Delivery of 4,520 gal of Penreco oil and 4,520 gal of Renkert oil to Fermilab. This is the first round of mineral oil deliveries and it will be used to blend scintillator for the IPND.
1.2.9.3.9	Mineral oil batch 2 for IPND delivered	Delivery of 4,520 gal of Penreco oil and 4,520 gal of Renkert oil to Fermilab. This is the second round of deliveries and it will be used to blend scintillator for the IPND.
1.2.9.3.12	Mineral oil batch 3 for IPND delivered	Delivery of 4,000 gal of Renkert oil. This is the final round of deliveries for the IPND.
1.2.9.4.1.2	Pseudocumene PO issued	The purchase order for pseudocumene from Dixie Chemical for the IPND liquid scintillator has been issued to the vendor.
1.2.9.4.2.2	Pseudocumene PO issued	The purchase order for pseudocumene from China for the IPND liquid scintillator has been issued to the vendor.
1.2.9.5.2	Waveshifter PO issued	The purchase order for waveshifters for the IPND liquid scintillator has been issued to the vendor.
1.2.9.6.11	Prototype scintillator production completed	Blending of liquid scintillator at Fermilab for the IPND has been completed.
1.2.10.3	Liquid scintillator final specifications completed	The composition of liquid scintillator, optimized to result in the required light output for the lowest cost, has been determined and documented.
1.3.3.6	Baseline (IPND) WLS fiber diameter chosen	This milestone is satisfied when the nominal diameter of the fiber for use in the IPND has been selected and documented.
1.3.3.7	Baseline (IPND) WLS fiber dye concentration chosen	This milestone is satisfied when the nominal composition of the fiber for use in the IPND has been selected and documented.
1.3.5.5	IPND WLS fiber production completed	All fiber for use in the integration prototype near detector has been produced and delivered by the vendor.
1.3.6.5	Production WLS fiber diameter confirmed	The production fiber diameter and radial profile has been selected and documented.
1.3.6.6	Production WLS fiber composition confirmed	The production fiber composition, including waveshifter ppm, has been selected
1.4.2.1.2	Raw materials requirements document released	The document that defines the requirements for the raw material components that are used to formulate the custom PVC blend required for NOVA is complete and posted in the document database.
1.4.2.2.2.3	Prototype 16-cell PVC horizontal extrusion compound specified	Based on the results of our R&D program, the custom PVC blend that will be used to produce horizontal extrusions for the IPND is specified and documented.

1.4.2.2.4	Prototype 16-cell PVC vertical extrusion compound specified	Based on the results of our R&D program, the custom PVC blend that will be used to produce vertical extrusions for the IPND is specified and documented. This resin could be different than the resin used for the horizontal extrusions.
1.4.2.3.1.2	RFP issued for raw PVC resin	A request for proposals is issued to a list of qualified vendors to bid on a custom PVC resin to use to produce prototype extrusions using the 16-cell prototype die.
1.4.2.3.2.2	PO for raw PVC resin for 16-cell horizontal extrusions released	The purchase order for the custom PVC resin required for the IPND horizontal extrusions is issued to the vendor.
1.4.2.4.2.2	PO for raw PVC resin for 16-cell vertical extrusions released	The purchase order for the custom PVC resin required for the IPND vertical extrusions is issued to the vendor.
1.4.2.5.2	PO for raw PVC resin for 16-cell horizontal extrusions released	A purchase order for PVC resin for further horizontal die tuning iterations, if necessary, is issued to the vendor.
1.4.2.6.2	PO for raw PVC resin for 16-cell vertical extrusions released	A purchase order for additional PVC resin for further vertical die tuning iterations, if necessary, is issued to the vendor.
1.4.3.4.5.2	Purchase order released (16-cell horizontals)	The purchase order to fabricate a 16-cell die to produce prototype horizontal extrusions is issued to the vendor.
1.4.3.4.5.9	16-cell horizontal extrusion prototypes specifications completed	The extruding parameters for the Horizontal extrusions for the IPND are fully specified and documented.
1.4.3.4.5.11	16-cell horizontal extrusions for IPND completed	All Horizontal extrusions for IPND have been extruded and characterized.
1.4.3.5.2	Initial 16-cell vertical extrusion prototype specifications completed	Extrusion profile mechanical drawings are complete, documented and ready for submission to extruder.
1.4.3.5.4	PO for die inserts released (16-cell verticals)	A purchase order for "Inserts" to be placed into the prototype die in order to produce vertical extrusions with thicker walls is issued to the vendor.
1.4.3.5.10	16-cell vertical extrusion prototypes specifications completed	The extruding parameters for the vertical extrusions for the IPND are fully specified and documented.
1.4.3.5.12	16-cell vertical extrusions for IPND completed	All Vertical extrusions for IPND have been extruded and characterized.
1.5.2.1.1.7	Integration prototype manifold concept selected	The concept of how to make the manifold has been selected and documented. This includes a design of the parts that make the seal and route the fibers to the optical connector. The design may not be final.
1.5.2.1.1.14	Preproduction prototype manifold design (for IPND) completed	This milestone is satisfied when the solid models of the IPND manifold parts are complete and ready to go out for bid. The manifold parts include the cover, top and bottom snout halves, side and center seals, top and bottom fiber raceways, fiber cover, and fill tubes. This does not include the optical connector.
1.5.2.2.6	End plate integration prototype concept selected	The concept of how to make the end seal has been selected and documented. This includes a design of the parts that make this seal. The design may not be final.
1.5.2.2.13	Design of preproduction prototype bottom plate (for IPND) completed	The solid models of the IPND bottom plate parts are complete and ready to go out for bid. The bottom plate parts include the bottom plate and side and center seals.
1.5.2.3.3	IPND adhesive selected	The choice of adhesives to be used to join all parts of the modules that will be assembled in the IPND module factory have been specified and documented. This includes glue to band the manifold, end plate, and optical connector assemblies and to bond these parts to their mating assemblies. This also includes the adhesive to bond two 16-cell extrusions to form a 32-cell extrusion assembly.

1.5.2.3.5	RF welding go/no go decision made	A decision to use glue adhesives or an RF welding technology to bond the manifold, bottom plate, optical adaptor, and extrusion assemblies (two 16 cell extrusion to make a 32-cell extrusion) has been made and documented.
1.5.3.6	Integration prototype optical connector design concept selected	This milestone is satisfied when the features of the optical connector have been agreed upon by those responsible for parts that must interface with the device. A complete solid model need not exist at this point.
1.5.3.10	Design of preproduction prototype photodetector interface (for IPND) completed	The design of the prototype photodetector interface for the IPND is complete, documented and ready for fabrication.
1.5.4.2.7	Prototype extrusion fiber-stringing machine for IPND ready to operate	The fiber stringing machine is ready to be used by workers to string IPND modules.
1.5.4.2.10	Prototype fiber facing machine for IPND ready to operate	This milestone is satisfied when the fiber facing machine has been built and tested and is ready to face IPND modules.
1.5.4.2.12	Prototype gluing machine for IPND ready to operate	This milestone is satisfied when the gluing machine has been built and tested on sample modules and is ready to face IPND modules.
1.5.5.4	Pressure-testing hardware for IPND production ready to operate	The pressure testing hardware is ready to test for leaks in IPND modules. The tester has enough channels to simultaneously test the maximum number of modules to be assembled by the IPND factory in one day.
1.5.5.7	Fiber mapping and continuity hardware for IPND production ready to operate	The fiber testing hardware is ready to test for damaged fibers in the IPND modules.
1.5.7.3.7	IPND modules for first 8-plane segment completed	Completed is defined as assembled, tested, and shipped.
1.5.7.3.8	IPND module production 50% complete	Half of the IPND modules have been assembled, tested, and shipped.
1.5.7.3.9	IPND module production completed	All IPND modules have been assembled, tested, and shipped.
1.6.1.1.2.7	APD module first prototypes qualified	This milestone is satisfied when the first functioning APD prototypes are delivered.
1.6.1.1.3.7	APD modules second prototype completed	This milestone is satisfied when functional housing is delivered for the APDs.
1.6.1.2.8	QA/QC station ready	This milestone is satisfied when the automated test station for APDs is functional and ready to test first set of APDs.
1.6.1.6.1.1	APD module production for IPND started	This milestone is satisfied when production of the housing for the APDs for use with the IPND has started.
1.6.1.6.1.7	APD modules for 8-plane segment completed	This milestone is satisfied when the first 20 functioning APD modules are completed and available for use to outfit the 8-plane prototype.
1.6.1.6.1.9	APD modules for IPND completed	This milestone is completed when all 303 APD modules for the IPND have been constructed and tested.
1.6.2.3.12	FEB prototype II released to DAQ	This milestone is satisfied when a functional APD readout board (FEB) is delivered.
1.6.2.4.12	FEB prototype III released to DAQ	This milestone is satisfied when a functioning APD readout board (FEB) is delivered.
1.6.2.5.1	FEB modules for IPND started	This milestone is satisfied when production of the front end boards for the IPND has started.
1.6.2.5.13	FEB modules for IPND completed	This milestone is satisfied once all 303 FEB modules for the IPND have constructed and tested.
1.6.2.6.11	FEB prototype V for near detector released to DAQ	This milestone is satisfied when the first fast readout version of the APD readout boards (FEB) are produced and ready for testing.

