FERMILAB-DESIGN-2009-01

September | 2009

FESS/Engineering Project No. 15-2-1

g-2 Conventional Facilities

PDR

Project Definition Report for the conventional facilities to house the g-2 Experiment.

Fermi National Accelerator Laboratory

U.S. DEPARTMENT OF ENERGY

Managed by Fermi Research Alliance, LLC.

This Project Design Report (PDR) is intended to be a self-consistent basis for the development of a planning level cost estimate for the conventional facilities to support the programmatic requirements. This report has not answered every technical design question and as such, the current level of contingency is believed to be consistent with the degree of technical confidence in the design at this stage. It is recognized that some basic construction concerns will be reviewed and optimized during the remaining stages of the project.

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Section I

The objective of this Project Definition Report (PDR) is to document one possible solution for the conventional facilities required to house the g-2 Experiment on the Fermilab site. It is recognized that this effort is done in support of obtaining project funding and that the programmatic requirements are still considered preliminary at this stage of the project.

The g-2 Conventional Facilities will be located on the Fermilab site, south of the AP-0 Target Hall and north of the MI-60 Service Building.

Project Costs

The Total Estimated Cost (TEC) for the Conventional Facilities portion of this project is estimated at $7,000,000.

The TEC includes Construction, EDIA (Engineering, Design, Inspection and Administration), Management Reserve and Indirect Costs. The TEC has been estimated in FY09 dollars. The Indirect Costs associated with this project are based on current laboratory rates, dated January 2009.

Schedule

Start Preliminary Design	Month 0
Start Project	Month 6
Start Engineering	Month 7
Begin Construction	Month 15
Construction Complete	Month 24
Engineering Construction	Month 26
Project Complete	Month 28

The schedule is based on technically driven parameters and does not incorporate lags for DOE approvals or funding restrictions. It is assumed that at this stage of PDR development that the conventional facilities portion of this experiment will be funded thru the FNAL's General Plant Project (GPP Project) program.

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The g-2 Conventional Facilities design described in this Project Definition Report is based on the g-2 muon storage ring components described in the "*The Brookhaven muon storage ring magnet paper*", dated June 15, 2000. Figure 1, below, is a brief description of the g-2 physics.

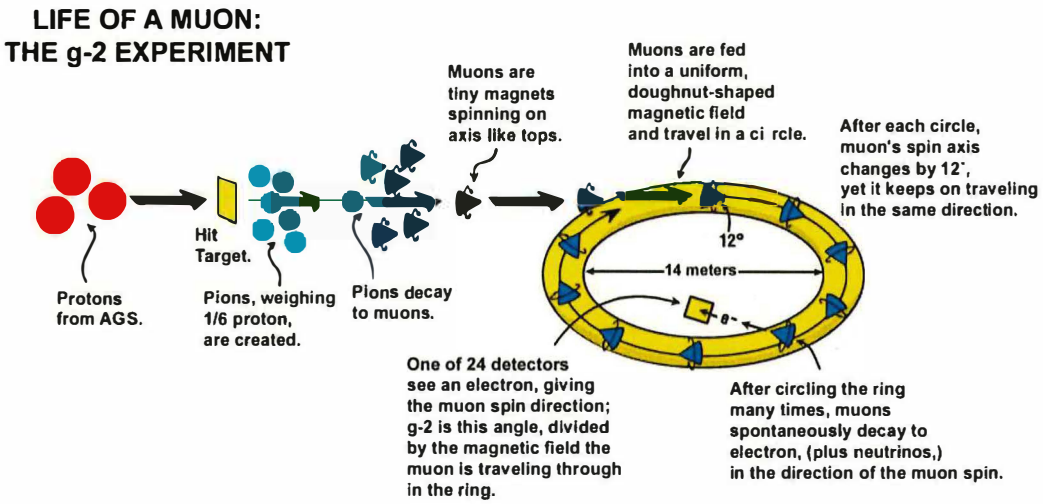

Figure 1 – The g-2 Experiment

The muon storage ring and associated components of the g-2 Experiment are currently housed in a building at Brookhaven National Laboratory. The goal of the g-2 collaborators is to relocate the g-2 Experiment to the Fermilab site. It has been determined that the existing Anti-Proton ring will act as the pion-to-muon decay region, so locating the new facility near the AP-0 Target Building appears reasonable. This Project Definition Report has been prepared assuming an appropriate site within the downstream region of the Anti Proton Target.

Figure 2 is a picture of the muon storage ring as it is housed at Brookhaven National Laboratory.

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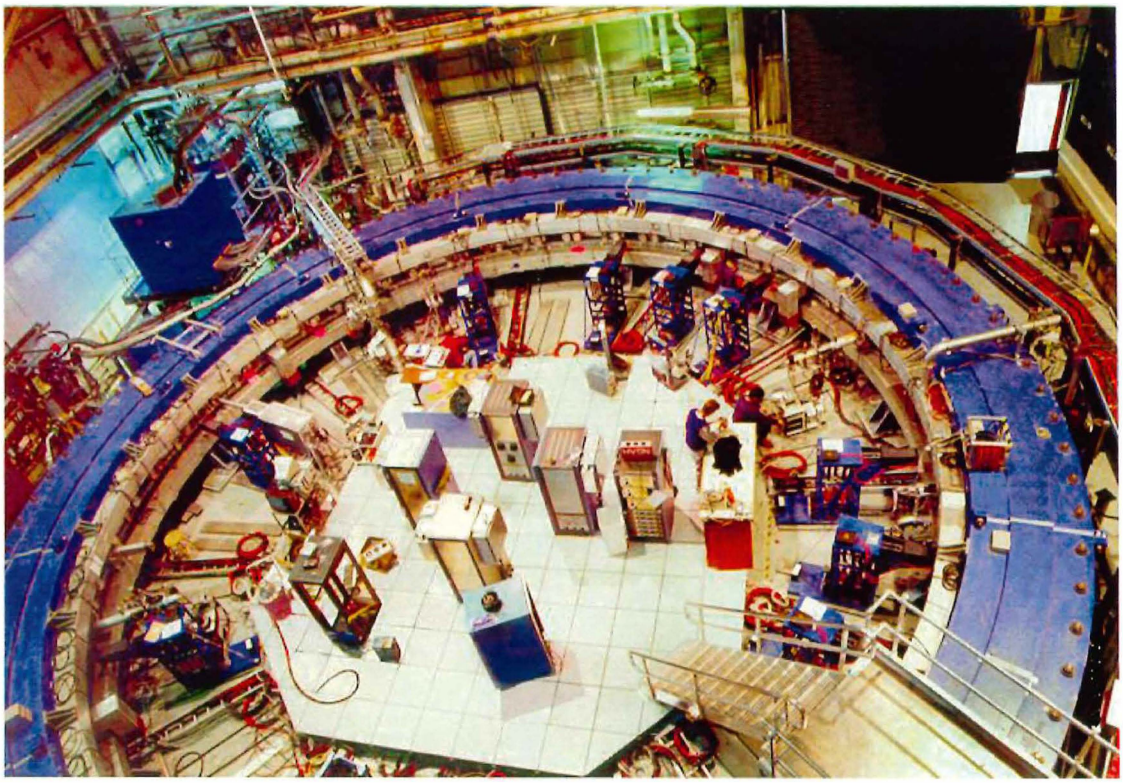

Figure 2 – The g-2 Experiment at Brookhaven National Laboratory

The following assumptions were incorporated into the development of this Project Definition Report.

- The existing Antiproton Ring will be reconfigured for use as a decay region to support the g-2 Experiment. It is assumed that the reconfiguration of the beamline and related devices is not part of the g-2 Conventional Facilities scope of work.
- Cryogenics for the g-2 Experiment will be provided separately, via the Tevatron system, and costs associated with reconfiguring the cryogenic systems are not included in the g-2 Conventional Facilities scope of work.
- With the exception of the magnet coils, all components of the muon storage ring will be shipped directly from BNL to FNAL. The three (3) magnet coils are assumed to be shipped intact to a nearby port and airlifted to the FNAL site. The costs of shipping these components are not included in the g-2 Conventional Facilities scope of work.

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- A new extraction tunnel will be installed to steer the muon beam up to the relocated storage ring. It is assumed that a small section of the existing pretarget enclosure can be removed and rebuilt to accommodate the construction of the new extraction enclosure.
- It is recognized that the shielding requirements are not finalized. For the purposes of this Project Definition Report, a shielding depth of 21 feet earth equivalent has been used for beamlines. Two feet of concrete shielding has been included at grade level to shield the exterior of the building from residual radiation from the muon storage ring.
- The normal occupancy of the g-2 Detector Support Building is assumed to be less than five (5) people.
- It is assumed that any uninterruptible power supply (UPS) required for components located in the Control Room will be provided by the experiment and is not contained in this scope of work.
- It is assumed that there is no requirement for an emergency generator.
- Installation and/or rigging of experiment components are not included in this scope of work.
- Interlocks and other equipment associated with this experiment is not included in this scope of work.
- The building will be designed to reflect the look and character of the Main Injector style buildings. While the g-2 Experimental Hall is located near the AP-0 Target Hall, which is itself a "legacy" building, no further refinement of the architectural style is considered other than the consistency with the Main Injector style buildings immediately adjacent to the new building.
- The guiding principals of high performance building design will be incorporated into the design of the g-2 Conventional Facilities. However, based on the type and use of the facilities, is not intended that the g-2 Conventional Facilities will become a LEED certified building. The project processes and each project element will be evaluated during design to reduce their impact on natural resources without sacrificing program objectives. The project design will incorporate maintainability, aesthetics, environmental justice and program requirements to deliver a well-balanced project. The cost for maintaining the documentation as if certification was being accomplished is included in the Total Project Cost.

The drawings contained in the Appendix B contain detailed descriptions of additional requirements for the g-2 Conventional Facilities.

The g-2 Conventional Facilities will be located in an area south of the Anti Proton Target Building (AP-0) on the Fermilab site. In general terms, a muon beam will be extracted from the existing pretarget enclosure, directed upward to a new building housing the g-2 muon storage ring.

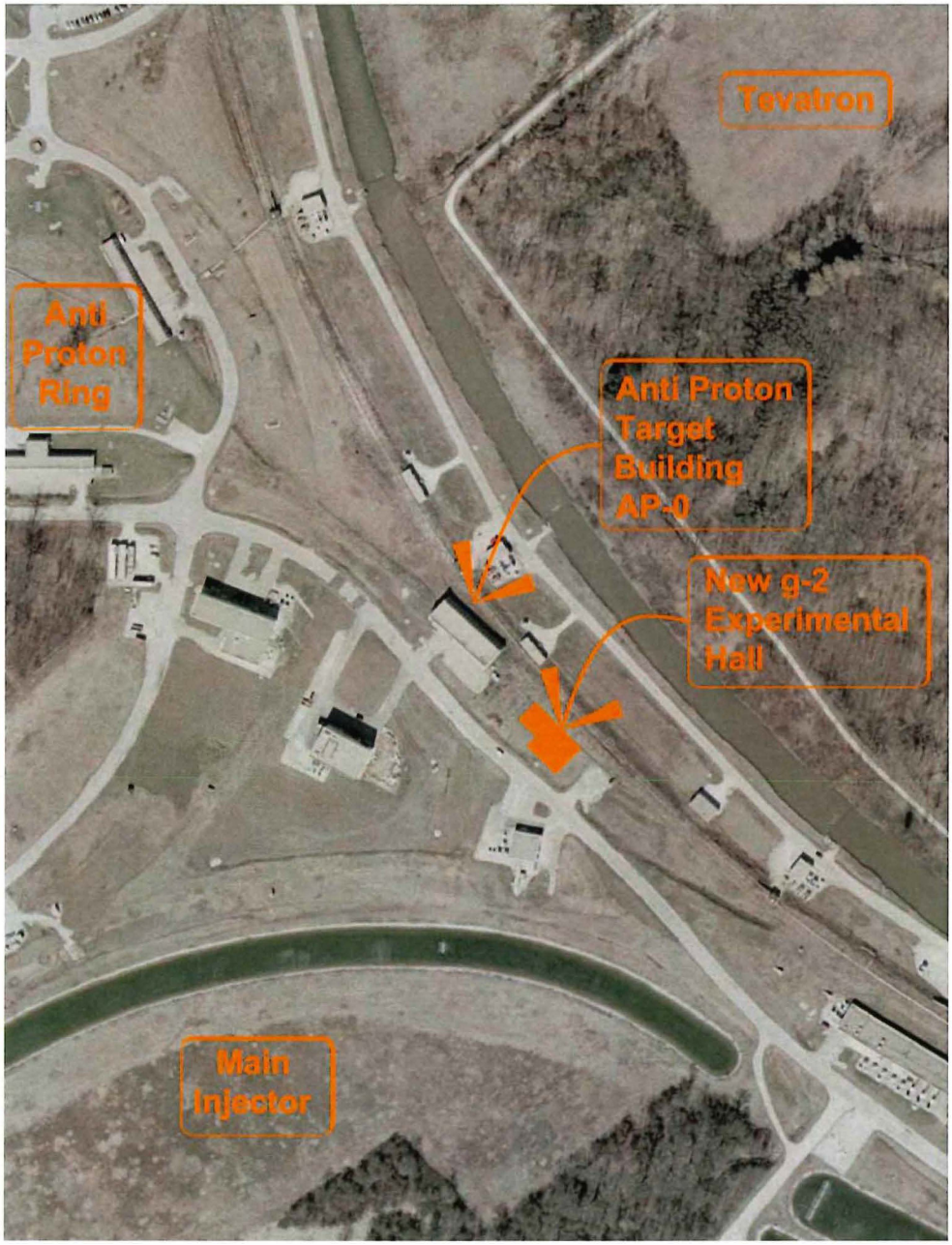

Figure 3 – g-2 Experimental Hall Site Plan

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DISCIPLINE DESCRIPTIONS

The detailed descriptions of the g-2 Conventional Facilities are listed below by discipline.

