Title 1 Design Report

FERMILAB LINAC UPGRADE

Project No. 90-R-104

CIVIL CONSTRUCTION

February 1990

For The

U. S. Department of Energy

Chicago Operations Office

Argonne, Illinois

Prepared by the Fermi National Accelerator Laboratory
Construction Engineering Services

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INTRODUCTION

1. Statement of Purpose

The Fermilab Linac Upgrade Project is motivated by the requirement to increase Collider luminosity which will increase the physics discovery potential of the Tevatron Collider. The Linac Upgrade is one of several steps which will increase the Collider luminosity. The basic accelerator physics motivation for the project is the following chain of logic. The existing Main Ring Accelerator has a fixed, relatively small admittance for 8 GeV protons injected from the Booster Accelerator. While it is demonstrably possible to increase the number of protons accelerated in the Booster, space charge effects at injection into the Booster from the Linac increase the emittance of the beam delivered from the Booster to the Main Ring beyond the available admittance of the Main Ring. An increase in the energy of the protons injected into the Booster, however, will reduce the emittance growth due to the space charge effects at injection. Therefore, for a given admittance into the Main Ring, a greater number of protons will be accelerated in the Booster with a matching emittance if the injection energy is raised. The goal of the Linac Upgrade is to double the output energy of the Linac from 200MeV to 400MeV.

The doubling of the Linac energy will be accomplished by replacing the last four "drift tube linac tanks" of the present Linac with 28 sections of a side-coupled cavity structure, each section consisting of 16 rf cavities, while raising the rf frequency by a factor of four to 805MHz.

2. Scope of the Project

It has been demonstrated that it is possible to make this replacement without altering the length of the Linac enclosure. It is the intention to build, test and commission (without beam) the entire replacement structure. When complete, the structure will rapidly be installed in place of the drift tube tanks. The entire new Linac structure will be set in place parallel to the existing Linac in the Linac enclosure, and completely powered prior to the replacement.

Thus, it will be necessary to have the capability to operate the existing downstream four tanks of the drift tube linac in parallel with the entire new side-coupled cavity structure. Every four of the 28 new sections will be jointly powered by a 12MWatt klystron operating at 805MHz. These klystrons, with their accompanying pulse transformers, pulse forming networks, and bulk charging supplies are relatively large items. It has not been possible to devise any plan to operate the existing Linac in parallel with the new structure in the Linac enclosure without a modest increase in the area of the Linac power supply gallery. Thus, the first major

component of the Linac Upgrade civil construction is to provide for an increase in area corresponding to about four of the required klystron system footprints, and to modify existing space to accommodate the remaining systems. Also, appropriate system and structural power and cooling must be provided.

The actual side-coupled cavity structures are assembled from precision tuned and machined pieces of copper. The bulk copper, rough machining, and first stages of the fine machining will be accomplished utilizing commercial vendors and machine shops. The final tuning and machining, however, involves an iterative series of steps of preliminary assembly and "cold" rf measurements, followed by fine cuts on local computer-controlled machine equipment. After this preliminary tuning is complete, the unassembled parts will be commercially brazed into sections, and then returned for final tuning and the addition of cooling and vacuum systems. Then, preliminary high voltage commissioning and testing must be done with some degree of accessibility before the sections are grouped by four into modules, further tested, and then placed into the Linac enclosure. The second civil construction project consists of the construction of an Assembly Area for this work. This Assembly Area must be convenient to both the mechanical and rf staff of the Upgrade Project, and provide for sufficient shielding for the powered testing of the sections and modules. The basic requirements are very similar to those for the existing separator/septum/kicker group at Fermilab, and an extension of the existing Assembly Building located at A-0 at Fermilab will be constructed.

II

SUMMARY AND RECOMMENDATIONS

1. Summary - Design Provisions and General Approach

The functional requirements and design provisions for the civil construction for the Linac Upgrade are summarized below:

Space: Additional space required for the Linac Upgrade equipment fabrication, testing and operation is provided in two locations; the Power Supply Gallery for the new Side-Coupled Cavities (SCC) adjoins the present Linac Gallery and a new A-0 Assembly Area for the SCC modules fills in between the existing A-0 Service Building and Laboratory.

Power and Cooling Systems: Extensions to existing primary power systems and cooling water systems are provided at both the new Linac Power Supply Gallery and the new Linac/A-0 Assembly Area.