1.6.3.5.8	IPND power distribution system online	This milestone is satisfied once the power distribution system for the IPND is functioning and can be operated by the Detector Control System.
1.7.1.10.1.5.3	Development database servers released for use	This milestone is satisfied when the online database is released for use.
1.7.1.11	DAQ software ready for IPND	This milestone is satisfied when all of the software required to take data with the IPND is completed and functioning.
1.7.1.2.4.8	Error handling system for first software release	This milestone is satisfied when the first version of the DAQ error handling system has been tested, documented and released for use with the DAQ.
1.7.1.3.4.8	Message passing system for software first release	This milestone is satisfied when the first version of the DAQ Message Passing System has been designed, evaluated, documented and released for use.
1.7.1.4.4.7	Run control system for software first release	This milestone is satisfied when the first version of the software for the Run Control System has been verified, documented and is released for use.
1.7.1.6.3.1.13	Event buffer farm core software for software first release	This milestone is satisfied when the first version of the Event Buffer Farm core software has been verified, documented and is released for use.
1.7.1.6.4.1.6	Event buffer farm server for software first release	This milestone is satisfied when the first version of the software for the Event Buffer Farm Server has been verified, documented and is released for use.
1.7.1.6.5.6	Trace kernel support for software first release	This milestone has been satisfied when the first version of Linux Kernel Support for Trace has been released for use with the DAQ.
1.7.1.8.3.6	Global trigger system for software first release	This milestone is satisfied when the software for the Global Trigger System has been verified, documented and is released for use.
1.7.1.8.4.8	Global trigger system for software second release	This milestone is satisfied when the second version of the Global Trigger System software has been verified, documented and is released for use.
1.7.2.1.1.3	Requirements approved for data concentrator	This milestone is satisfied when the requirements document for the Data Concentrator Module (DCM) has been documented and approved by the L2 manager.
1.7.2.1.2.2.3	Specifications approved for data concentrator	This milestone has been satisfied when the specifications for the Data Concentrator Module have been documented and approved by the L2 manager.
1.7.2.1.2.3.4	Schematic approved for data concentrator	This milestone is satisfied when DCM prototype schematics have reviewed and approved by the L2 manager.
1.7.2.1.2.8	Data concentrator design completed	This milestone is satisfied when the design for the Data Concentrator Module is complete, documented, and the simulations are complete.
1.7.2.1.3.3	PCB manufacturing approved	This milestone is satisfied when the requirements have been reviewed and documented for the PC boards for the prototype Data Concentrator Modules and the L2 manager has signed off on procurement of the prototype boards.
1.7.2.1.3.5	Prototype data concentrator PCBs and components received	This milestone is satisfied when the PC boards for the prototype Data Concentrator Modules have been received from the vendor.
1.7.2.1.4.4	DCM prototype completed	This milestone is satisfied when the prototype Data Concentrator Module is complete and ready for evaluation.
1.7.2.1.6.2	IPND data concentrator PCBs and components received	This milestone is satisfied when the boards and all necessary components for the IPND Data Concentrator Modules have been received.
1.7.2.1.8	IPND data concentrators ready for installation	This milestone is satisfied when the Data Concentrator Modules for the IPND have been fully tested and are ready for installation.
1.7.2.2.1.3	Requirements approved for Timing and Control System	This milestone is satisfied when the requirements for the Timing and Control System have been documented and approved by the L2 manager.
1.7.2.2.2.2.3	Specifications approved for Timing and Control System.	This milestone is satisfied when the specifications for the DAQ Timing and Control System have been evaluated, reviewed, documented and approved by the L2 manager.

1.7.2.2.2.3.4	Schematic approved for Timing and Control System.	This milestone is reached once the schematic for the circuit design of the Timing and Control System is approved by the L2 manager.
1.7.2.2.3.3	PCB manufacturing approved for Timing and Control System.	This milestone is satisfied once the requirements for the Timing and Control System PC boards have been documented and reviewed and the L2 manager confirms that the boards are ready for fabrication.
1.7.2.2.3.5	Prototype PCBs and components received for Timing and Control System.	This milestone is satisfied when the boards and all necessary components for the Timing and Control System have been received.
1.7.2.2.4.4	Control and Timing prototype tests completed	This milestone is satisfied when the tests of the prototype Control and Timing System have been completed and the results documented.
1.7.2.3.1.3	Networking requirements approved	This milestone is satisfied when the networking requirements for the DAQ have been documented, reviewed and approved by the L2 manager.
1.7.2.3.4	Evaluation components received for networking system.	This milestone is satisfied when all of the networking components have been received such that the network can be evaluated and the performance documented.
1.7.2.4.1.3	Control Room requirements approved	This milestone is satisfied when the document describing the Control room requirements has been approved by the L2 manager.
1.7.2.4.3	Evaluation components received for control room	This milestone is satisfied when all of the Control Room components have been received such that the system can be evaluated and the performance documented.
1.7.2.5.1.3	Requirements approved for buffer farm	This milestone is satisfied when the requirements document for Buffer Farm has been approved by the L2 manager.
1.7.2.5.3	Evaluation components received for buffer farm	This milestone is satisfied once the Buffer Farm components for evaluation have been received and evaluation may proceed.
1.7.2.6.1.3	Data storage requirements approved	This milestone is satisfied when the Data Storage requirements documentation has been approved by the L2 manager.
1.7.2.6.3	Evaluation components received for data storage system	This milestone has been reached when the components required for Data Storage evaluation have been received and evaluation may proceed.
1.7.2.7.1.3	Cabling Requirements approved	This milestone is achieved when the cabling requirements documentation is approved by the L2 manager.
1.7.2.7.3	Evaluation components received for cabling	This milestone is satisfied when the components required for cabling evaluation have been received and evaluation may proceed.
1.7.4.11	Detector control system released	This milestone is satisfied when the Detector Control System software is released.
1.8.1.6	Baseline plane assembly adhesive selected	This milestone is satisfied when an adhesive has been selected for use in assembling PVC modules into planes.
1.8.1.11	Final adhesive for plane assembly selected.	This milestone is satisfied when the selection of the final adhesive for use in assembling PVC modules into planes has been made and the decision documented.
1.8.2.2.4	Far detector structural concept selected	This milestone is completed when conceptual designs for the structure of assembled Far Detector blocks and the relationship between adjacent blocks have been documented.
1.8.2.10	Structural design validated	The Project Office will conduct an engineering design review of FEA simulations of the Far Detector mechanical structure. Benchmarking tests of the FEA on smaller-scale prototypes and cross-checks on the analysis, where possible, will also be included. This milestone is satisfied once the review process has been completed and documented.
1.8.3.3.4	Safety review of far detector scintillator handling techniques completed	This milestone is satisfied when a review of the handling techniques for liquid scintillator at the Far Detector site has been completed and the results documented.
1.8.3.3.7	FD filling machine design completed	This milestone is satisfied when the design of the prototype Far Detector filling machine has been completed and documented.
1.8.4.1.10	Conceptual design review of near detector mechanical systems	This milestone is satisfied once a design review for the Near Detector mechanical systems has been completed and documented.