1. Site Location – Designer: R. Alber

The location for the g-2 Conventional Facilities was selected based on the programmatic requirement for extraction of a muon beam from the existing pretarget beamline enclosure. The location to the south of the AP-0 Target Building was selected to allow for adequate decay length for the pion decay to pure muon beamline. Beam extraction appears possible south of the target hall in a region where precast tunnel sections can be removed for easy access to the existing beamline elements. A new extraction enclosure will be installed including a series of step-ups from the lower level of the extraction point to the new grade level building elevation where the muon storage ring will be housed.

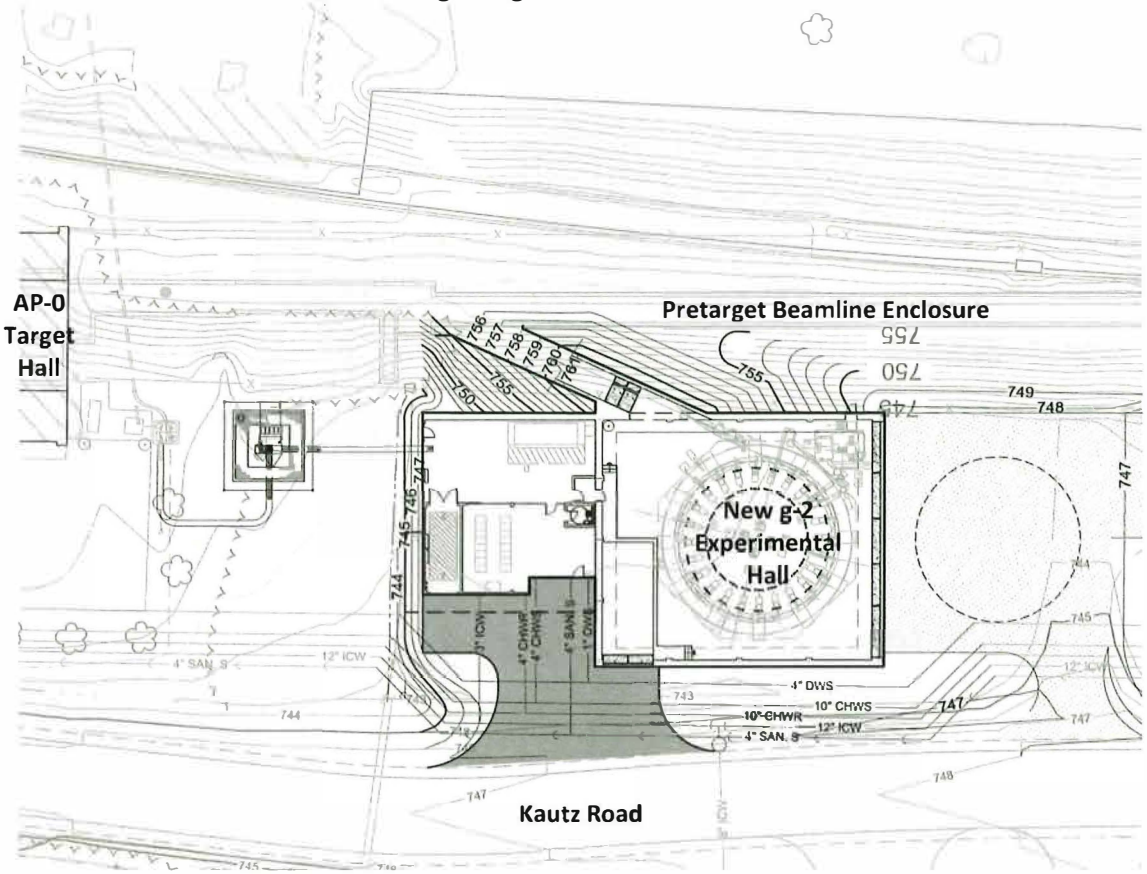

Figure 4 – Site Location Plan

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2. Civil Construction – Designer: J. Hunt

The civil portion of the g-2 Conventional Facilities will consist of the work required to extend existing utilities around and to the project site, excavation associated with the below grade cast-in-place concrete enclosures and the site work associated with completing the project.

The ICW (Industrial Cooling Water), DWS (Domestic Water Supply), CHWS (Chilled Water Supply), CHWR (Chilled Water Return), COM (Communications ductbank) and SS (sanitary Sewer) services for the project will be extended from existing services along Kautz Road (see Figure 4 – Site Location Plan) The existing utility corridor will be rerouted around the limits of the new building construction.

A new access road will provide access to the g-2 Conventional Facilities from existing Kautz Road. This road will be constructed in a similar manner to existing Fermilab roads and will be suitable for all weather access for assembly of the storage ring components and normal operations. The access road and associated parking area will be an extension of the Kautz Road right-of-way. Paved parking will be provided for three (3) vehicles at the facility along with an 80-foot x 60-foot gravel hardstand that will provide a staging area for the coil assembly and installation. A paved approach to the at-grade loading dock with suitable truck maneuvering space will be provided.

A combination of earth and steel shielding will be provided at the extraction beamline enclosures in order to provide the equivalent of 21 feet of shielding. An earthen berm with maintainable side slopes will be installed and the use of steel shielding is expected to keep the top of berm at a reasonable elevation.

An existing drainage ditch to the north of the new facility will be rerouted and restored to maintain drainage between the infield of the Tevatron and the Main Injector site.

3. Architectural – Designer: G. Contreras

The architectural features of the g-2 Conventional Facilities will include a high-bay experimental hall that will house the muon storage ring and a low-bay service building to house support equipment. The floor of the high-bay will be set at an elevation 4-foot below grade. The south end of the building will incorporate an 8-foot high removable wall the length of the building to allow for installation of the three (3) magnet coils. The experimental hall will be serviced by a 30-ton bridge crane and at grade truck loading dock.

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The low-bay service building will house support function for the experiment as well as mechanical/electrical support for the high-bay. Included in the design of the service building will be spaces allocated for a control room and counting room, toilet facilities, mechanical area and an area dedicated for power supplies and compressor equipment. An entry vestibule will be provided between the high-bay and low-bay to maintain temperature stability in the high-bay as well as providing radiation protection for service building occupants.

The building will be constructed as a braced frame, steel construction with prefinished insulated metal siding. The construction type and style will be based on similar adjacent Main Injector style buildings. Figure 6, below, is a photo rendering looking south toward the g-2 Experimental Hall.

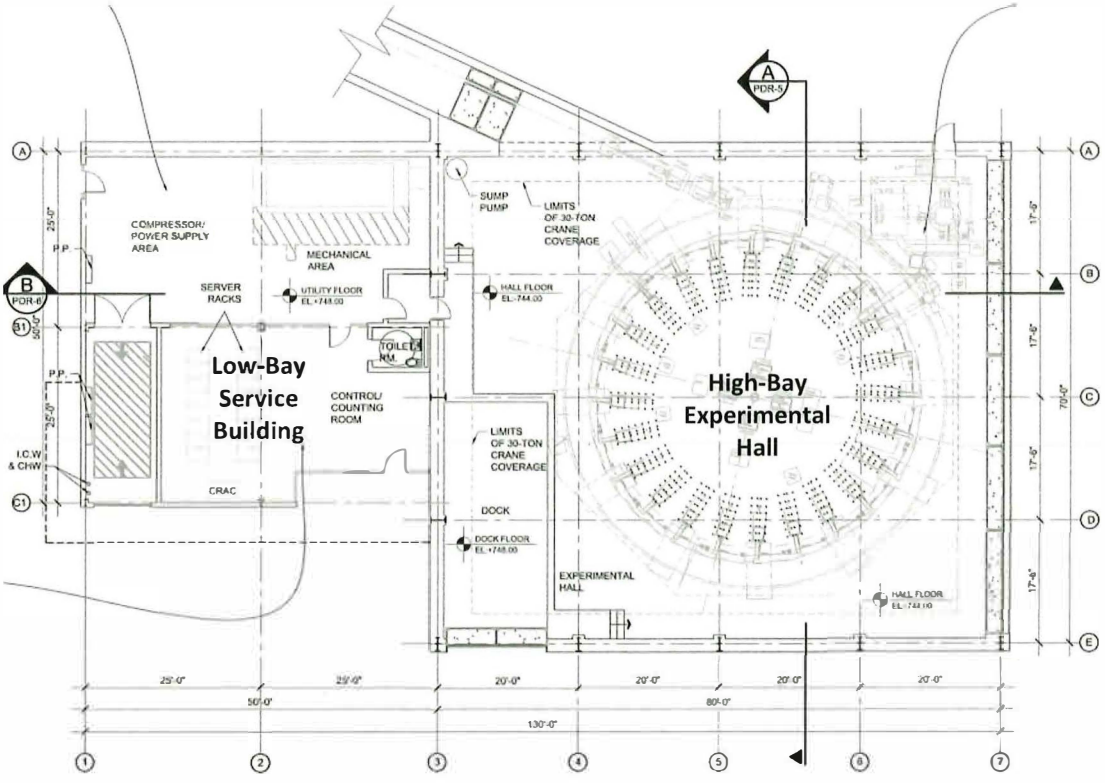

Figure 5 – Architectural Floor Plan

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Figure 6 – Rendering of the g-2 experimental Hall (looking south along Kautz Road)

Each function of the g-2 Detector Support Building is described below:

High-Bay Experimental Hall

The high-bay will provide space for staging and assembling the muon storage ring. The space is surrounded by 2' thick concrete walls to provide radiation shielding to the exterior of the building. Once assembly is complete, the overhead door and removable exterior wall on the south end of the building will be filled with precast concrete shielding blocks to a depth of two (2) feet to provide the required shielding.

The high-bay will be provided with a thirty (30) ton capacity overhead bridge crane that will be used for ring assembly as well as shield block handling. The high-bay contains space for the temporary staging of portions of the shield blocks should removal be required for maintenance and/or repair of the storage ring components.

Low-Bay Service Building

The Control Room/Counting Room provides space for the operation of the g-2 Experiment including the associated computer hardware. It is recognized that this space will be minimally occupied as the day to day operation of the detector will likely

occur at a central facilities located elsewhere. As such, this space will serve as the front end to remote systems and will be used mainly during assembly, initial start up and maintenance/repair activities. This space will be designed in a similar manner to existing control rooms found on the Fermilab site.

Mechanical Area
This space will house the mechanical equipment that supports the heating and cooling of the high-bay experimental hall.

Compressor & Power Supply Area
This space will house the electrical equipment that supports the assembly and operation of the detector. This includes the incoming electrical service switchgear, panelboards, and related power supplies. Space is also provided for the installation of a compressor and related equipment.

Support Functions
The low-bay service building contains a single uni-sex toilet facility required to support a minimally occupied building.

4. **Structural** – Designer: S. Stoica

The structural systems for the g-2 Conventional Facilities are expected to be constructed utilizing conventional methods similar to systems utilized at Fermilab in the past.

The extraction beamline enclosure will be constructed of cast-in-place concrete, including base, wall and roof slabs. These enclosures will be designed to support the shielding loads. Removal of three (3) existing precast hoop sections will be required to facilitate the connection of the extraction beamline enclosure.

Below grade building foundations and retaining walls will be constructed of cast-in-place concrete. A separate and isolated foundation for the muon storage ring will be constructed with drilled piers installed to and supported by bedrock allowing for a stable foundation for the storage ring. The building columns will benefit from drilled piers as well, with pile caps and retaining walls spanning between the piers. An interior floating slab will be installed between the outer retaining walls and the isolated storage ring foundation.

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5. Mechanical – Designer: E. Huedem

The HVAC systems for the g-2 Conventional Facilities will conform to ASHRAE 90.1, ASHRAE 62 and applicable NFPA requirements and applicable sections of the Fermilab Engineering Standards Manual

Mechanical systems and Metasys controls will be further investigated during subsequent phases in accordance with ASHRAE 90.1 and Federal Life Cycle costing analysis.

Heating, Ventilation and Air Conditioning Design Parameters:
High-Bay Experimental Hall

- Temperature: Winter - 68 degrees F (+/- 2 F) / Summer - 78 degrees F (+/- 2F)
- Humidity: 55% maximum relative humidity, no minimum
- Air distribution: Special care to be taken to ensure even distribution of heating and cooling – assume two branch ducts on each side of experimental hall to maintain temperature stability

Low-Bay Service Building

- Temperature: Compressor/Power Supply Room
  Winter – 68 degrees F min. / Summer – Ambient

  Control/Counting
  Winter – 68 degree F min. / Summer – 75 degrees F
- Humidity: No maximum or minimum humidity requirement

All plumbing work to be installed in accordance with Illinois Plumbing Code and Standard Specifications for Water & Sewer Main Construction in Illinois.

A 10 Ton CRAC unit will be installed in the Counting/Control Room. The unit will be air-cooled, downflow, compressorized systems. The 10 Ton unit is selected based on an equipment load of 16 one-kw racks. Operation data from this system will be passed to a Johnson Metasys DDC device for connection to the site wide DDC network.

A duplex sump pump system will be installed to collect subsurface water from around the g-2 Conventional Facilities.

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6. Fire Protection/Life Safety – Designer: J. Niehoff

For the purposes of the Project Definition Report, it is assumed that no hydrogen will be used throughout this facility.

Fire Alarm/Fire Suppression systems for the g-2 Conventional Facilities shall be designed in accordance with the applicable sections of the Fermilab Engineering Standards Manual.