Equipment Access: Access to the present Linac Enclosure for installing the new SCC modules and removing the present Linac tanks is provided with a temporary shielded access pit and an access ramp.

Power and Communications Access: Wave Guides and control/communication cables between the SCC modules and the power supplies are routed through new penetrations constructed between the Linac Gallery and Linac Enclosure.

The general design approach used for this Title 1 Design Report is based on the following conditions and assumptions:

New Equipment Criteria: Physical sizes, required services and operational characteristics for the new Linac Upgrade equipment is accommodated in the design criteria for buildings and services.

Architecture: The exterior shape and appearance of the new building additions is designed to be compatible with adjoining buildings and to retain design elements common to the Fermilab site. Interior layouts of the buildings accommodate the equipment and personnel requirements.

Site Conditions: Existing soil borings are used for Title 1 design and new geotechnical studies will be done during Title 2 design. Sub-surface bearing conditions as well as soil activity will be measured and preliminary designs will be modified as needed.

Operational Schedules: Construction for the new Linac Access and Wave Guide Penetrations will be scheduled during accelerator shutdown periods.

2. Cost Estimate Overview

The cost estimates for the various civil construction WBS elements are summarized by fiscal years below. Cost breakdowns, tabulations and details are shown in Section V and in Appendix D.

WBS No./Description	FY 1990	FY 1991	TOTAL
WBS 1.2.1, 1.2.2, 1.2.3 & 1.2.4.	$ 1,120,000	$ 590,000	$ 1,710,000
E.D.I.A.	315,000	71,000	386,000
Subtotal with E.D.I.A.	$ 1,445,000	$ 651,000	$ 2,096,000
Contingency	288,000	132,000	420,000
Subtotal with Contingency	$ 1,733,000	$ 783,000	$ 2,516,000
Escalation	62,000	32,000	94,000
TOTAL	$ 1,795,000	$ 815,000	$ 2,610,000

3. Safety Provisions

The many and varied aspects of safety are incorporated into the basic design for the Linac Upgrade construction. In summary, the following items highlight the safety provisions that have been considered.

Life Safety: Outside exits are arranged for all stairs, hand rails are provided and aisle widths are ample for both personnel passage and utilities. Safe entry and egress are considered in power supply and equipment test areas. Emergency lighting is provided. Access for handicapped employees is not provided in power supply and equipment test areas.

Fire Safety: Non-combustible materials are specified for all building components. Fire suppression systems as well as alarm and detection systems are provided in the new building additions.

Electrical Safety: All equipment is specified in accordance with the National Electrical Code and Underwriters Laboratory. Switchboards and panels are placed in easily accessible locations with sufficient ventilation available.

Mechanical Safety: All equipment is specified in accordance with the appropriate safety standards and codes. Items of standard safety practice such as belt guards, fan screens and mechanical interlocks are used throughout.

Radiation Safety: Appropriate radiation shielding materials are incorporated into the design and construction techniques specified. Construction work near areas with active soil will be scheduled during accelerator down-times. (Refer to Radiation Shielding, Section IV.)

Construction Safety: The basic phasing of the construction work is arranged so that safety is not compromised at any time. Traffic control, construction limits, fences and barriers, and temporary partitions are all considered. Soil test results and recommendations of soil consultants are incorporated into slope protection, site drainage, active soil protection and construction procedures. Existing asbestos insulation is removed according to prescribed EPA procedures.

4. Energy Conservation Provisions

In accordance with current energy conservation practice, the total energy consumption for both the materials of the initial construction as well as the energy for operation of the facility for its projected lifetime is considered.

Environmental Criteria: Requirements for ventilation, heating, lighting, humidity control and air conditioning are limited to the essential needs of equipment and personnel for effective operations. The extreme high and low ends of the possible range of conditions are not accommodated by these criteria.

Material Selections and Payback Periods: Material alternates for improved insulations, lower maintenance, longer lifetimes, etc., are considered in the view of energy balance of a payback period of 5 years or less.

Alternate Energy Sources: Consideration of other energy sources such as solar, wind, natural gas, etc., require that such sources compete against the heavy electrical service needed in the Linac Power Supply Gallery and Linac/A-0 Assembly Area. When generation equipment and utility extension costs are considered, these alternate energy sources do not compete with electrical service.

5. Environmental Provisions

The sites on which the two new building additions will be constructed are presently used as parking lots and hardstand areas that date from the initial Fermilab construction in 1968-1970. The impact of the proposed buildings is no different than existing adjacent buildings. There are no wetlands, flood plains, archaeological or historical sites involved.