	completed	
1.8.4.5	30% design of Near Detector design complete	This milestone is satisfied when the 30% design of the Near Detector has been completed and documented.
1.8.5.1.5	IPND requirements documents completed	This milestone is satisfied when the document that describes the requirements for the mechanical systems for the IPND is completed and approved by the L2 manager.
1.8.5.2.7	IPND systems review completed	This milestone is satisfied when a review of the mechanical systems for the IPND has been completed and documented.
1.8.5.2.12	IPND systems designs completed	This milestone is satisfied when the design of the IPND block structure, lifting and support fixturing and infrastructure in the MINOS Service Building has been completed and documented.
1.8.5.4.5	IPND block assembly facility completed	This milestone is satisfied when the facility for assembling IPND blocks is completed and a readiness review has been completed and documented.
1.8.5.5.7	IPND blocks completed	This milestone is satisfied when all of the IPND blocks have been assembled and are ready for installation in the IPND enclosure.
1.8.5.6.1.4	Notice to proceed - Phase 1 of IPND infrastructure in MSB	The IPND enclosure is built in two phases that are separated by the installation of the IPND detector. This milestone is satisfied when notice to proceed on the first phase of construction has been issued.
1.8.5.6.1.6	Notice to proceed - Phase 2 of IPND infrastructure in MSB	The IPND enclosure is built in two phases that are separated by the installation of the IPND detector. This milestone is satisfied when notice to proceed on the final phase of construction has been issued.
1.8.5.6.1.11	Infrastructure contract work completed	This milestone is satisfied when all of the infrastructure and secondary containment work for the IPND enclosure has been completed.
1.8.5.6.2.4	Notice to proceed - Phase 1 of IPND containment	The secondary containment for the IPND is built in two phases that are separated by the installation of the IPND detector. This milestone is satisfied when notice to proceed on the first phase of construction has been issued.
1.8.5.6.2.6	Notice to proceed - Phase 2 of IPND containment	The secondary containment for the IPND is built in two phases that are separated by the installation of the IPND detector. This milestone is satisfied when notice to proceed on the final phase of construction has been issued.
1.8.5.6.3.5	Beneficial occupancy of IPND enclosure	This milestone is satisfied once beneficial occupancy has been granted for the IPND enclosure.
1.8.5.7.7	IPND module filling completed	This milestone is satisfied when all of the IPND modules have been filled with liquid scintillator.
1.8.5.7.11	IPND ready to take data	This milestone is satisfied when the IPND modules are filled with scintillator and fully outfitted with electronics that connect to an operational DAQ system.
1.8.6.1.10	Mechanical systems CD-1 design completed	This milestone is satisfied when the conceptual design of the Far Detector mechanical systems, required for CD-1 approval, is completed, documented and approved by the L2 manager.
1.8.6.2.15	Assembly fixtures CD-1 design completed	This milestone is satisfied when the conceptual design of the assembly fixtures for the Far Detector, required for CD-1 approval, is completed, documented and approved by the L2 manager.
1.8.6.4	30% design of FD mechanical system and tooling complete	The 30% design for the Far Detector assembly fixtures and tooling has been completed, reviewed and documented.
1.8.7.6	Far detector installation procedures completed	This milestone is satisfied once the installation procedures for the Far Detector have been completed and documented.
1.8.7.7	FD installation procedure value engineering completed	This milestone is satisfied when the value engineering study for the Far Detector installation procedure has been completed and the results documented.
1.8.8.1.13	Full-scale block assembly prototype testing completed	This milestone is satisfied when the tests of the full-scale assembly prototype have been completed and documented.
1.8.8.2.6	Select site for block installation at FNAL	This milestone is completed when a site at Fermilab has been selected by the Project Manager for the full-height engineering prototype test.
1.8.8.2.17	Full-height engineering prototype testing started	This milestone has been satisfied once the full-height engineering prototype has been constructed, an operational readiness review has been completed and the prototype is ready to be filled with liquid.

1.8.8.2.18	Full-height engineering prototype testing completed	This milestone is satisfied when testing of the full-height engineering prototype has been completed and documented.
1.9.4.1	CD-0	DOE signs off on Critical Decision CD-0 – approval of mission need
1.9.4.2	CD-1	DOE signs off on Critical Decision CD-1
1.9.5.5	Cooperative-agreement institution determined	DOE identifies the institution that will enter into the cooperative agreement for the far detector site and building construction.
1.9.5.6	Acquisition strategy approved by DOE	The NOVA project acquisition strategy document is approved by the DOE
1.9.5.10	Cooperative-agreement in place	The cooperative agreement between DOE and the designated CA institution is signed by all parties.
1.9.5.15	Cooperative-agreement funds available	Initial funding based on the approved cooperative agreement is available for obligation by the cooperative agreement institution
1.9.5.20	Far detector site selected	The specific location of the far detector site is chosen.
1.9.5.25	Building conceptual design frozen (FESS)	FNAL Facilities Engineering Services Section freezes their initial conceptual design for the far detector site and building.
1.9.4.3	CD-2	DOE signs off on Critical Decision CD-2 – Baseline approval
2.0.1.1.5.1	Recycler Ring (RR); 53 MHz RF Ready for Beam	53 MHz cavities installed and power tested. Vacuum in the area has been reconstituted.
2.0.1.1.5.2	RR; Permanent Magnet Quads Refurbished & Mapped	38 permanent magnet quadrupoles will be removed from the tunnel, taken to TD, refurbished (to accommodate requested strength), and measured. This milestone marks the point where all magnets have gone through the process.
2.0.1.1.5.3	RR; Orders Placed for Copper for 53 MHz RF	Requisition issued to purchase copper to be used in the construction of the RR 53 MHz cavities.
2.0.1.1.5.4	RR; ADCW Magnet Refurbish Complete	The ADCW is a wide gap ADC magnet. All necessary magnets (3+1 hot spare) have had their gaps widened, been power tested, and mapped.
2.0.1.1.5.5	RR; LCW System Mods Complete	RR LCW Systems on line and operational
2.0.1.2.8.1	Gap Clearing / RR Injection Kicker Magnet Design Complete	After the final high voltage testing of one pre-production RR Injection magnet, the L4 manager decides to accept the design as final and go ahead with ordering parts for all production magnets.
2.0.1.2.8.2	RR; Extraction MI Injection Line Kicker Checkout/Test Complete	This Milestone is complete after the RR Extraction & MI Injection Line kicker magnets are installed with all cable and fluorinert piping, and tested with the pulser system, the checkout/test is complete and the kicker system is ready for beam.
2.0.1.2.8.3	RR; Beam Abort Kicker Checkout/Test Complete	This Milestone is complete after the RR Beam Abort Line kicker magnet is installed with all cable and fluorinert piping, and tested with the pulser system, the checkout/test is complete and the kicker system is ready for beam.
2.0.1.2.8.4	RR; Injection & Gap Clearing Magnets & Fluorinert Piping in Tunnel Checkout/Test Complete	This Milestone is complete after the RR Injection Line and Gap Clearing Line kicker magnets are installed with all cable and fluorinert piping, and tested with the pulser systems, the checkout/test is complete and the kicker systems are ready for beam.
2.0.1.2.8.5	RR; All Kicker Systems Ready for Beam	This Milestone is complete when all kicker systems are installed and tested and ready for beam. This includes the RR Injection, RR Gap Clearing, RR Extraction, MI Injection, and the RR Beam Abort kicker systems.
2.0.1.3.4.3	RR; DCCT Ready for Installation	DCCT in hand, inspected, calibrated, cleaned, and ready for installation.
2.0.1.3.4.5	RR; BPM System Procurement Complete	Purchased, received and inspected cables/connectors/transition boards for the RR BPM upgrade project.
2.0.1.3.4.6	RR; BPM Transition Boards Ready for Installation	All 216 BPM transition boards passed testing and are ready for installation.
2.0.2.1.4.1	Main Injector (MI); Vertical Quad Bus	The new transformer has been installed and tested, and the power supply modifications are complete.