Automatic sprinkler systems shall be designed to a minimum of an Ordinary Hazard Group 2 classification, in accordance with National Fire Protection Association (NFPA) latest edition. The most commonly used NFPA standards relative to automatic sprinkler systems are: 13, 20, 25, 318 and 750.

Fire alarm systems shall be designed with a minimum standby power (battery) capacity. These batteries shall be capable of maintaining the entire system in a non-alarm condition for 24 hours, in addition to 15 minutes in full load alarm condition. The most commonly used NFPA standards relative to fire alarm systems are: 70, 72, 90A, and 318.

The facility will be equipped with a hard-wired, zoned, general evacuation fire alarm system consisting of:

- Manual fire alarm stations at the building exits
- Sprinkler system water flow and valve supervisory devices
- Combination fire alarm horn/strobe located throughout the building
- A 24 volt addressable fire alarm control panel
- Connection to the site wide FIRUS monitoring system
- Smoke detection as required.

7. Electrical – Designer: T.B.D.

The electrical power for the g-2 Conventional Facilities will be provided by a new 1,500 kVA transformer. The transformer has been sized to accommodate the anticipated electrical power for both the conventional facilities and the g-2 programmatic equipment.

A new concrete encased power duct bank will be installed to connect the g-2 facility to the existing Fermilab 13.8 kv electrical infrastructure system. This connection will occur at the existing air switch located along side the AP-0 Target Hall. A spare bay will allow for connection to Feeder 24. The new transformer will be connected to the

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g-2 Experimental Hall via a new concrete encased ductbank and will be routed to new electrical service switchgear inside the g-2 Service Building. The switchgear will be sized to accommodate the entire 1,500 kVA power from the new transformer. From the switchgear the electrical power will serve conventional facilities equipment and programmatic equipment for the g-2 Experiment.

The power for the conventional HVAC equipment will be provided from the new electrical panelboard, utilizing 480v power.

New electrical panels serving the lights, outlets and general house power will be included in the electrical power distribution system.

Equipment power will be provided from panelboards in the service building. No provisions for running electrical to equipment loads are provided in this PDR.

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The g-2 Conventional Facilities project team developed a cost estimate and schedule based on the preliminary design described in the drawings and Section III. The design drawings, detailed descriptions and cost estimate should be considered preliminary and based on the assumptions and requirements contained in Section II. As the programmatic requirements are refined the cost and schedule implications will also require refinement and adjustment.

PART 1 COST SUMMARY

Listed below is a summary table of the costs associated with the scope of work contained in this project definition report.

PDR Funding Profile

	Fiscal Year 1	Fiscal Year 2	Total
Construction	$350,000	$3,677,000	$4,027,000
EDIA	$620,000	$266,000	$886,000
Management Reserve	$243,000	$983,000	$1,226,000
Space Management	$0	$450,000	$450,000
Subtotal	$1,213,000	$5,376,000	$6,589,000
Indirect Costs	$287,000	$124,000	$411,000
TOTAL	**$1,500,000**	**$5,500,000**	**$7,000,000**

Construction Funding is planned to be distributed over two fiscal years, the first year will include pre-procurement of long lead items, i.e. overhead bridge crane and 1,500kVA transformer and the balance of construction funding requested the following year to cover the balance of construction.

EDIA (Engineering, Design, Inspection and Administration) is estimated at 22% of the full construction cost. EDIA is planned to be distributed over two fiscal years, the first year will include final design utilizing both in-house and subcontracted A/E professional services and the balance of EDIA requested the following year to cover the construction oversight costs.

Management Reserve is established at this stage of preliminary design at 25%.

Space Management is assumed to be costed in Fiscal Year 2. Beginning in FY03, all new DOE funded construction projects, including line items and GPP, which provide new space, must have an equivalent amount of excess space allocated from the DOE

Office of Science Space Bank. This Project Definition Report includes funding for the elimination of existing Fermilab square footage equal to the new space. The FY09 cost for disposal of similar space is $38 per square foot, not including EDIA, MR or indirect costs. While these costs are included in this PDR, it is assumed that upon project approval, a waiver will be requested to use existing square footage from the DOE Office of Science Space Bank, or similarly, square footage from the FNAL Space Bank will identified and allocated to offset the additional square footage.

Indirect Costs are planned to be costed as Construction and EDIA funding are utilized. For this funding profile, it is estimated that two construction packages (pre-procurement and building construction) will result in 2 x $500K construction packages at an indirect rate of 16% (M&S) with the balance of construction cost (>500K) exempt from indirect charges. Indirect Costs for EDIA is established assuming that half of the EDIA will be utilized in-house at an indirect rate of 42% and half of the EDIA utilized by subcontract A/E professional services at an indirect rate of 16%.

Listed below are descriptions of the basic components used to develop the cost estimate.

PART 2 COST METHODOLOGY

The costs ranges contained in this Project Definition Report are based on FY2009 dollars. Escalation adjustment to the above costs will need to be applied once a funding profile has been baselined.

The above suggested project budget is based on cost data taken from Means Cost Estimating Guides, historical data and recent construction history here at Fermilab. While the suggested project budget can provide input for the feasibility of the project, further design refinement will affect the final cost of the project.

Engineering Design and Inspection (ED&I) activities are included in the suggested project budget. ED&I activities include the engineering and design activities in Preliminary and Final Design, the inspection activities associated with Construction Phase Support. The descriptions are based on DOE Directive G430.1-1, Chapter 6. Administration activities include those defined by DOE Directive G430.1-1, Chapter 6 as Project Management (PM) and Construction Management (CM). Past historical data and DOE Directive G430.1-1, Chapter 25 indicate that 18%-25% of the construction costs is an appropriate range.

The application of risk-based contingency has been considered in the development of this PDR. The contingency has derived from a risk analysis of various aspects of the scope being estimated. This analysis takes into consideration budget, schedule, and technical risks as they apply to the project effort, underscoring the uncertainties that exist in each of the elements. The magnitude of the contingency estimate will depend on the status of planning, design, procurement, and construction, and the complexities and uncertainties of the operation or component parts of the project element. Part 3 below contains the preliminary risks identified with the conventional facilities at this stage of the project.

Indirect Costs rates are defined by DOE Order 4700.1 that states indirect costs are "...costs incurred by an organization for common or joint objectives and which cannot be identified specifically with a particular activity or project". The suggested costs above include Indirect Costs calculated at the current rate for projects. The Directorate Budget Office should be consulted for current rates and procedures.

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PART 3 COST ESTIMATE CLASSIFICATION

DOE Guide 430.1-1X, *DOE Cost Estimating Guide for Program and Project Management*" classifies cost estimates into one (1) of five (5) categories. These classifications are listed below:

Cost Estimate Classification	Primary Characteristics	
	Level of Definition (% of Complete Definition)	Cost Estimating Description (Techniques)
Class 5, Order of Magnitude	0% to 2%	Stochastic, most parametric, judgment (parametric, specific analogy, expert opinion, trend analysis)
Class 4, Intermediate	1% to 15%	Various, more parametric (parametric, specific analogy, expert opinion, trend analysis)
Class 3, Preliminary	10% to 40%	Various, including combinations (detailed, unit-cost, or activity-based; parametric; specific analogy; expert opinion; trend analysis)
Class 2, Intermediate	30% to 70%	Various, more definitive (detailed, unit-cost, or activity-based; expert opinion; learning curve)
Class 1, Definitive	50% to 100%	Deterministic, most definitive (detailed, unit-cost, or activity-based; expert opinion; learning curve)

These classifications are based on the Association for the Advanced of Cost Engineering (AACE) Recommended Practice No. 18R-97. These classifications help ensure that the quality of the cost estimate is appropriately considered when applying escalation and contingency.

The level of detail and accuracy of the budget becomes more definitive as the project's scope is refined. In a project's earliest phases, the Initiation, or Pre-Conceptual Phase (before Critical Decision [CD] -0, an Order-of-Magnitude (or Parametric) Estimate is usually required. When a capital asset acquisition project has completed the Conceptual Design Phase, a Preliminary Budget Range is required to establish the Budget Baseline at CD-1. Budget refinements shall be based on a Definitive Estimate for every element in the WBS and is required for CD-2.

The classification for the g-2 Conventional Facilities PDR is considered a Class 4 (Intermediate) based on the preliminary nature and level of definition of the programmatic requirements.

PART 4 PRELIMINARY RISK IDENTIFICATION

Contingency estimates are generally applied as a percentage of a particular cost or category of work. The PDR cost estimate is based on using the best available information to develop the expected cost, and then a risk analysis is performed to develop the required contingency budget based on risk probability and consequence. It is recognized that higher or lower contingency amounts are appropriate throughout the project based on an analysis of project complexity, technical characteristics, and associated risks. As part of the development of the cost estimate, the project team has developed a preliminary list of high impact risks for the g-2 Conventional Facilities.

Risk #1 – Programmatic Requirements
The early stage of the project and the likely evolution of the programmatic requirements has the ability to impact the cost and schedule for the conventional facilities.

Risk #2 – Subsurface Characteristics
The g-2 project is intended to be located on a portion of the Fermilab site with limited historic subsurface data. Experience at similar adjacent projects has been used as a basis of assumption for the development of this PDR. However, unknown subsurface conditions have the ability to impact the cost and schedule for the conventional facilities.

Risk #3 – Program Scheduling
It is currently assumed that construction of the g-2 Experimental Hall must be performed during a major laboratory accelerator shutdown. Program scheduling may impact the timing of construction and therefore, impact schedule and the future escalation of costs.

PART 5 PRELIMINARY PROJECT SCHEDULE

The g-2 Conventional Facilities project team developed a preliminary project schedule based on discussions with the g-2 collaborators and information obtained while compiling this project definition report.

The baseline schedule listed below sets forth the major activities and milestones essential for the completion of the project. The milestones are defined as:

MILESTONE	DEFINITION	BASELINE
Start Preliminary Design	Prepare Project Plan and Directive	Month 0
Start Project	Directive signed	Month 6
Start Engineering	Engineering work for the project starts when a task is entered into the Task Database	Month 7
Begin Construction	Notice To Proceed/Purchase Order Issued	Month 15
Construction Complete	Final acceptance of all work	Month 24
Engineering Complete	Completion of Close-out Documents	Month 26
Project Complete	Project Closed	Month 28

Ideally, the beginning of construction at Month 15 would correspond with a major lab accelerator shutdown, such as the major shutdown planned for October 2011 (FY12). In order to meet this milestone date to coincide with this shutdown, preliminary design should be initiated by July 2010 (FY10).

PART 6 PREVIOUS COST ESTIMATES

The g-2 Collaboration submitted an initial proposal to FNAL dated February 9, 2009 to bring the g-2 Experiment to the FNAL site. Included in this proposal was an estimated cost for conventional facilities at $4M. See Appendix C – Previous Cost Estimate dated August 25, 2008.

A cost review was performed by an FNAL cost review committee to evaluate the costs associated with the original proposal. The review of the conventional facilities cost estimate resulted in a new cost range of $8M to $13M. See Appendix D – g-2 Conventional Facilities Cost Review dated May 6, 2009.

This PDR was created in response to this later review and is intended to better define the project requirements for housing the g-2 storage ring on the FNAL site.

The following is list of responses to the cost review now that a Project Definition Report and Class 4 cost estimate has been created:

Cost Review Comment	Incorporated into PDR?	PDR Response
Site Considerations		
The site is lower than the adjacent Kautz Road and buildings by three to four feet. Raise site with structural fill.	No	Building floor level for the experimental hall is at 4' below grade level. No fill required.
A swale transverses the site at the proposed building site - provide drainage.	No	Building has been located on the site to minimize the impact to the existing swale.
An existing utility corridor runs thru the building site - relocate utilities.	Yes	Utility corridor relocated.
The exit discharge from the AP0 Pretarget Enclosure butts to the proposed building - modify existing stairs.	No	Building has been located on the site to avoid affecting the stairs.
Rad Worker Training required for the conventional facilities workforce.	Yes	Rad Worker Training is included in the PDR cost estimate.
Include costs for a new 1500kVA transformer	Yes	Breakdown of costs included in the cost estimate.
Relocate existing electrical equipment to allow for installation of extraction beamline.	No	The extraction beamline has been located on the site to avoid the existing equipment.
Building and Beamline Enclosure		
Building square-foot costs are too low.	Yes	Cost estimate performed on preliminary design elements - not square -foot costs.
No provisions included for loading dock bay - add additional bay to building.	No	Loading dock fits within the building footprint.
Cost estimate of bridge crane too low.	Yes	Increased estimated cost of crane.
Lower the ring to the level of the PBar transport beamline.	No	Cost deemed to be prohibitive.

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Include cost for extraction enclosure.	Yes	Cost estimate for extraction enclosure performed.
Building adjacent to "legacy" building - increase cost of new building.	No	Main Injector building style has been included in the cost estimate as many MI buildings surround the area.
Building Services, HVAC, Process Water, Electrical, Fire Protection/Detection		
Increase costs for HVAC & Process Water Systems	Yes	Breakdown of costs included in the cost estimate.
Increase costs for electrical distribution	Yes	Breakdown of costs included in the cost estimate.