	Upgrade Complete	
2.0.2.2.5.1	MI; RF Cavities Bus Bar Fabrication & Installation Complete	The bus bars for the 2 new RF stations have been fabricated and installed and tested.
2.0.2.2.5.2	MI; RF Cavities Fabrication of Ferrite Bias Supplies Complete	The fabrications of the two new bias supplies have been completed.
2.0.2.2.5.3	MI; RF Cavities Fabrication of Modulators Complete	The fabrications of the two new modulator supplies have been completed.
2.0.2.2.5.4	MI; RF Cavities (2) Installation & Testing Complete	The two MI RF cavities have been installed in the tunnel and testing without beam has been completed and the results documented.
2.0.2.2.5.5	MI; LCW System Mods Complete	MI LCW Systems on line and operational
2.0.3.1.5.1	NuMI; Charging PS Upgrades Testing Complete	The upgraded charging power supply for the NuMI extraction kicker has been assembled, tested, and approved for operational use.
2.0.3.1.5.2	NuMI; Primary Beamline Ready for Faster Cycle Time	The NuMI Primary Beamline has been tested and is capable of operating at a 1.33 second repetition rate. This includes the upgrade to the NuMI extraction kicker, the installation of the replacement quadrupole magnets, and the operation of the improved regulation of the dipole power supplies.
2.0.3.2.3.1	NuMI; Begin Baffle Procurement	The design of the target baffle has been completed with signed off drawings and a design review such that the procurement of the baffle can begin.
2.0.3.2.3.2	NuMI; Baffle Delivered	The baffle for the medium energy target has been delivered to Fermilab and has been inspected and accepted for installation into the target carrier
2.0.3.2.3.3	NuMI; ME Target/Carrier/Baffle Assembly Complete	The medium energy target, the baffle, and the target carrier have been assembled into a single unit that is ready for installation into the target chase.
2.0.3.2.3.4	NuMI; Target Carrier Delivered	The target carrier has been delivered to Fermilab, inspected, and approved.
2.0.3.2.3.7	NuMI; IHEP ME Target Accord Signed	An accord for the construction and delivery of a medium energy target has been written, approved, and signed by IHEP, Protvino and Fermilab.
2.0.3.2.3.8	Replacement Hadron Monitor Delivered	The replacement Hadron Monitor has been delivered to Fermilab, and has been inspected, and approved for installation.
2.0.3.3.4.1	NuMI; Shielding Blocks & Carriage Complete	This milestone defines the receipt of shielding & support components after fabrication from the vendor. These components are now ready for installation in the target hall. It includes fabrication completion and installation readiness of the following items: 1. Shielding blocks and 2. Carriage Assembly.
2.0.3.3.4.2	NuMI; Installation of Target Chase Cooling Complete	This milestone defines the completion of the Target Chase Cooling upgrades installation and successful testing & troubleshooting of all components with all systems online and operational.
2.0.3.3.4.3	NuMI; Stripline Assembly Complete	This milestone defines the completion of the Horn 2 stripline extension and stand components assembly. The stripline assembly is now ready for installation in the target hall.
2.0.3.4.4.2	NuMI; RAW Systems Mods Complete	NuMI RAW Systems on line and operational
2.0.3.4.4.3	NuMI; Cooling Water (Non-RAW) Mods Complete	NuMI Non-RAW Systems on line and operational
2.0.4.3.1	ANU Approval to Proceed with Project	This marks the date at which the original efforts on ANU were authorized to proceed (this was before ANU was incorporated into NOVA).
2.0.4.3.12	Start of ANU Accounting	This is the date at which accounting on the TPC began.

2.0.4.3.13	ANU Shielding Assessment Updates Complete	This milestone is defined as the point at which the MI and NuMI/MINOS Shielding Assessments have been updated/appended for NOvA operation and approved as defined in Fermilab Radiological Control Manual (FRCM) Chapter 8.
2.0.4.3.14	Ready for Shutdown to Install Accelerator Upgrades	All necessary preparation and planning work complete in order to begin the Accelerator Upgrades Shutdown.
2.0.4.3.15	MI Ring Modifications Ready for Beam Transport	All the NOvA Main Injector modifications have been completed and tested as appropriate and the machine is ready for beam transport.
2.0.4.3.16	RR; Modifications Ready for Beam Transport	This milestone is defined as the completion of the NOvA Recycler Ring modifications for beam transport. It includes the installation, testing, alignment, and vacuum certification of all the beamline elements (magnets, instrumentation, kickers) for injection into the Recycler from the MI8 line and extraction from the Recycler to the Main Injector.
2.0.4.3.17	Ready to Commission Upgrades with Medium Energy Neutrino Beam	Milestones for RR and MI ready for beam transport completed. The Target Hall has been reconfigured to the medium energy optics and the medium energy target has been installed in the target chase and tested. Horn 2 has been relocated to the medium energy position, connected to the extended stripline and tested. Also all NOvA upgrades for higher beam power down the NuMI line have been completed and tested as appropriate.
2.0.4.3.21	ANU Subproject Complete	The Ready to Commission Upgrades with Medium Energy Neutrino Beam milestone has been satisfied, all ANU cost accounts have been closed out and as-built documents have been completed.
2.0.4.4.1.2	Off Project: Gap Clearing Kicker System Ready for Installation	The gap clearing kicker system is ready for installation in the Recycler Ring.
2.0.4.4.1.3	Off-Project: Receive & Inspect ceramic beamtubes for RR Inj, Gap Clearing & MI Magnets	Ceramic beamtubes purchased off-project have been received at Fermilab, inspected, and accepted for use.
2.0.4.4.1.4	Off-Project:: MI-14 SB Construction Complete	Beneficial Occupancy is obtained for MI-14 allowing technical component installation to begin.
2.0.4.4.1.5	Off-Project:: MI-39 SB Construction Complete	Beneficial Occupancy is obtained for MI-39 allowing technical component installation to begin.
2.0.4.4.1.6	Off-Project:: MI-60 Anode Supply Room Construction Complete	Beneficial Occupancy is obtained for MI-60 APS Room allowing for the installation of technical components to begin.
2.0.4.4.2.8	Off-Project: NuMI Horn 1 Modules Installed in Chase Complete	The Horn 1 (ANU) has been attached to the Horn 1 Module, installed in the target chase. The stripline, water, and electrical connections have all been completed.
2.0.4.4.2.11	Off-Project: Work Cell & Equipment Ready for ANU Operation	The Work Cell and Equipment has been assembled in the target hall and is ready for use.
2.0.4.4.2.12	Off-Project:: RCRP Equipment & Procedures Ready for ANU Operations	The RCRP (Radioactive Component Repair/Removal Plan) has been completed and is ready for ANU operations.
2.0.4.4.2.13	Off-Project:: NuMI Modified Horn 1 Ready for Installation	The Horn 1 (ANU) has been assembled, tested on the test stand, and the magnetic field mapping has been completed.
2.0.4.4.2.39	Off-Project:: Radioactive Component Repairs/Removal Conceptual Design Review Complete	A review of the Radioactive Component Repair/Removal Conceptual Design has been completed and a report transmitted to the L2 manager.

2.0.4.4.2.40	Off Project: Profile Monitor Conceptual Design Complete	The Conceptual Design for the Profile Monitor has been completed
2.1.1.1.2	Issue RFP to A/E for Title 2 for Site Prep Package	This milestone is complete when a Request for Proposals has been issued to a list of A&E firms to bid on Title 2 design package for preparation of the Far Detector Hall site.
2.1.1.1.7	PO Released for Title 2 for Site Prep Package	The purchase order is issued to the A&E firm that wins the competitive bid to perform the Title 2 design for preparation of the Far Detector Hall site.
2.1.1.1.21	Site Prep Package Title 2 Complete	This milestone is complete when the Title 2 design of the Far Detector Hall site preparation package has been finished and the report transmitted to the L2 manager.
2.1.1.2.2	Wetland permit submitted	This milestone marks the point where the wetland permit has been submitted to the U.S. Army Corps of Engineers
2.1.1.2.6	Wetland Permit Issued	This milestone marks the point where a U.S. Army Corps of Engineer wetland permit is issued.
2.1.1.3.4	Issued RFP for Site Prep Package	This milestone is complete when a Request for Proposals has been issued to a list of construction firms to bid on the preparation work for the Far Detector Hall site.
2.1.1.3.7	Site preparation purchase order released	The purchase order is issued to the construction firm that wins the competitive bidding to execute the preparation work at the Far Detector Hall site.
2.1.1.4.1	Notice to proceed - far detector site preparation package	This milestone marks the point where construction on the Site Prep package may begin
2.1.1.4.7	Beneficial occupancy - far detector site preparation package	This milestone marks the point where the Site Prep package has been completed to a point where other subcontractors may begin to use the road
2.1.1.4.9	Final acceptance - far detector site preparation package	This milestone marks the point where all work is complete on the Site Preparation package.
2.1.2.1.2	Issue request for proposal to A/E	This milestone is complete when a Request for Proposals has been issued to a list of A&E firms to bid on Title 2 design package for the Far Detector Hall.
2.1.2.1.7	PO issued for Title 2 for Far Detector Building	The purchase order is issued to the A&E firm that wins the competitive bid to perform the Title 2 design of the Far Detector Hall.
2.1.2.1.21	Far Detector Building Title 2 Complete	This milestone is complete when the Title 2 design of the Far Detector Hall has been finished and the construction documents are transmitted to the L2 manager.
2.1.2.2.4	Issue RFP for Far Detector Building	This milestone is complete when a Request for Proposals has been issued to a list of construction firms to bid on the construction of the Far Detector Hall.
2.1.2.2.7	Purchase order released - far detector building	The purchase order has been issued to the construction firm that is awarded the contract to construct the Far Detector Hall.
2.1.2.3.1.1	Notice to proceed - DE/AA concrete	This milestone marks the point where construction on the Detector Enclosure and Assembly Area concrete work may begin
2.1.2.3.1.11	Detector enclosure/assembly area concrete completed	This milestone marks the point where all concrete work is completed on the detector enclosure and assembly area.
2.1.2.3.2.18	Outfitting completed	This milestone marks the point where all of the building outfitting, including walkways, secondary containment, electrical rough-ins, elevator, cranes, and movable access platforms, has been completed.
2.1.2.3.3	Beneficial occupancy - far detector building construction	This milestone marks the point where the Far Detector Building is essential complete and other subcontractors and NOVA Project personnel may begin to share the building.
2.1.2.3.5	Final acceptance - far detector building construction	This milestone marks the point where the Far Detector Building is complete.
2.2.1.4	Mineral oil PO issued	The purchase order for 3,082,145 gal of mineral oil is issued to the vendor.

2.2.1.5.1	Mineral oil production and delivery begins	The first delivery of mineral oil for liquid scintillator has been received by the toll blender. Deliveries will continue for 3 years.
2.2.1.5.5	Mineral oil production and delivery 25% completed	770,536 gal of mineral oil, corresponding to 25% of the total, has been received by the toll blender.
2.2.1.5.6	Mineral oil production and delivery 50% completed	1,541,073 gal of mineral oil, corresponding to 50% of the total, has been received at the toll blender.
2.2.1.5.7	Mineral oil production and delivery 75% completed	2,311,609 gal of mineral oil, corresponding to 75% of the total, has been delivered to the toll blender.
2.2.1.5.8	Mineral oil production and delivery completed	3,082,145 gal of mineral oil, corresponding to 100% of the total, has been received by the toll blender.
2.2.2.4	Pseudocumene PO issued	The purchase order for 128,439 gal of pseudocumene is issued to the vendor.
2.2.2.5.1	Pseudocumene production and delivery begins	The first delivery of pseudocumene for liquid scintillator has been received by the toll blender. Deliveries will continue over 3 years.
2.2.2.5.5	Pseudocumene production and delivery 25% completed	32,110 gal of pseudocumene, corresponding to 25% of the total, has been received by the toll blender.
2.2.2.5.6	Pseudocumene production and delivery 50% completed	64,220 gal of pseudocumene, corresponding to 50% of the total, has been delivered to the toll blender.
2.2.2.5.7	Pseudocumene production and delivery 75% completed	96,329 gal of pseudocumene, corresponding to 75% of the total, has been delivered to the toll blender.
2.2.2.5.8	Pseudocumene production and delivery completed	128,439 gal of pseudocumene, corresponding to 100% of the total, has been received by the toll blender.
2.2.3.4	Waveshifter PO issued	A purchase order for the 9,373 kg of PPO and 131 kg of bis-MSB required for production scintillator blending is issued to the vendor.
2.2.3.5.1	Waveshifter production and delivery begins	Waveshifter production begins and the first shipment is delivered to the toll blender. Periodic shipments will continue over two years.
2.2.3.5.4	Waveshifter production 15% completed	The first 15% of the waveshifters, corresponding to 1,406 kg of PPO and 19.7 kg of bis-MSB, have been delivered to the toll blender.
2.2.3.5.5	Waveshifter production completed	The full quantity of 9,373 kg of PPO and 131 kg of bis-MSB has been delivered to the toll blender.
2.2.4.1.4	Toll blending PO issued	A purchase order for blending the 3,210,584 gal of liquid scintillator required for the near and far detectors at a toll blender is issued to the vendor.
2.2.4.3.5	Scintillator blending begins	The first production batch of liquid scintillator has been blended at the toll blender and is ready for shipment.
2.2.4.3.6	Scintillator production for superblock 1 completed	The blending and QA/QC of 496,994 gal of liquid scintillator, corresponding to the volume required for the first Far Detector superblock, has been completed.
2.2.4.3.7	Scintillator production for superblock 2 completed	The blending and QA/QC of 993,998 gal of scintillator, corresponding to the volume required for the first two superblocks, has been completed.
2.2.4.3.8	Scintillator production for superblock 3 completed	The blending and QA/QC of 1,490,982 gal of scintillator, corresponding to the volume required for the first 3 superblocks, has been completed.
2.2.4.3.9	Scintillator production for superblock 4 completed	The blending and QA/QC of 1,987,976 gal of scintillator, corresponding to the volume required for the first 4 superblocks, has been completed.
2.2.4.3.10	Scintillator production for superblock 5 completed	The blending and QA/QC of 2,484,970 gal of scintillator, corresponding to the volume required for the first 5 superblocks, has been completed.
2.2.4.3.11	Scintillator production for superblock 6 completed	The blending and QA/QC of 2,981,964 gal of scintillator, corresponding to the volume required for the first 6 superblocks, has