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APPENDIX A

g-2 Conventional Facilities

Cost Details

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FERMILAB: FESS COST ESTIMATE

				ESTIMATED SUBCONTRACT AWARD AMOUNT	$4,027,000
Subcontractor's Overhead and Profit @	18.0%				$614,000
Economic Conditions and Training @	3.0%				$99,000
Subcontract Base Estimate					$3,314,000
g-2 EXPERIMENTAL HALL - Conventional Facilities		Project No.	Status:	Date:	Rev Date
		15-2-1	PDR	Sep 09	

	DESCRIPTION OF WORK:		QUANTITY	UNITS	UNIT COST	AMOUNT
01	**SITE PREP/SITE FINISH**	$357,000				
	Mobilize/Survey/Temp. Power/Phone		1	Lot	$5,000	$5,000
	Silt Fencing/Erosion Control		1	Lot	$5,000	$5,000
	Topsoil Stripping and Stockpiling		1	Lot	$3,000	$3,000
	Demo existing underground water and sanitary mains		860	LF	$20	$17,200
	Demo existing asphalt on Kautz Road for utility installation		150	SY	$10	$1,500
	Excavate for foundations and utilities		3000	CY	$25	$75,000
	Temp. sump		1	Lot	$2,000	$2,000
	Drain tile piping		350	LF	$15	$5,300
	Backfill and compact around building		1500	CY	$30	$45,000
	Install sanitary sewer		250	LF	$40	$10,000
	Install water mains (ICW, DWS, CHWS, CHWR)		925	LF	$60	$55,500
	Fire hydrant and PIVS		4	Ea	$2,500	$10,000
	Shoring for utilities		1	Lot	$5,000	$5,000
	Install ground grid		1	Lot	$7,500	$7,500
	Electrical ductbank		140	LF	$150	$21,000
	Communication ductbank		30	LF	$150	$4,500
	Asphalt pavement parking lot		285	SY	$9	$2,600
	Stripe parking lot		1	Lot	$1,200	$1,200
	Guardrail		25	LF	$80	$2,000
	Aggregate hardstand		680	SY	$42	$28,600
	Stockpile extra soils		1500	CY	$15	$22,500
	Rework drainage swale and culverts		1	Lot	$10,000	$10,000
	Final grade and seeding		1	Lot	$8,000	$8,000
	Landscaping		1	Lot	$10,000	$10,000
02	**BUILDING FOUNDATION**	$560,000				
	4' dia concrete caissons		20	Ea	$6,000	$120,000
	2.5' thick base slab		160	CY	$300	$48,000
	Isolation joint		1	Lot	$2,700	$2,700
	2' thick concrete walls		345	CY	$450	$155,300
	4' wide footings		250	CY	$350	$87,500
	1' wide perimeter walls		15	CY	$450	$6,800
	Column footing and pier		1	Lot	$5,000	$5,000
	Granular under slab 6"		150	CY	$30	$4,500
	Transformer foundation		1	Lot	$50,000	$50,000
	Concrete Slab-On-Grade		6400	SF	$8	$51,200
	Concrete bollards		10	Ea	$350	$3,500
	Loading dock		1	Lot	$25,000	$25,000
03	**TRANSPORT LINE ENCLOSURE**	$302,000				
	Excavation		1600	CY	$35	$56,000
	Temp. sump		1	Lot	$2,000	$2,000
	Remove 3 precast enclosure sections		1	Lot	$25,000	$25,000
	1.5' thick base slabs		60	CY	$400	$24,000
	1' thick walls and ceilings		175	CY	$550	$96,300
	Install 40' x 10' x 4' thick steel shielding (on-site steel)		1	Lot	$25,000	$25,000
	Drain tile piping		200	LF	$15	$3,000
	Backfill and compact berm		1600	CY	$35	$56,000
	Final grade and seeding		1	Lot	$15,000	$15,000
04	**BUILDING STEEL**	$652,000				
	Low-Bay Building		$97,400			
	Columns		2.1	Ton	$3,500	$7,400
	Roof Girders		8.6	Ton	$4,500	$38,700
	Girt framing members		6.3	Ton	$6,000	$37,800

g-2 EXPERIMENTAL HALL - Conventional Facilities			Project No.	Status:	Date:	Rev Date
			15-2-1	PDR	Sep 09	
	DESCRIPTION OF WORK:		QUANTITY	UNITS	UNIT COST	AMOUNT
	1 1/2" roof decking (diapram action)		2500	SF	$3	$7,500
	Misc. steel and bent plates		1	Ton	$6,000	$6,000
	High-Bay Building		**$554,900**			
	30-Ton Bridge Crane		1	Lot	$250,000	$250,000
	Columns		19.5	Ton	$3,500	$68,300
	Roof Trusses		8.4	Ton	$3,500	$29,400
	Roof beams		26.3	Ton	$4,500	$118,400
	Girt framing members		10	Ton	$6,000	$60,000
	1 1/2" roof decking (diapram action)		5600	SF	$3	$16,800
	Misc. steel and bent plates		2	Ton	$6,000	$12,000
05	**BUILDING SHELL**	**$502,000**				
	Exterior Siding					
	Exterior siding w/ liner panel & insulation		10500	SF	$30	$315,000
	Trim & flashing		1	Lot	$15,000	$15,000
	Built-up roofing					
	Rigid insulation board		8200	SF	$5	$41,000
	4-ply roofing		8200	SF	$5	$41,000
	Blocking & flashing		1	Lot	$10,000	$10,000
	Glass window walls and doors (exterior)		500	SF	$50	$25,000
	Exterior Doors					
	HM door (4'x7') insulated		2	Ea	$5,000	$10,000
	Roll-up (16'x20' high) insulated		1	Ea	$30,000	$30,000
	Roll-up (8'x12' high) insulated		1	Ea	$15,000	$15,000
06	**INTERIOR WORK**	**$185,000**				
	CMU walls		2750	SF	$9	$24,800
	Doors and hardware					
	HM door (4'x7')		3	Ea	$1,000	$3,000
	HM door (4'x7' dbl)		1	Ea	$1,500	$1,500
	Interior windows		150	SF	$25	$3,800
	Misc. shield blocks (custom)		65	CY	$750	$48,800
	Painting					
	Structural steel		1	Lot	$20,000	$20,000
	CMU & concrete walls		1	Lot	$12,500	$12,500
	Paint doors & misc		1	Lot	$7,500	$7,500
	Epoxy paint on conc. slab		8100	SF	$4	$32,400
	Trim-out Electrical					
	Receptacle Trim-out		1	Lot	$1,500	$1,500
	Lighting Trim-out		1	Lot	$12,000	$12,000
	Telecom Trim-out		1	Lot	$2,500	$2,500
	Trim-out Mechanical		1	Lot	$10,000	$10,000
	Misc. trim & finishes		1	Lot	$5,000	$5,000
07	**MECHANICAL**	**$366,000**				
	HIGH BAY HVAC *(based on minimal load to air)*		**$125,000**			
	HIGH BAY - HVAC Unit (chw airhandler 20 Ton)		1	EA	$ 40,000	$40,000
	HIGH BAY - supply ductwork 18" round		60	LF	$ 32	$1,900
	HIGH BAY - supply ductwork 20" round		40	LF	$ 37	$1,500
	HIGH BAY - supply ductwork 22" round		130	LF	$ 40	$5,100
	HIGH BAY - supply ductwork 30" round		40	LF	$ 57	$2,300
	HIGH BAY - duct elbows allowance		8	EA	$ 125	$1,000
	HIGH BAY - return air ductwork		380	LB	$ 7.75	$2,900
	HIGH BAY - outside air ductwork		820	LB	$ 7.75	$6,400
	HIGH BAY - exhaust air ductwork		219	LB	$ 7.75	$1,700
	HIGH BAY - duct insulation (mech rm only)		1342	SF	$ 3.03	$4,100
	HIGH BAY - supply diffuser		12	EA	$ 125	$1,500
	HIGH BAY - balancing dampers		2	EA	$ 200	$400
	HIGH BAY - return grille		1	EA	$ 330	$300
	HIGH BAY - miscellaneous duct hardware		1	LOT	$ 1,000	$1,000
	HIGH BAY - Intake Vent and Relief Vent (or louver)		1	LOT	$ 8,600	$8,600

g-2 EXPERIMENTAL HALL - Conventional Facilities			Project No.	Status:	Date:	Rev Date
			15-2-1	PDR	Sep 09	
	DESCRIPTION OF WORK:		QUANTITY	UNITS	UNIT COST	AMOUNT
	HIGH BAY - piping 2-1/2" chilled water piping		70	LF	$ 35	$2,400
	HIGH BAY - elbows 2-1/2"		4	EA	$ 115	$500
	HIGH BAY - piping 2-1/2" insulation		70	LF	$ 7	$500
	HIGH BAY - piping 3" chilled water piping		46	LF	$ 43	$2,000
	HIGH BAY - elbow 3"		4	EA	$ 163	$700
	HIGH BAY - pipe insulation		46	LF	$ 7	$300
	HIGH BAY - Tee 3"		4	EA	$ 257	$1,000
	HIGH BAY - miscellaneous fittings		1	LOT	$ 800	$800
	HIGH BAY system startup. Leak test, etc		16	HR	$ 50	$800
	HIGH BAY - stratification fans		2	EA	$ 925	$1,900
	HIGH BAY - heater 5kw loading dock		1	EA	$ 725	$700
	HIGH BAY - DDC controls and metasys connection		1	LOT	$ 35,000	$35,000
	CONTROL ROOM/ COUNTING ROOM HVAC		**$20,000**			
	CONTROL ROOM -hvac unit (basis is 10-ton crac)		1	EA	$ 15,600	$15,600
	CONTROL ROOM -chilled water piping 2"		100	LF	$ 25	$2,500
	CONTROL ROOM -elbow 2"		4	EA	$ 77	$300
	CONTROL ROOM - misce fittings		1	LOT	$ 500	$500
	CONTROL ROOM -pipe insulation		100	LF	$ 6	$600
	CONTROL ROOM -miscellaneous startup testing		16	HR	$ 50	$800
	OTHER - HEATING VENTILATION		**$11,000**			
	UTILITY CRYO ROOM - Louvers (basis 4'x4')		16	SF	$ 41	$700
	UTILITY CRYO ROOM - motorized damper		1	EA	$ 985	$1,000
	UTILITY CRYO ROOM - exhaust fans		2	EA	$ 1,925	$3,900
	UTILITY CRYO ROOM - heaters		4	EA	$ 725	$2,900
	UTILITY CRYO ROOM - simple controls		1	LOT	$ 800	$800
	TOILET - Exhaust fans and duct, & heaters		1	LOT	$ 2,000	$2,000
	PLUMBING		**$37,000**			
	4" Size C.I. Roof Drain Piping		200	LF	$25.00	$5,000
	4" C.I. "Y" & Clean-Outs		20	EA	$150.00	$3,000
	4" PVC San. Piping		125	LF	$28.00	$3,500
	4" Floor Drains W/Traps & Clean-Outs		3	EA	$250.00	$800
	3" Vent Piping		70	LF	$24.50	$1,700
	Water Supply Piping, 3/4" Copper		100	LF	$14.30	$1,400
	Hose Bibbs		1	EA	$125.00	$100
	Water Closet system		1	Lot	$1,880.00	$1,900
	Lavatory W/Faucet		1	Lot	$1,000.00	$1,000
	Water Heater, Electric		1	EA	$1,000.00	$1,000
	Misc. Piping, Fittings & Valves		1	Lot	$2,500.00	$2,500
	Duplex Sump with Pit and Piping		1	EA	$15,000.00	$15,000
	FIRE PROTECTION		**$172,000**			
	Fire Protection		8600	SF	$10.00	$86,000
	Fire Detection		8600	SF	$10.00	$86,000
08	**ELECTRICAL**	**$390,000**				
	1500 kVA Transformer (exterior pad mounted)		1	Lot	$100,000	$100,000
	1200A Panelboard		1	Ea	$65,000	$65,000
	HV & MV feeder pulls, terminations and testing		1	Lot	$30,000	$30,000
	225A Panelboard		3	Ea	$15,000	$45,000
	75 kVA Transformer		2	Ea	$10,000	$20,000
	Electrical Rough-in (conduits, boxes, appliances, etc)					
	Receptacle Rough-in		1	Lot	$45,000	$45,000
	Lighting Rough-in		1	Lot	$75,000	$75,000
	Telecom Rough-in		1	Lot	$10,000	$10,000