	completed	been completed.
2.2.4.3.12	Scintillator production for superbloc 7 completed	The blending and QA/QC of 3,210,584 gal of scintillator, corresponding to the volume required for the first 7 superblocs, has been completed.
2.2.4.3.90	Scintillator production for 15 kt completed	The blending and QA/QC of liquid scintillator required for a 15 kt detector has been completed.
2.2.5.3.39	Scintillator delivery for first superbloc completed	The 496,994 gal of scintillator required for superbloc 1 has been shipped from the toll blender and received at the Far Detector site.
2.2.5.3.40	Scintillator delivery for all blocks completed	3,210,584 gal of scintillator, corresponding to 100% of the total, has been delivered to Ash River.
2.3.1.5	WLS fiber PO issued	The purchase order for the WLS fiber for the Near and Far detectors has been released to the vendor and fiber production can proceed.
2.3.2.1.6	WLS fiber production begins	This milestone is satisfied when the vendor informs us that fiber production for NOvA has started.
2.3.2.1.7	WLS fiber production 3% complete	450 km of fiber has been produced and delivered by the vendor.
2.3.2.1.8	WLS fiber production 35% complete	4,950 km of fiber has been produced and delivered by the vendor.
2.3.2.1.9	WLS fiber production 70% complete	9,450 km of fiber has been produced and delivered by the vendor.
2.3.2.1.14	WLS fiber for 15 kt detector produced and delivered	13,000 km of fiber has been produced and delivered by the vendor (15 kt detector).
2.4.1.1.5	Extrusion PO issued	A contract to fabricate Horizontal and Vertical dies and associated hardware and to extrude PVC according to NovA schedule is issued to the vendor.
2.4.1.2.5	Raw material Pos issued	A contract to produce a custom PVC resin on a time scale that is consistent with the NovA schedule is issued to the vendor.
2.4.2.1.4	First horizontal extrusions available for evaluation	The first horizontal test extrusions from the preproduction run are completed and available for evaluation.
2.4.2.1.13	Pre-production horizontal extrusions authorized	Tuning of the extruding process and the die geometry for horizontal extrusions is complete.
2.4.2.2.4	First vertical extrusions available for evaluation	The first vertical test extrusions from the preproduction run are completed and available for evaluation.
2.4.2.2.13	Pre-production vertical extrusions authorized	Tuning of the extruding process and the die geometry for vertical extrusions is complete
2.4.3.1.1.5	Near detector horizontal extrusions completed	The horizontal extrusions required for the Near Detector have been extruded, QA has been completed and the extrusions are ready to be shipped to the module factory.
2.4.3.1.2.5	Near detector vertical extrusions completed	The vertical extrusions required for the Near Detector have been extruded, QA has been completed and the extrusions are ready to be shipped to the module factory.
2.4.3.2.1.1.1	Production of horizontal extrusions authorized	After satisfying all of the preproduction requirements, the L2 manager authorizes the extrusion vendor to begin production of horizontal extrusions for the Far Detector.
2.4.3.2.1.2.1	Production of vertical extrusions authorized	After satisfying all of the preproduction requirements, the L2 manager authorizes the extrusion vendor to begin production of vertical extrusions for the Far Detector.
2.4.3.2.44.1	Far detector extrusion production started	After satisfying all of the preproduction requirements, the L2 manager authorizes the extrusion vendor to begin production of extrusions for the Far Detector.
2.4.3.2.44.2	Extrusions for superbloc 1 produced	The vertical and horizontal extrusions required for superbloc 1 have been extruded and QA has been completed and documented.
2.4.3.2.44.3	Extrusions for superbloc 2 produced	The vertical and horizontal extrusions required for superbloc 2 have been extruded and QA has been completed and documented.
2.4.3.2.44.4	Extrusions for superbloc 3 produced	The vertical and horizontal extrusions required for superbloc 3 have been extruded and QA has been completed and documented.

2.4.3.2.44.5	Extrusions for superblock 4 produced	The vertical and horizontal extrusions required for superblock 4 have been extruded and QA has been completed and documented.
2.4.3.2.44.6	Extrusions for superblock 5 produced	The vertical and horizontal extrusions required for superblock 5 have been extruded and QA has been completed and documented.
2.4.3.2.44.7	Extrusions for superblock 6 produced	The vertical and horizontal extrusions required for superblock 6 have been extruded and QA has been completed and documented.
2.4.3.2.44.8	Extrusions for superblock 7 produced	The vertical and horizontal extrusions required for superblock 7 have been extruded and QA has been completed and documented.
2.4.3.2.44.10	Far Detector extrusions for 15 kt completed	All vertical and horizontal extrusions required for a 15 kt Far Detector have been extruded and QA has been completed and documented.
2.5.1.1.5	Manifold production purchase orders released	Completed purchase orders have been issued to the vendor.
2.5.1.2.5	End plate and seals production purchase orders released	Completed purchase orders have been issued to the vendor.
2.5.2.5	Optical connector production purchase order released	Completed purchase orders have been issued to the vendor.
2.5.3.2.6.9	Factory infrastructure completed for block 1 module production	Enough factory machines, tooling, and material handling, procedures, and factory infrastructure outfitting is completed to begin assembling the first module.
2.5.3.2.6.10	Factory infrastructure completed for block 2 module production	Enough factory machines, tooling, and material handling, procedures, and factory infrastructure outfitting is completed to begin assembling the second block's worth of modules at a faster rate defined in the cost and schedule.
2.5.3.2.6.11	Factory infrastructure completed for block 3 (full rate) module production	Enough factory machines, tooling, and material handling, procedures, and factory infrastructure outfitting is completed to begin assembling modules at the full production rate.
2.5.3.3.2.45.44	Far detector module assembly started	Started is defined as the beginning of assembly of the first far detector module.
2.5.3.3.2.45.45	Far detector modules for superblock 1 completed	Completed is defined as all modules having been assembled and tested.
2.5.3.3.2.45.50	Far detector modules for superblock 2 completed	Completed is defined as all modules having been assembled and tested.
2.5.3.3.2.45.60	Far detector modules for superblock 3 completed	Completed is defined as all modules having been assembled and tested.
2.5.3.3.2.45.70	Far detector modules for superblock 4 completed	Completed is defined as all modules having been assembled and tested.
2.5.3.3.2.45.80	Far detector modules for superblock 5 completed	Completed is defined as all modules having been assembled and tested.
2.5.3.3.2.45.90	Far detector modules for superblock 6 completed	Completed is defined as all modules having been assembled and tested.
2.5.3.3.2.45.110	Far detector modules for superblock 7 completed	Completed is defined as all modules having been assembled and tested.
2.5.3.3.2.45.120	Far detector modules for 15 kt detector shipped	Modules for a 15 kt Far Detector have been assembled, tested and shipped to detector site.
2.5.3.3.3.2	Near detector module fabrication started	Started is defined as the beginning of assembly of the first near detector module.
2.5.3.3.3.6	All near detector modules completed	Completed is defined as all near detector modules having been assembled and tested.
2.6.1.1.1.2	POs released-manufactured parts	The purchase orders for the parts required for the APD housings have all been issued to the respective vendors.
2.6.1.1.2.2	PO released-TE coolers	The purchase order for the thermo-electric coolers has been released to the vendor.
2.6.1.1.4	APD housings completed and tested - superblock 1	This milestone is satisfied once the APD housings required for superblock 1 have been assembled and QA completed.
2.6.1.1.5	APD housings completed and tested - superblock 2	This milestone is satisfied once the APD housings required for the first 2 superblocks have been assembled and QA completed.
2.6.1.1.6	APD housings completed and tested - superblock 3	This milestone is satisfied once the APD housings required for first 3 superblocks have been assembled and QA completed.

2.6.1.1.7	APD housings completed and tested - superblock 4	This milestone is satisfied once the APD housings required for first 4 superblocks have been assembled and QA completed.
2.6.1.1.8	APD housings completed and tested - superblock 5	This milestone is satisfied once the APD housings required for first 5 superblocks have been assembled and QA completed.
2.6.1.1.9	APD housings completed and tested - superblock6	This milestone is satisfied once the APD housings required for first 6 superblocks have been assembled and QA completed.
2.6.1.1.10	APD housings completed and tested - superblock 7	This milestone is satisfied once the APD housings required 7or first 3 superblocks have been assembled and QA completed.
2.6.1.1.11	All APD housings completed and tested	This milestone is satisfied when all APD housings required for near and far detectors have been assembled and QA completed.
2.6.1.2.2	PO released-APDs	The purchase order for APD Array production is released to the vendor.
2.6.1.2.5.1	APDs for superblock 1 delivered	The APD arrays required for superblock 1 have been received from Hamamatsu.
2.6.1.2.5.2	APDs for superblock 2 delivered	The APD arrays required for the first 2 superblocks have been received from Hamamatsu.
2.6.1.2.5.3	APDs for superblock 3 delivered	The APD arrays for the first 3 superblocks have been received from Hamamatsu.
2.6.1.2.5.4	APDs for superblock 4 delivered	The APD arrays for the first 4 superblocks have been received from Hamamatsu.
2.6.1.2.5.5	APDs for superblock 5 delivered	The APD arrays for the first 5 superblocks have been received from Hamamatsu.
2.6.1.2.5.6	APDs for superblock 6 delivered	The APD arrays for the first 6 superblocks have been received from Hamamatsu.
2.6.1.2.5.7	APDs for superblock 7 delivered	The APD arrays for the first 7 superblocks have been received from Hamamatsu.
2.6.1.2.5.8	All APD arrays delivered	All of the APD arrays required for the near and far detectors have been received from Hamamatsu.
2.6.1.3.47	APD modules assembled and tested	All APD modules required for the near and far detectors have been assembled and tested.
2.6.1.4.47	All Far Detector APD modules shipped	All Far Detector APD modules shipped to far site
2.6.2.2.3	Front-end board fabrication and assembly completed	All of the front-end boards and front-end board assemblies required for the near and far detectors have been completed and tested.
2.6.2.3.1	FEB modules for near detector started	This milestone is satisfied once assembly of the front-end modules for the near detector has started.
2.6.2.3.5	FEB modules for near detector completed	This milestone is satisfied once the front-end modules required for the near detector have been completed and fully tested.
2.6.3.6.3	Cooling system hardware delivered	This milestone is satisfied once the complete set of cooling systems for the far detector have been delivered to the far detector site.
2.7.1.1.1.6	Error handling system for software second release	This milestone is satisfied when the second version of the DAQ error handling system has been tested, documented and released for use.
2.7.1.1.2.6	Error handling system for software third release	This milestone is satisfied when the third version of the DAQ error handling system has been tested, documented and released for use.
2.7.1.2.1.6	Message passing system for software second release	This milestone is satisfied when the second version of the DAQ Message Passing System has been designed, evaluated, documented and released for use.
2.7.1.3.1.10	Run control system for software second release	This milestone is satisfied when the second version of the software for the Run Control System has been verified, documented and is released for use.
2.7.1.3.2.6	Run control system fourth release	This milestone is satisfied when the fourth version of the DAQ Run Control system has been tested, documented and released for use.
2.7.1.4.1.6	Event buffer farm core software for software second release	This milestone is satisfied when the second version of the Event Buffer Farm core software has been verified, documented and is released for use.
2.7.1.4.2.6	Event buffer farm server for software second release	This milestone is satisfied when the second version of the Event Buffer Farm Server software has been verified, documented and is released for use.

2.7.1.4.3.6	Event buffer farm server for software third release	This milestone is satisfied when the third version of the Event Buffer Farm Server software has been verified, documented and is released for use.
2.7.1.5.8	Data logger server for software second release	This milestone is satisfied when the second version of the Data Logger Server software has been verified, documented and is released for use.
2.7.1.6.11	Data file transfer system for software second release	This milestone is satisfied when the second version of the Data File Transfer System has been tested, documented and released for use.
2.7.1.7.11	DAQ monitoring system for software second release	This milestone is satisfied when the second version of the DAQ monitoring software has been tested, documented and released for use.
2.7.1.8.14	Event monitoring system for software second release	This milestone is satisfied when the second version of the DAQ Event Monitoring System has been tested, documented and released for use.
2.7.1.9.14	Event display software for software second release	This milestone is satisfied when the second version of the Event Display software has been verified, documented and is released for use.
2.7.1.10.2.3	Release integration database servers for use	This milestone is satisfied when the online integration database has been released.
2.7.1.10.3.3	Release production database servers for use	This milestone is satisfied when the online database has been deployed on the production servers, is fully configured and released for use.
2.7.1.10.4.1.7	Deploy online calibration application in production environment	This milestone is satisfied when the online calibration software has been fully integrated, tested, documented and implemented in the production environment.
2.7.1.10.4.2.7	Deploy online run history application in production environment	This milestone is satisfied when the online run history application has been fully integrated, tested, documented and implemented in the production environment.
2.7.1.10.4.3.7	Deploy online monitoring application in production environment	This milestone is satisfied when the online monitoring system has been fully integrated, tested, documented and implemented in the production environment.
2.7.2.1.2.7	Release production hold	This milestone has been satisfied when evaluation of first production articles for the Data Concentrator Modules is complete and successful. This allows for production to resume.
2.7.2.1.2.8	Production data concentrators received	This milestone is satisfied when all of the Data Concentrator Modules required for the Near and Far detectors have been received.
2.7.2.2.2.2	Pre-production PCBs and components received for Timing and Control System	This milestone is satisfied when the PC boards and all necessary components for the pre-production version of the Timing and Control System have been received.
2.7.2.2.4	Production approved for Timing and Control System.	This milestone is satisfied when the pre-production components for the Timing and Control System have been fully tested and documented and the L2 manager has approved manufacture of the production components.
2.8.1.1.5	Administrative and safety signoffs on ear Detector (ND) excavation design	Excavation design is certified as buildable and safe. This milestone is satisfied when the Project Mechanical Engineer or his designee signs off.
2.8.1.3.4	Notice to Proceed on phase 1 of tunnel infrastructure contract	This milestone is satisfied once a contractor has been selected and they are ready to begin the first phase of the tunnel infrastructure work to move the MINOS utilities.
2.8.1.3.6	Notice to Proceed on phase 2 of tunnel infrastructure contract	This milestone is satisfied once the cavern excavation is complete and the contractor is ready to begin the second phase of the infrastructure work that includes safety systems, lighting and HVAC.
2.8.1.3.12	Infrastructure contract completed	This milestone is satisfied when the contractor has completed all of the Near Detector infrastructure work and only the FIRUS installation is still needed for beneficial occupancy.
2.8.1.4.4	Notice to Proceed – ND excavation	This milestone has been satisfied once the MINOS utilities have been moved, a contractor has been selected and they are ready to begin excavation of the Near Detector cavern.
2.8.1.4.7	ND Excavation contract completed	This milestone is satisfied when the cavern excavation has been completed.

2.8.1.7	Beneficial occupancy of new cavern	This milestone is satisfied when all cavern work has been completed and the cavern is ready for detector installation.
2.8.2.2.3	Muon catcher mechanical construction completed	This milestone is satisfied when the muon planes have been assembled, attached to the steel, moved underground and connected to the support structure.
2.8.2.3.1.2	Release of four blocks from IPND to ND	This milestone is satisfied when operation of the IPND is terminated and preparations may begin to prepare the blocks to be moved underground.
2.8.2.3.2.2.1	Modules for final two blocks available	The Near Detector consists of the four IPND blocks plus two additional blocks. This milestone is satisfied when the modules for the two additional blocks have been completed.
2.8.2.6	Muon catcher, all blocks and bookend in place	The Near detector mechanical construction is complete. The six blocks and the muon catcher are in place and captured between the two bookends. The detector is ready to be filled with liquid scintillator.
2.8.3.7	Shaft and Near Detector containment systems ready to accept scintillator	Both the Near Detector secondary containment and the secondary containment for the MINOS shaft are in place and ready to support scintillator filling.
2.8.4.6.1.2	Operational readiness approved for ND	This milestone is satisfied once Fermilab has performed an operational readiness review of the Near detector and given the OK to begin operations.
2.8.4.6.3	First cosmic ray tracks observed in near detector	The Near Detector, including the DAQ, is fully operational and cosmic rays are observed in the detector.
2.8.4.6.4	First NuMI beam events observed in near detector	The Near Detector, including the DAQ, is fully operational and neutrino events from the NuMI beam are observed in the detector.
2.8.4.6.5	Near detector completed and ready to operate	The Near Detector is fully complete, all approvals have been obtained and the detector is ready for continuous, un-manned operation.
2.9.1.1.3	Final design approved - module lifting fixture	Milestone achieved when the lifting fixture design is documented and approved for production by the L2 manager.
2.9.1.1.9	Module lifting fixtures completed	Milestone completed when the vacuum lifting fixtures are produced and are approved for use.
2.9.1.1.11	Module lifting fixtures ready for shipping	Milestone completed when the operation of the module lifting fixtures has been documented, operational readiness clearance has been granted and they have been disassembled and packed for shipping.
2.9.1.2.7	Adhesive dispenser completed	Milestone completed when the operation of the adhesive dispenser has been documented, operational readiness clearance has been granted.
2.9.1.2.9	Adhesive dispenser ready for shipping	Milestone achieved when the adhesive dispenser has been completed, tested, disassembled and packed for shipping.
2.9.1.3.8	Block safety constraint completed	Milestone achieved when the block safety beam has been constructed, documented and passed a readiness review.
2.9.1.3.10	Constraint beam ready for shipping	Milestone achieved when the block safety beam has been completed, tested, disassembled and packed for shipping.
2.9.1.4.3	Final design approved - block pivoter and pallet	Milestone achieved when the block pivoter design has been documented and approved by the L2 manager.
2.9.1.4.14	Block pivoter completed	Milestone achieved when the block pivoter has been built, tested
2.9.1.4.16	Block pivoter ready for shipping	Milestone achieved when the block pivoter has been constructed, documented, passed a readiness review, disassembled and packed for shipping to the Far Detector site.
2.9.1.5.4	Survey equipment ready for assembly	Milestone achieved when the survey equipment has been procured and all procedures for the assembly process have been approved.
2.9.2.2.21.3	Final design approved-south bookend	Milestone achieved when the south bookend has been designed, documented and approved for production by the L2 manager.
2.9.2.2.21.6	South bookend components ready for shipment	Milestone achieved when the components of the south bookend are ready to ship to the Ash River site.
2.9.2.2.22.3	Final design approved-north bookend	Milestone achieved when the design of the north bookend hardware has been documented and approved for production by the L2 manager.
2.9.3.1.3	Scintillator transfer facility final design approved	Milestone achieved when the transfer facility design is documented and approved for construction by the L2 manager.