APPENDIX B

g-2 Conventional Facilities

Preliminary Drawings

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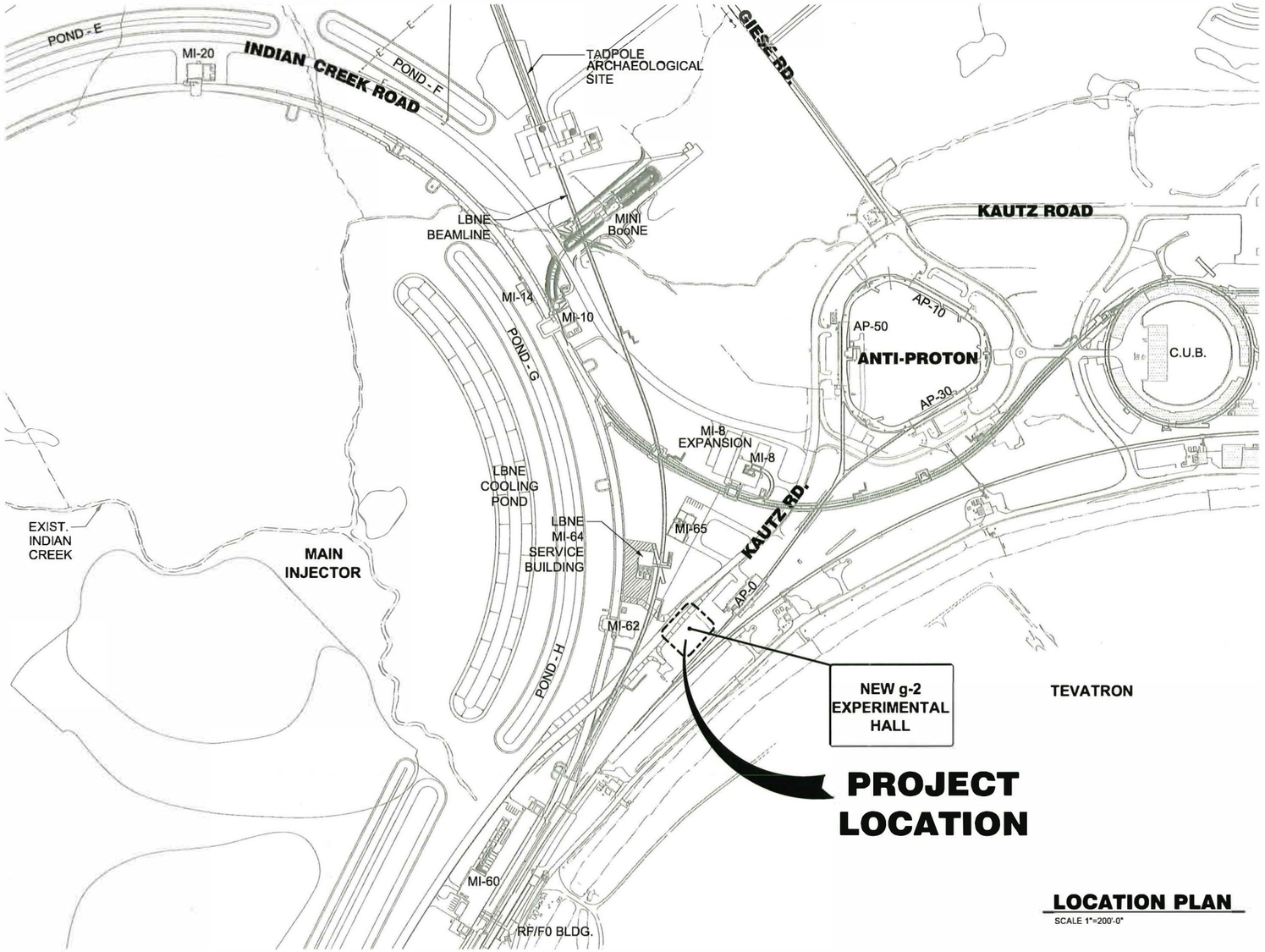
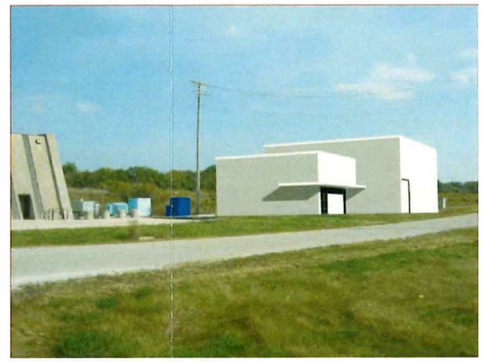


LOCATION PLAN
SCALE 1"=200'-0"



DRAWING LIST

INDEX	
PDR-1	g-2 TITLE SHEET
PDR-2	g-2 SITE PLAN
PDR-3	g-2 FLOOR PLAN
PDR-4	g-2 ENCLOSURE PLAN
PDR-5	g-2 SECTION A
PDR-6	g-2 BUILDING ELEVATION & SECTION

g-2 CONVENTIONAL FACILITIES
EXPERIMENTAL HALL

SCALE:
200 0 200 400 FEET
SCALE
1" = 200'-0"

PROJECT NORTH

g-2 CONVENTIONAL FACILITIES
EXPERIMENTAL HALL LOCATION PLAN

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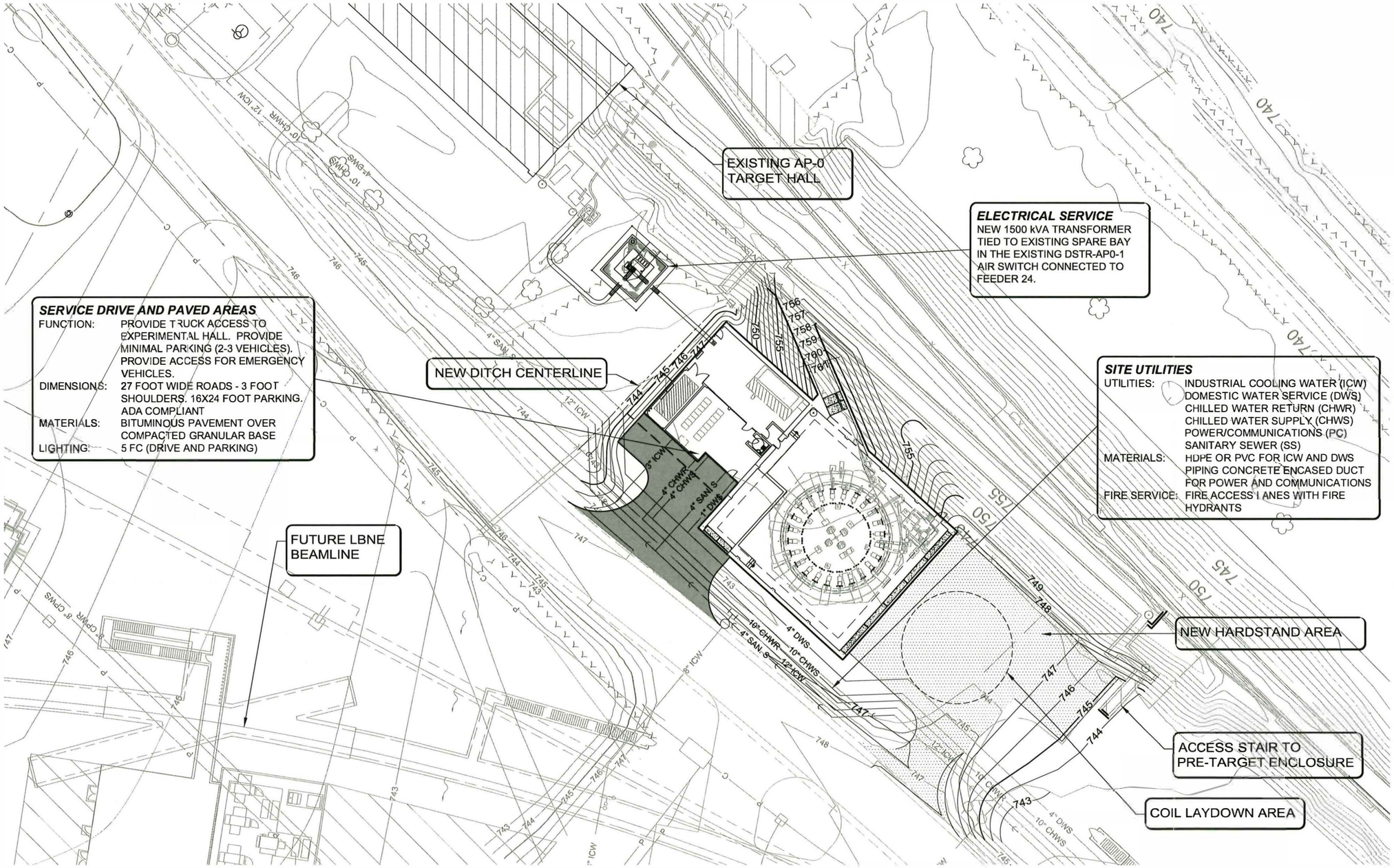
PDR-1



SCALE:

1" = 20'-0"

PROJECT NORTH

g-2 CONVENTIONAL FACILITES

EXPERIMENTAL HALL -SITE PLAN

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DRAWING NO.

PDR-2

COMPRESSOR / POWER SUPPLY MECHANICAL AREA

VENTILATION & HEATING ONLY:
HUMIDITY: NO MINIMUM OR MAXIMUM HUMIDITY REQUIREMENT.

TEMPERATURE STABILITY: NONE

TEMPERATURES: SUMMER AMBIENT VENTILATION, AND WINTER 68F MINIMUM.

EQUIPMENT HEAT LOAD TO AIR: AS ASSUMED 5KW FROM POWER SUPPLY AND 17KW FROM AIRCOOLED-CRYO COMPRESSOR

LCW: NOT INCLUDED (WATER COOLING TO POWER SUPPLY AND MAGNETS BY OTHERS, ASSUMED TO BE TIED IN FROM EXISTING TUNNEL LCW SYSTEM BY ACCELERATOR DIVISION).

BASIS: INTAKE AIR WALL LOUVER W/ MOTORIZED DAMPER, INTERLOCK WITH EXHAUST FANS, AND ELECTRIC HEATERS

PURGE VENTILATION: NO REQUIRMENT

FIRE SUPPRESSION: WET PIPE SPRINKLER SYSTEM DESIGNED TO ORDINARY HAZARD GROUP 2

FIRE DETECTION: SPOT TYPE SMOKE DETECTION MANUAL PULL STATIONS AT EXITS AND ALARM (VOICE) NOTIFICATION THROUGHOUT

LIGHTING:	30 FC
EMERGENCY LIGHTING:	AS REQUIRED
EXIT SIGNS:	PER CODE
CONV. RECEPT:	120/208V AS REQ.

CONTROL/COUNTING

HVAC:
HUMIDITY: NO MINIMUM OR MAXIMUM HUMIDITY REQUIREMENT

TEMPERATURE STABILITY: NONE

TEMPERATURES: 75F SUMMER, 68F WINTER MINIMUM

EQUIPMENT LOAD TO AIR: TBD

BASIS: ASSUME 10 TON INDOOR CRAC-TYPE HVAC UNIT UTILIZING AVAILABLE CHILLED WATER FROM CUB, WITH ELECTRIC HEAT. NO BACK-UP UNIT.

PURGE VENTILATION: NO REQUIREMENT

OCCUPANT LOAD: 5 PERSONS

FIRE SUPPRESSION: WET PIPE SPRINKLER SYSTEM DESIGNED TO ORDINARY HAZARD GROUP 2

FIRE DETECTION: SPOT TYPE SMOKE DETECTION MANUAL PULL STATIONS AT EXITS AND ALARM (VOICE) NOTIFICATION THROUGHOUT

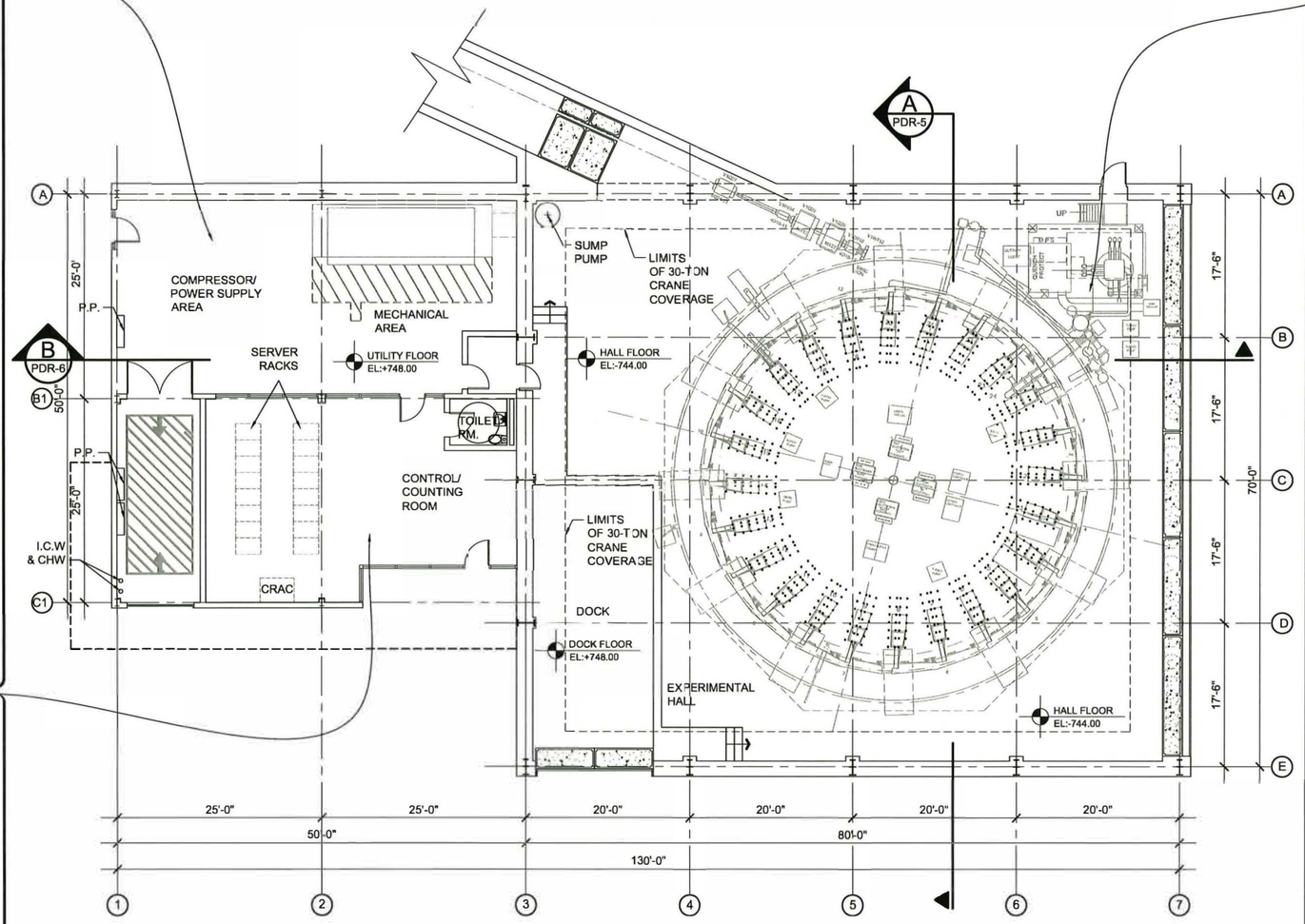
LIGHTING: 55 FC

EMERGENCY LIGHTING: AS REQUIRED

EXIST SIGNS: PER SCOPE

CONV. RECEPT: 120/208V AS REQUIRED

NO. RACKS: 16 - (2'X3')



FLOOR PLAN
SCALE: 1/8"=1'-0"

EXPERIMENTAL HALL

FUNCTION: HOUSE MUON STORAGE RING AND ASSOCIATED EQUIPMENT
EXTERIOR RADIATION SHIELDING: 2 FT.
EQUIPMENT ACCESS: 1-30 TON OVERHEAD CRANE IN BUILDING ABOVE

HVAC:
HUMIDITY: NO MINIMUM OR MAXIMUM REQUIREMENT (ASSUME 55% RH MAX).