2.9.3.6	Scintillator filling system completed	Milestone achieved when the scintillator filling equipment is completed and approved to deliver scintillator to detector modules.
2.9.4.1.7.6	Adhesive dispenser ready for operation	Milestone achieved when the adhesive dispenser is installed in the Far Detector Hall, passed a readiness review and is ready to be used on detector modules.
2.9.4.1.8.7	Block pivoter ready for operation	Milestone achieved when the block pivoter is installed in the Far Detector Hall, passed a readiness review and is ready for block construction to begin.
2.9.4.3.2	Ready for Far Detector plane assembly	Milestone achieved when the assembly equipment is ready for production and the assembly procedures are established and approved.
2.9.4.3.8	Super-block 1 assembled	Milestone achieved when this superblock has been assembled, installed, and is ready for final survey.
2.9.4.3.14	Super-block 2 assembled	Milestone achieved when this superblock has been assembled, installed, and is ready for final survey.
2.9.4.3.20	Super-block 3 assembled	Milestone achieved when this superblock has been assembled, installed, and is ready for final survey.
2.9.4.3.26	Super-block 4 assembled	Milestone achieved when this superblock has been assembled, installed, and is ready for final survey.
2.9.4.3.32	Super-block 5 assembled	Milestone achieved when this superblock has been assembled, installed, and is ready for final survey.
2.9.4.3.38	Super-block 6 assembled	Milestone achieved when this superblock has been assembled, installed, and is ready for final survey.
2.9.4.3.44	Super-block 7 assembled	Milestone achieved when this superblock has been assembled, installed, and is ready for final survey.
2.9.4.3.60	Block assembly and alignment completed	Milestone achieved when the final survey of all assembled and installed blocks has been completed.
2.9.4.4.7	Super-block 1 filled	Milestone achieved when this superblock has been filled with scintillator.
2.9.4.4.13	Super-block 2 filled	Milestone achieved when this superblock has been filled with scintillator.
2.9.4.4.19	Super-block 3 filled	Milestone achieved when this superblock has been filled with scintillator.
2.9.4.4.25	Super-block 4 filled	Milestone achieved when this superblock has been filled with scintillator.
2.9.4.4.31	Super-block 5 filled	Milestone achieved when this superblock has been filled with scintillator.
2.9.4.4.37	Super-block 6 filled	Milestone achieved when this superblock has been filled with scintillator.
2.9.4.4.43	Super-block 7 filled	Milestone achieved when this superblock has been filled with scintillator.
2.9.4.5.22	Superblock 1 outfitting completed	Milestone achieved when this superblock has all electronics infrastructure installed and operational.
2.9.4.5.25	Superblock 2 outfitting completed	Milestone achieved when this superblock has all electronics infrastructure installed.
2.9.4.5.28	Superblock 3 outfitting completed	Milestone achieved when this superblock has all electronics infrastructure installed.
2.9.4.5.31	Superblock 4 outfitting completed	Milestone achieved when this superblock has all electronics infrastructure installed.
2.9.4.5.34	Superblock 5 outfitting completed	Milestone achieved when this superblock has all electronics infrastructure installed.
2.9.4.5.37	Superblock 6 outfitting completed	Milestone achieved when this superblock has all electronics infrastructure installed.
2.9.4.5.49	15kt installation completed	Milestone achieved when a detector mass of 15 kt is installed, filled with scintillator and outfitted with electronics infrastructure.
2.9.4.6.3	First cosmic ray tracks observed in Far Detector	Milestone achieved when the first cosmic ray events are observed in Superblock 1.
2.9.4.6.4	First NuMI neutrino events observed in Far Detector	Milestone achieved when the first neutrino events from the NuMI beam are detected and read out from Superblock 1.

2.10.10.1	2007 Shutdown Begun	This milestone defines the start of the FNAL 2007 accelerator shutdown as defined by laboratory management
2.10.10.2	2007 Shutdown Completed	This milestone defines the finish of the FNAL 2007 accelerator shutdown as defined by laboratory management.
2.10.10.3	2008 Shutdown Begun	This milestone defines the start of the FNAL 2008 accelerator shutdown as defined by laboratory management.
2.10.10.4	2008 Shutdown Completed	This milestone defines the finish of the FNAL 2008 accelerator shutdown as defined by laboratory management.
2.10.10.5	Accelerator Shutdown Begun	This milestone defines the start of the accelerator shutdown in FY2011 used to install the accelerator upgrades and start the NuMI upgrades as defined by NOvA management.
2.10.10.6	Accelerator Shutdown Completed	This milestone defines the end of the accelerator shutdown in FY2011 used to install the accelerator upgrades and start the NuMI upgrades as defined by NOvA management.
2.10.10.7	NuMI Upgrades Shutdown Begun	This milestone defines the start of the NuMI shutdown in FY2012 used to install the remainder of the NuMI upgrades and change to the medium energy neutrino beam configuration as defined by NOvA management.
2.10.10.8	NuMI Upgrades Shutdown Completed	This milestone defines the end of the NuMI shutdown in FY2012 used to install the remainder of the NuMI upgrades and change to the medium energy neutrino beam configuration as defined by NOvA management.
2.10.8.1	CD-3a	DOE signs off on Critical Decision CD-3a - construction start for long-lead items
2.10.8.2	CD-3b	DOE signs off on Critical Decision CD-3b - approval of construction start
2.10.8.3	CD-4	DOE signs off on Critical Decision CD-4 - Project complete
2.10.9.4	FY08 Funds Available	DOE funding for FY08 is available for obligation
2.10.9.5	CD-3a Funds Available	DOE makes CD-3a funding available for obligation
2.10.9.6	CD-3b Funds Available	DOE makes CD-3b (construction) funding available for obligation
2.10.9.7	FY09 Funds Available	DOE makes FY09 (construction) funding available for obligation
2.10.9.8	FY10 Funds Available	DOE makes FY10 (construction) funding available for obligation
2.10.9.9	FY11 Funds Available	DOE makes FY11 (construction) funding available for obligation
2.10.9.10	FY12 Funds Available	DOE makes FY12 (construction) funding available for obligation
2.10.9.11	FY13 Funds Available	DOE makes FY13 (construction) funding available for obligation
2.10.9.12	Decision point for more detector mass - waveshifter powders	Milestone to assess contingency usage to determine if more waveshifter powders should be purchased to build additional detector mass.
2.10.9.13	Decision point for more detector mass - WLS fiber	Milestone to assess contingency usage to determine if more WLS fiber should be purchased to build additional detector mass.
2.10.9.14	Decision point for more detector mass - APDs	Milestone to assess contingency usage to determine if more APDs should be purchased to build additional detector mass.
2.10.9.15	Decision point for more detector mass - extrusions, modules, mineral oil, pseudocumene	Milestone to assess contingency usage to determine if more components should be purchased to build additional detector mass.