TEMPERATURE: SUMMER 78F ± 2F, WINTER 68F ± 2F

EQUIPMENT HEAT LOAD TO AIR: NEGLIGIBLE

LCW (LOW CONDUCTIVITY WATER) NOT INCLUDED: WATER COOLING TO POWER SUPPLY AND MAGNETS BY OTHERS. ASSUMED TO BE TIED IN FROM EXISTING TUNNEL LCW SYSTEM BY ACCELERATOR

BASIS: INDOOR AIR HANDLER (LOCATED IN MECHANICAL ROOM) UTILIZING CHILLED WATER FROM CUB. UNIT WILL HAVE ELECTRIC HEAT, METASYS CONTROLS, ECONOMIZER, AND DUCT DISTRIBUTION INTO THE HALL WITH STRATIFICATION FANS. UNIT WILL BE TIED INTO SITEWIDE FESS METASYS SYSTEM. NO BACK-UP UNIT.

PURGE VENTILATION: NO REQUIREMENT FROM EXPERIMENT.

OCCUPANT LOAD: 5 PERSONS

FIRE SUPPRESSION: WET PIPE SPRINKLER SYSTEM DESIGNED TO ORDINARY HAZARD GROUP 2

FIRE DETECTION: AIR SAMPLING SMOKE DETECTION AND ALARM (VOICE) NOTIFICATION THROUGHOUT

LIGHTING: 75 FC

EMERGENCY LIGHTING: AS REQUIRED

EXIT SIGNS: PER SCOPE

CONV. RECEPT: 120/208V AS REQUIRED
2-480VOLT WELDING RECEPTACLES

SCALE: 1/8"=1'-0"

PROJECT NORTH

g-2 CONVENTIONAL FACILITIES

EXPERIMENTAL HALL - FLOOR PLAN

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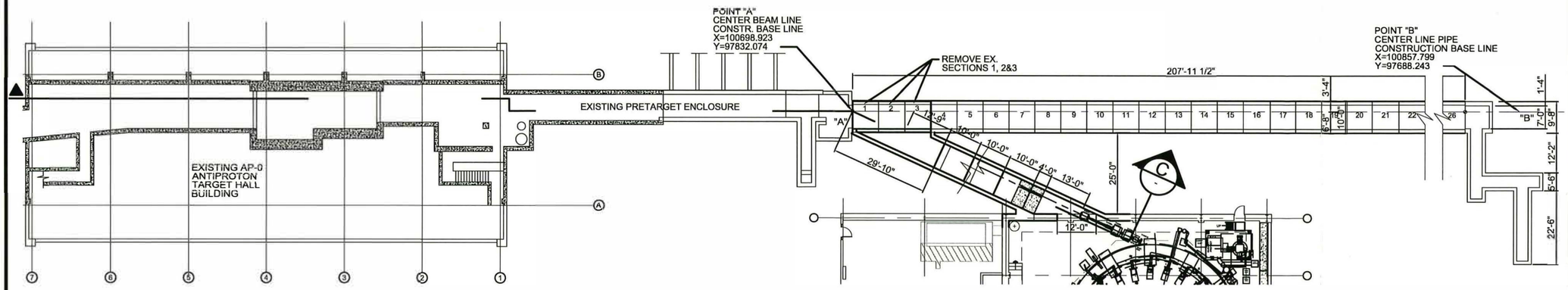
SEPTEMBER 2009

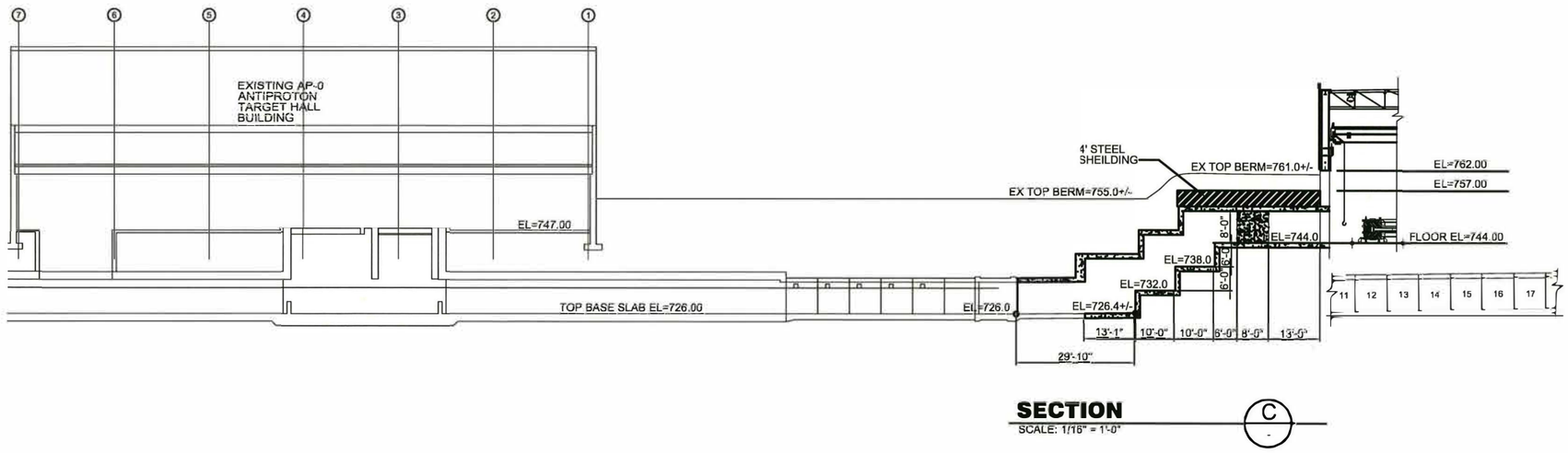
PROJECT NO.
15-2-1

DRAWING NO.
PDR-3



PRE-TARGET ENCLOSURE PLAN

SCALE: 1/16"=1'-0"



SECTION C

SCALE: 1/16" = 1'-0"

DOWNSTREAM BEAM LINE TRANSPORT ENCLOSURE AND EXTINCTION CHANNEL

DIMENSIONS: 8' WIDE BY 8' HIGH

CONSTRUCTION: CONCRETE

FUNCTION: TRANSPORT MUON FROM PBAR RINGS; TRANSPORT CRYO FROM AP30 TO MU2E DETECTOR AREA

SHIELDING: UNLIMITED OCCUPANCY-21 FEET PROVIDED

EQUIPMENT: TARGET BUILDING OR EXPERIMENTAL HALL

ACCESS: FROM EXISTING PRE-TARGET ENCLOSURE OR EXPERIMENTAL HALL

HVAC:
TEMPERATURE: 60 DEGREE F MIN/NO MAXIMUM
HUMIDITY CONTROL: NONE
AIR PRESSURE: NEG. TO AP RINGS

LCW: EXTENDED FROM PBAR (ASSUMED THAT PBAR LCW USAGE WILL BE REDUCED AT THE TIME OF THIS PROJECT)

OCCUPANT LOAD: LESS THAN 5 PERSONS

EGRESS:
STAIR IN AP TARGET BUILDING - 152'-0" FEET
STAIR AT END OF ENCLOSURE - 242'-0" FEET

SMOKE CONTROL:
EMERGENCY PERSONNEL MANUAL ACCESS FAN FOR SMOKE ABATEMENT

FIRE DETECTION: AIR SAMPLING SMOKE & LINEAR TYPE HEAT DETECTION

FIRE NOTIFICATION: AUDIO AND VISUAL DEVICES THROUGHOUT.

FIRE SUPPRESSION: PRE-ACTION (DRY PIPE) AUTOMATIC SPRINKLER SYSTEM (DUAL INTERLOCK)

SCALE: 1/16"=1'-0"

PROJECT NORTH

g-2 CONVENTIONAL FACILITES

EXPERIMENTAL HALL -ENCLOSURE PLAN

PDR

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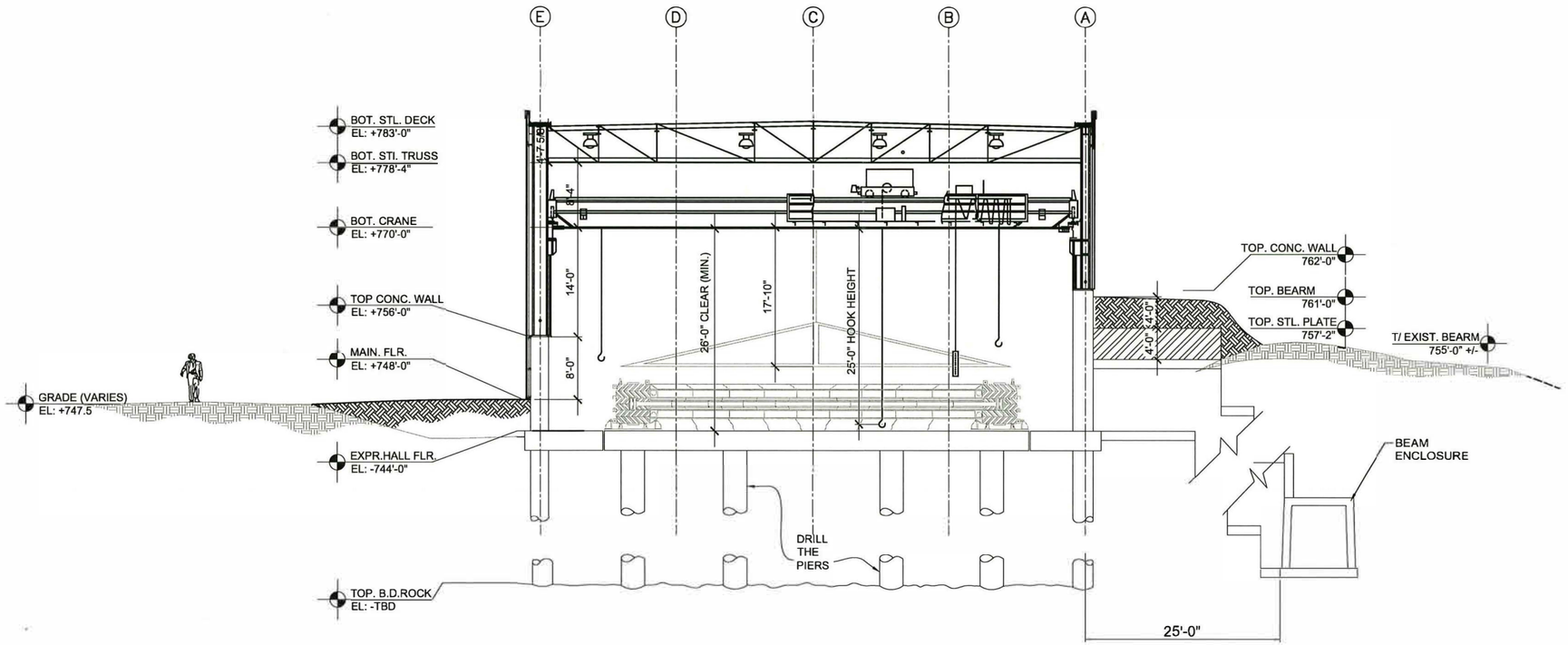
15-2-1

DRAWING NO.

PDR-4



SECTION (A / PDR-3)
SCALE: 1/8"=1'-0"

SCALE:
16 8 0 8 FEET
SCALE
1/8" = 1'-0"

g-2 CONVENTIONAL FACILITES

EXPERIMENTAL HALL - BUILDING SECTION

PDR

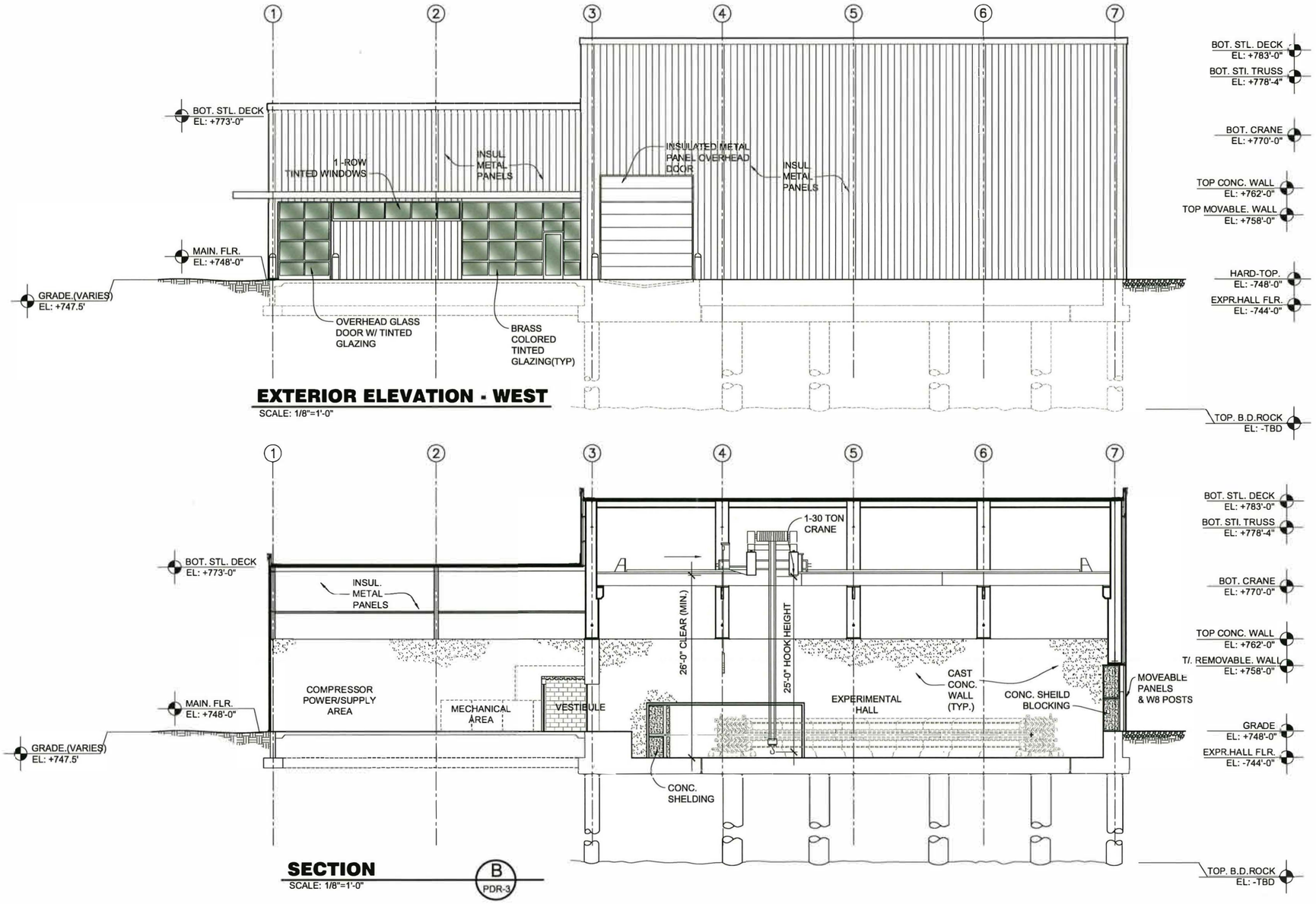
Fermilab

U.S. DEPARTMENT OF ENERGY

DATE
SEPTEMBER 2009

PROJECT NO.
15-2-1

DRAWING NO.
PDR-5



EXTERIOR ELEVATION - WEST

SCALE: 1/8"=1'-0"

SECTION

SCALE: 1/8"=1'-0"

B
PDR-3

SCALE:
16 FEET
8
0
8
SCALE
1/8"=1'-0"

g-2 CONVENTIONAL FACILITES

EXPERIMENTAL HALL-BUILDING SECTION & ELEVATION

PDR

Fermilab

U.S. DEPARTMENT OF ENERGY

DATE

SEPTEMBER 2009

PROJECT NO.

15-2-1

DRAWING NO.

PDR-6

g-2 Conventional Facilities

Previous Cost Estimate dated August 25, 2008

Fermi National Accelerator Laboratory / Kirk Road and Pine Street / P.O. Box 500 / Batavia, IL 60510 / 630.840.3000 / www.fnal.gov / fermilab@fnal.gov
Office of Science / U.S. Department of Energy / Managed by Fermi Research Alliance, LLC

Fermilab

Russell J. Alber
FESS Engineering
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ralber@fnal.gov

Memorandum

August 25, 2008

To: Milorad Popovic, AD

From: Russ Alber, FESS Engineering

Subject: Project Definition Report
G-2 Experimental Hall

FESS/E has investigated the proposed G-2 Experimental Hall addition near the AP-0 Target Building and has developed suggested budgetary cost estimates for the conventional construction portion of the work.

Project Description

This project will erect a new Experimental Hall to house the G-2 experiment near the AP-0 Target Building. (See Figure 1 for Location Plan)

The construction materials and methods will be similar to existing Service Buildings located along the Main Injector. The items listed below are included in the construction cost estimates:

- Site construction, including; final grading, 480V and 120V electrical service and telecommunications service and an access roadway and parking/staging area,
- Concrete foundation with concrete slab-on-grade construction, steel superstructure, insulated wall panels and metal deck w/built-up roofing.
- Walls and finishes, including; painting and roofing,
- Mechanical and Electrical Equipment, including; lighting, heating and cooling (HVAC).

The following assumptions were used in preparing this cost estimate;

- No water services are required from the existing AP-0 Target Building,
- A 40-ton building bridge crane will be provided spanning the building width of 80',
- Typical experimental building HVAC requirements, i.e. heating and cooling required, and
- Fire protection throughout new facility.

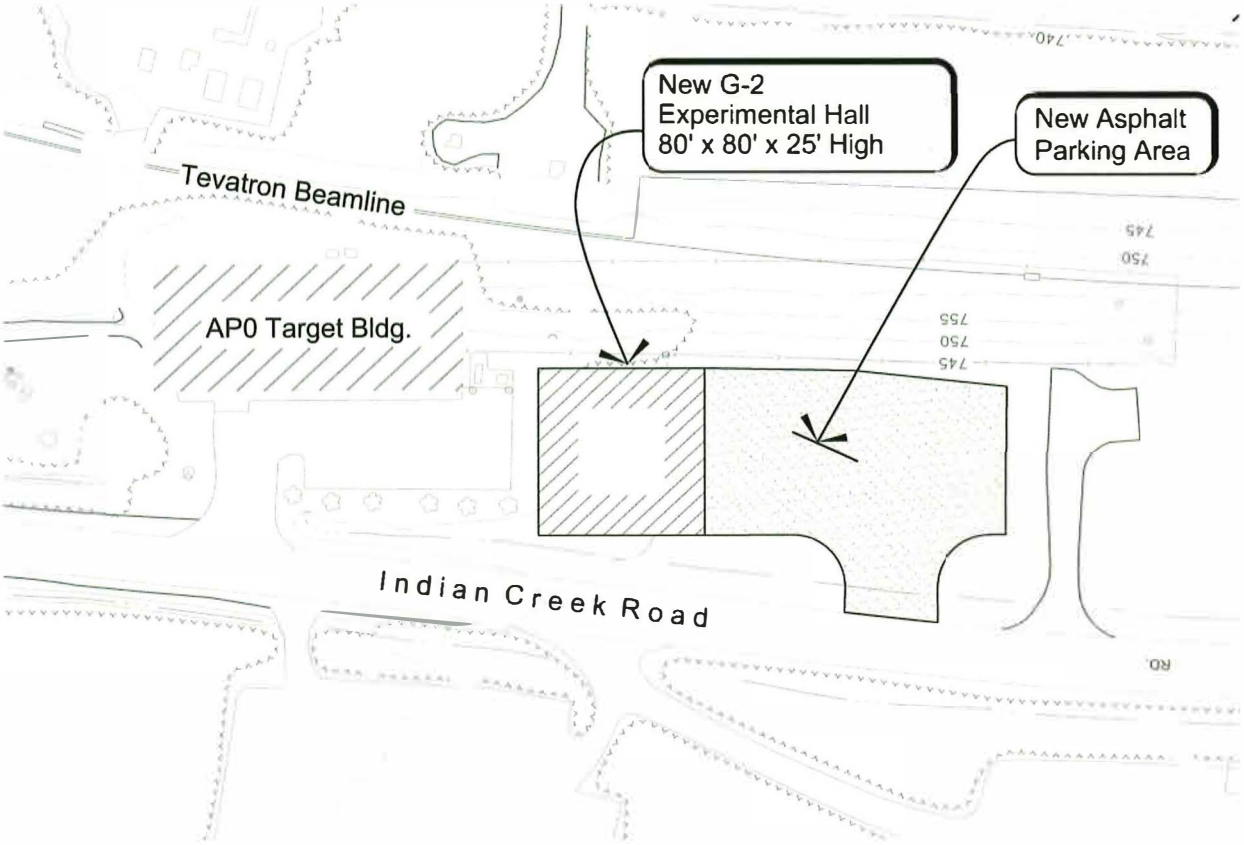

Figure 1 – Location Plan of the New G-2 experimental Hall

Suggested Project Budget

Listed below is the estimated construction cost for this project as described in the sections above:

	G-2 Experimental Hall
Construction	$2,200,000
EDIA @ 22%	$485,000
Management Reserve @ 25%	$675,000
Indirects	$640,000
CONSTRUCTION TOTAL	**$4,000,000**

Cost Estimate Basis

The costs ranges contained in this Project Definition Report are based on FY2008 dollars. Appropriate escalation will need to be applied once a funding source and schedule is identified.

The above suggested project budget is based on cost data taken from Means Cost Estimating Guides, historical data and recent construction history here at Fermilab. While the suggested project budget can provide input for the feasibility of the project, further design refinement will affect the final cost of the project.

Engineering Design and Inspection (ED&I) activities are included in the suggested project budget. ED&I activities include the engineering and design activities in Titles 1 and II, the inspection activities associated with Title III. The descriptions are based on DOE Directive G430.1-1, Chapter 6. Administration activities include those defined by DOE Directive G430.1-1, Chapter 6 as Project Management (PM) and Construction Management (CM). Past historical data and DOE Directive G430.1-1, Chapter 25 indicate that 18%-25% of the construction costs is an appropriate range.

Based on DOE Directive G430.1-1, Chapter 11DOE guidelines and the pre-conceptual nature of the design at this stage a Management Reserve of 15%-35% of the above costs is considered an appropriate range. Based on the scope and scale of the proposed project, the determination of the suggested Management Reserve did not include a Monte-Carlo analysis. If required, this analysis can be accomplished. The suggested project budget listed above contains a 25% multiplier for Management Reserve.

Indirect Costs rates are defined by DOE Order 4700.1 that states indirect costs are "...costs incurred by an organization for common or joint objectives and which cannot be identified specifically with a particular activity or project. If this work should become a GPP project, Indirect Costs will have to be applied, but the amount will be affected by the rates in effect at the time this project is initiated. Currently, the Indirect Cost multiplier is approximately 19% of the above costs.

Schedule

Listed below is an estimated schedule for the work described above:

S + 0 days - Start
S + 120 days – Develop Subcontract Documents – issue for Comment and Compliance Review
S + 150 days - Complete drawings, ready to send out for bids
S + 210 days - Award subcontract
S + 390-420 days - Complete Construction

Summary

This Project Definition Report provides suggested budgetary cost estimates based on preliminary designs and conversations and is intended for planning purposes. The information produced is subject to refinement during the subsequent design process.

Please contact me at x2501 with questions.

Encl. Construction Cost Estimate

cc: E. Crumpley, FESS/E (w/encl.)
T. Lackowski, FESS/E (w/encl.)
Project File (electronic copy)

FERMILAB: FESS COST ESTIMATE

Project Title: G-2 Experimental Hall			Project No.	Status:	Date: 8/25/2008	Revision Date:
ITEM NO.	DESCRIPTION OF WORK:		QUANTITY	UNITS	UNIT COST	AMOUNT
01	**SITE CONSTRUCTION**	**$240,000**				
	Demolition of Offsetting Square Footage		6400	SF	$20.00	$128,000.00
	Mobilization		1	Lot	$5,000.00	$5,000.00
	Soil Erosion Control		1	Lot	$5,000.00	$5,000.00
	Clear & grub		1400	SY	$10.00	$14,000.00
	Excavation		1	Lot	$10,000.00	$10,000.00
	Electrical service from AP-0 Target Building		1	Lot	$30,000.00	$30,000.00
	Tele/Fiber service from AP-0 Target Building		1	Lot	$7,500.00	$7,500.00
	ICW connection to existing service/FP		1	Lot	$15,000.00	$15,000.00
	Access roadway and parking area		900	SY	$30.00	$27,000.00
	Final grading and seeding		1	Lot	$2,500.00	$2,500.00
02	**BUILDING**	**$1,430,000**				
	Typical High-Bay Building		6400	SF	$200.00	$1,280,000.00
	25' High - Insulated Metal Service Building					
	40 Ton Bridge Crane - 80' span		1	Lot	$150,000.00	$150,000.00
04	**MECHANICAL/ELECTRICAL**	**$140,000**				
	Lighting		6400	SF	$7.50	$48,000.00
	HVAC		6400	SF	$10.00	$64,000.00
	Receptacles		50	Ea	$250.00	$12,500.00
	Misc. panelboards and electrical suppplies		1	Lot	$20,000.00	$20,000.00
	SUBTOTAL:	$1,810,000				
	OVERHEAD & PROFIT @ 20%	$362,000				
	TOTAL:	**$2,200,000**				

g-2 Conventional Facilities Cost Review dated May 6, 2009

Fermi National Accelerator Laboratory / Kirk Road and Pine Street / P.O. Box 500 / Batavia, IL 60510 / 630.840.3000 / www.fnal.gov / fermilab@fnal.gov
Office of Science / U.S. Department of Energy / Managed by Fermi Research Alliance, LLC

Fermilab

Facilities Engineering Services Section
630.840.3640(phone)
630.840.4980 (fax)

Memorandum

May 6, 2009

To: Ron Ray

From: Tom Lackowski; FESS Eng.

Subject: G-2 Conventional Facilities Review

Review Process

The G-2 Conventional Construction review started with the Project Definition Report, G-2 Experimental Hall, dated August 25, 2008, attached in the Appendix. Conforming to the charge to the committee, costs were evaluated for implementing the (g-2) experiment. The items listed in this report reflect those requirements developed in conjunction with the other members of the review committee and are to be considered additive to the original cost estimate of $4,000,000. Costs were calculated using 20% contractors profit and fees and a contingency of 30%.

Site Considerations

The proposed site is south of AP0 Target Hall in a depressed area bounded by Kautz Road to the west, the NuMI extraction beam to the south, the AP0 Pretarget beamline berm to the east and the AP-0 Building and parking lot to the north. The proposed building footprint is 80' x 80' with a hardstand measuring 80' x 140'. The site is small with respect to the proposed building and hardstand.

- The site is lower than the adjacent Kautz Road and buildings by three to four feet. It is advisable to remove 2 feet of the existing soils and raise the level of the building and parking area with structural fill.

		Site Preparation								
		Item	Quantity	Units	Unit Cost	Extended Cost	Profit	Subcontract Cost	Contingency	Line Total
		Excavate 2 feet of soils	1300	CY	$18	$23,400	$4,680	$28,080	$8,424	$36,504
		5 Feet of structural Fill	3250	CY	$40	$130,000	$26,000	$156,000	$46,800	$202,800
									Subtotal	$243,360

- A swale transverses the site at the proposed building site, draining the MI-65 area via a culvert that is situated under Kautz Road. Another culvert extends through the berm. This drainage will need to be substantially modified. The site drains to the swale and does not appear to hold water except in the swale itself. A wetland determination should be done to classify the area.

		Site Drainage								
		Item	Quantity	Units	Unit Cost	Extended Cost	Profit	Subcontract Cost	Contingency	Line Total
		Manholes	3	Ea	$6,000	$18,000	$3,600	$21,600	$6,480	$28,080
		24" RC Concrete Pipe	200	LF	$80	$16,000	$3,200	$19,200	$5,760	$24,960
									Subtotal	$53,040

- Domestic water piping, ICW, Sanitary Sewer force main, and chilled water supply and return run parallel to Kautz Road approximately 25 feet from the pavement edge. As shown they are under the proposed building. These utilities will need to be relocated to the west, either along the road or across the road.

		Relocate Piping								
		Item	Quantity	Units	Unit Cost	Extended Cost	Profit	Subcontract Cost	Contingency	Line Total
		ICW	175	LF	$80	$14,000	$2,800	$16,800	$5,040	$21,840
		Chilled Water	175	LF	$120	$21,000	$4,200	$25,200	$7,560	$32,760
		Domestic Water	175	LF	$60	$10,500	$2,100	$12,600	$3,780	$16,380
		Sanitary Sewer	175	LF	$60	$10,500	$2,100	$12,600	$3,780	$16,380
									Subtotal	$87,360

- The exit discharge from the AP0 Pretarget Enclosure butts up to the proposed building. Modifications to the top of the stair will be required.

		Modify PreTarget Exit Stair								
		Item	Quantity	Units	Unit Cost	Extended Cost	Profit	Subcontract Cost	Contingency	Line Total
		Rework Top Landing	1	Lot	$10,000	$10,000	$2,000	$12,000	$3,600	$15,600
		Extend 2 hour enclosure to parking area	30	LF	$1,000	$30,000	$6,000	$36,000	$10,800	$46,800
									Subtotal	$62,400

- The "beamline" and the excavation for the building foundations will be in the zone of the AP-0 Pre-Target enclosure. It is anticipated that Rad Worker Training will be required for a large percentage of the subcontractor's workforce.

		Rad Training								
		Item	Quantity	Units	Unit Cost	Extended Cost	Profit	Subcontract Cost	Contingency	Line Total
		Rad Training	50	man-days	$320	$16,000	$3,200	$19,200	$5,760	$24,960
									Subtotal	$24,960

- Feeder 24 (with backup from feeder 52/53) is located at a switch at the southwest corner of the APO building. There is feeder capacity and an open bay in the 4 way air switch to provide the 1.3mw required for G-2 (.8mw for cryo + .5mw for the building). A new 1500kva transformer will be required.

		Primary Electrical								
		Item	Quantity	Units	Unit Cost	Extended Cost	Profit	Subcontract Cost	Contingency	Line Total
		Purchase 1500 KVA Transformer	1	Ea	$140,000	$140,000	$0	$140,000	$42,000	$182,000
		Install Transformer	1	Lot	$20,000	20000	$4,000	$24,000	$7,200	$31,200
		Duct Bank	50	LF	$200	$10,000	$2,000	$12,000	$3,600	$15,600
		480 Secondary	50	LF	$400	$20,000	$4,000	$24,000	$7,200	$31,200
		Pad w/ containment	1	Lot	$25,000	$25,000	$5,000	$30,000	$9,000	$39,000
									Subtotal	$299,000

- At the location of the 4 way air switch, besides the switch there is a 750 KVA transformer and an AC unit. While the details of the beamline enclosure are not known, this equipment will most likely need to be removed or supported during construction of the enclosure.

		Relocate Existing Equipment								
		Item	Quantity	Units	Unit Cost	Extended Cost	Profit	Subcontract Cost	Contingency	Line Total
		Transformer	1	Lot	$10,000	$10,000	$2,000	$12,000	$3,600	$15,600
		Air Switch	1	Lot	$7,000	$7,000	$1,400	$8,400	$2,520	$10,920
		HVAC Unit	1	Lot	$7,000	$7,000	$1,400	$8,400	$2,520	$10,920
									Subtotal	$37,440

Building and Beamline Enclosure

The building is currently proposed at 80' x 80' x 25 'high steel braced frame with metal siding, built up roof supported by shallow foundations and has a slab on grade. The detector weights a total of 600 metric tons distributed in a ring roughly 14 meters in diameter. A 40 ton crane spans the 80 foot length. Two methods of installing the 14 meter diameter coils which are coming from Brookhaven, placing the coils on the slab and building around it or to install the coils through a slot in the building wall. Either of the two methods will be at a premium to the construction cost.

- At 6400 gross square feet of floor area the $200/SF cost used in the estimate appears low for the following reasons:
  - 80 foot clear span of roof structural members
  - 40 ton Crane Support
  - A more appropriate height for the building would be 3'-6" roof structure (6' if trusses are used), 10'-6" crane height, and 18 'hook lift height or 32' to 34'.
  - Fire protection and detection
  - Mat foundation for 600 metric ton

		Building Add. Cost								
		Item	Quantity	Units	Unit Cost	Extended Cost	Profit	Subcontract Cost	Contingency	Line Total
		Original Sq. Foot Cost	6400	SF	$200					
		Upgrade for Long Span Roof	6400	SF	$19	$121,600	$24,320	$145,920	$43,776	$189,696
		Upgrade for 40 ton Crane	6400	SF	$10	$64,000	$12,800	$76,800	$23,040	$99,840
		Upgraded Mat under Ring	3600	SF	$22	$79,200	$15,840	$95,040	$28,512	$123,552
		Difficulty Factor for inserting Coils	1	Lot	$100,000	$100,000	$20,000	$120,000	$36,000	$156,000
		Upgrade for Add. Bldg. Height	6400	SF	$10	$64,000	$12,800	$76,800	$23,040	$99,840
		Fire Protection	6400	SF	$8	$48,000	$9,600	$57,600	$17,280	$74,880
		Fire Detection	6400	SF	$3	$19,200	$3,840	$23,040	$6,912	$29,952
		Revised Base SF Building Cost			*$250*				Subtotal	$773,760

- Crane hook approach is approximately 25 feet (10' one end and 13' on the other end) in the direction of bridge travel and 10' in the other direction. Thus the crane hook footprint in 55' x 70' in the 80' x 80' building. It is not clear if there is room for a truck to enter into building and be under crane coverage. Additionally there are space requirements for control room and cryo equipment. Cost of an Additional 20' bay

		20' x 80' Additional Building								
		Item	Quantity	Units	Unit Cost	Extended Cost	Profit	Subcontract Cost	Contingency	Line Total
		20' x 80' Additional Building	1600	SF	$250	$400,000	$80,000	$480,000	$144,000	$624,000
									Subtotal	$624,000

- Counting Room often has increased power and cooling requirements, raised computer floors, and ceilings. It is assumed that any counting room space will be constructed within the building with light framing.

		Counting Room								
		Item	Quantity	Units	Unit Cost	Extended Cost	Profit	Subcontract Cost	Contingency	Line Total
		25' x 25' Counting Room Space	625	SF	$60	$37,500	$7,500	$45,000	$13,500	$58,500
									Subtotal	$58,500

- Re-evaluation of the cost of a 40 ton bridge crane with an 80 foot span is estimated at $280,000.

		40 ton Crane w/ 80 foot span Cost								
		Item	Quantity	Units	Unit Cost	Extended Cost	Profit	Subcontract Cost	Contingency	Line Total
		$280k - $150K Difference	1	lot	$130,000	$130,000	$26,000	$156,000	$46,800	$202,800
									Subtotal	$202,800

- The review committee asked for a cost to lower the ring to the level of the PBar Transport beam line. The following cost is for a 60' x 60' depressed area with the base mat at Elevation 728'-0"

		Ring @ 732' Alternative								
		Item	Quantity	Units	Unit Cost	Extended Cost	Profit	Subcontract Cost	Contingency	Line Total
		Excavate 90 x90 x18	5400	CY	$18	$97,200	$19,440	$116,640	$34,992	$151,632
		Backfill	2400	CY	$40	$96,000	$19,200	$115,200	$34,560	$149,760
		Base Mat 2 x 72 x72	384	CY	$450	$172,800	$34,560	$207,360	$62,208	$269,568
		Walls 4 x 60 x 16 x 1.667	266	CY	$800	$212,800	$42,560	$255,360	$76,608	$331,968
		Counterforts 8 x 2 x 8 x18	64	CY	$800	$51,200	$10,240	$61,440	$18,432	$79,872
		Sumps	1	Lot	$43,000	$43,000	$8,600	$51,600	$15,480	$67,080
		Stairs	2	Ea	$30,000	$60,000	$12,000	$72,000	$21,600	$93,600
		Misc painting, damp proofing	1	Lot	$60,000	$60,000	$12,000	$72,000	$21,600	$93,600
									Subtotal	$1,237,080

- The requirements and routing of the Beam Enclosure is not clear. The team thought 100' would provide a reasonable placeholder for this element of work.

		Beam Enclosure								
		Item	Quantity	Units	Unit Cost	Extended Cost	Profit	Subcontract Cost	Contingency	Line Total
		8' x 8' Enclosure for Magnets	100	LF	$4,000	$400,000	$80,000	$480,000	$144,000	$624,000
									Subtotal	$624,000

- The building design may be deemed important since it is adjacent to one of the legacy buildings. This could impact the building costs by 5 to 10 percent or $12.50 to $25.00 per square foot of base building construction cost.

Building Services, HVAC, Process Water, Electrical, Fire Protection/Detection

- Building and equipment heating, cooling and ventilation costs have been calculated using engineering judgment for the distribution of loads between air and water systems.

		HVAC & Process Water Systems								
		Item	Quantity	Units	Unit Cost	Extended Cost	Profit	Subcontract Cost	Contingency	Line Total
		Base Cost in PDR	6400	SF	$10					
		Addition Cost For Systems	6400	SF	$30	$192,000	$38,400	$230,400	$69,120	$299,520
									Subtotal	$299,520

- Electrical distribution (in addition to house power)

		Electrical Destitution								
		Item	Quantity	Units	Unit Cost	Extended Cost	Profit	Subcontract Cost	Contingency	Line Total
		2000Amp Switchboard (Cryo)	1	Ea	$47,000	$47,000	$9,400	$56,400	$16,920	$73,320
		Install 2000 Amp Switchboard	1	Lot	$15,000	$15,000	$3,000	$18,000	$5,400	$23,400
		1200 Amp Building Panel	1	Ea	$28,000	$28,000	$5,600	$33,600	$10,080	$43,680
		User Power Distribution	3600	SF	$12	$43,200	$8,640	$51,840	$15,552	$67,392
									Subtotal	$23,400

- Cryo Services Upgrade is limited to the .8 MW of power and the primary cooling. The electrical scope is accounted for in the section above. Primary cooling for the cryo equipment assumes the use of the existing Main Ring Ponds via the existing LCW systems in the Main Ring or PreTarget Enclosure. The capacity of these existing systems will need to be verified. The Scope is included in the HVAC and Process Water costs above.

Schedule

The schedule provided in the PDR reflects a GPP and not the requirements of a line item. Construction is shown at 6 to 8 months. While the time frame between Critical Decisions will be established by the project, at this point a minimum of one year should be used between CD-0 and CD-1; CD-1 and CD-2: and CD-2 and CD-3. Construction is now estimated to be between 14 and 18 months.

Summary

Based on the still very preliminary nature of the requirements and minimal engineering or design, the additional construction costs beyond the $2,200,000 are summarized below within a relatively large cost range.

Site Considerations	$700,000	to	$900,000
Building and Beamline Enclosure	$2,000,000	to	$5,600,000
Building Services	$250,000	to	$350,000
Subtotal	$3,000,000	to	$6,850,000

The above cost range would result in an increase of the EDIA by $800,000 to $1,883,750 including contingency and indirects. In addition to the EDIA, Level 2 Project Management cost for 4.5 years at a .25 FTE level should be used equaling $250,000.

The cost range for the G-2 Experimental Hall Conventional Facilities is now recommended to be $8,000,000 to $13,000,000.

It is strongly suggested that a funded PDR be commissioned to properly develop the scope, cost, and schedule for the Conventional Facilities portion of this project.

Cc: R. Ortgiesen
E. Crumpley
S. Dixon
R. Alber
Project File