6. Quality Assurance and Value Engineering

Documented Quality Assurance Programs for the Construction Engineering Services Section are in place, and these procedures will be followed for all work with the Linac Upgrade Project. Value Engineering has been an integral part of all Conceptual and Title 1 design work, and engineering and design calculations and cost evaluations are on file.

7. Proposed Method of Accomplishing Work

A series of fixed-price construction subcontracts and Fermilab procurement subcontracts is planned for the civil construction for the Linac Upgrade Project. The subcontracts and procurements parallel closely the WBS elements that will be used and are listed below:

WBS No./Description	Construction Subcontracts	Procurement Subcontracts	Start Construction
WBS 1.2.1 Linac Power Supply Gallery	1	2	May, 1990
WBS 1.2.2 Linac/A-0 Assembly Area	1	2	June 1990
WBS 1.2.3 Linac Utilities & Services	1	1	May 1990
WBS 1.2.4 Linac Enclosure Access and Wave Guide Penetrations	1	-	March 1991

8. Recommendations

The design of the civil construction for the Linac Upgrade Project as described in this Report, has been dictated by the functional needs of the Fermilab High Energy Physics Program, by safety requirements for operating personnel and the the general public, and by architectural conformity with other facilities at the Fermilab site.

This design is in accordance with recognized architectural and engineering practice, and complies with the applicable standards of the Department of Energy and other standards and codes listed in Appendix B.

It is therefore recommended that immediate authorization be granted to proceed with the preparation of Title 2 construction drawings and specifications.

III

CONSTRUCTION OVERVIEW

1. WBS 1.2.1 Linac Power Supply Gallery

The Linac Power Supply Gallery will be a single-story structure built on the east side of the existing Linac Gallery. Present exterior walls and windows will be removed/reconfigured to provide access between new and existing areas. Foundations will be concrete caissons and grade beams. Framing for walls and roof will be structural steel. Walls will be of insulated metal siding. The roof of the new structure can accommodate a future second floor and would match adjacent structures at that elevation.

2. WBS 1.2.2 Linac/A-0 Assembly Area

The Linac/A-0 Assembly Area is a combination high bay with two-level side bay building that will fit between existing A-0 Service Building and A-0 Lab. An existing wall will be removed to allow the existing A-0 Lab bridge crane to travel into the new A-0 Assembly Area. Light assembly and technical work area is provided in the low bay and the mezzanine above. Concrete spread footings will support a structural steel frame for wall and roof support. Walls will be of insulated metal siding with windows to match the existing A-0 Lab building.

3. WBS 1.2.3 Linac Utilities and Services

Two new substations with primary feeders will be installed at the Linac Power Supply Gallery. A storm water lift station will also be added to accommodate relocated storm sewers presently under the new building footprint. Switchboards and secondary power distribution will be made to the SCC Power Supplies.

An existing small substation at the A-0 Service Building will be replaced with a larger substation to provide power for the Linac/A-0 Assembly Area. Switchboards and secondary power distribution will be installed to power a test area for a SCC Power Supply.

4. WBS 1.2.4 Linac Enclosure Access and Penetrations

Equipment access to the existing Linac enclosure will be through an existing wall opening sealed with a removable concrete panel at the downstream end of the Linac enclosure aisle. This opening, at 10' below grade, was used during the initial Linac drift tank installation by means of a long access ramp and will be used again for the installation of the SCC modules and subsequent removal of the drift tube tanks.

An access pit will be constructed by the wall opening with steel sheet piling and temporary concrete shield blocks. Periodic access to the Linac enclosure is accommodated by this pit for the installation of the SCC modules over 3-5 short accelerator shutdowns. When the Linac drift tanks are scheduled for removal during the 400 MeV conversion, the pit will be enlarged and a long ramp will be constructed. After all equipment moves are complete, the ramp will be backfilled. The sheet piling will remain in place should re-excavation and additional access to the Linac enclosure be required in the future.

Nine new penetrations from the Linac Gallery to the Linac enclosure are required for the SCC module wave guides and control/communication conduits. Vertical shafts will be sunk in the shielding berm between the Linac Gallery and Linac enclosure. These shafts will provide access for horizontal pipes to be drilled into both enclosure sidewalls. After placement of the wave guides and conduits, the voids are backfilled with polyethylene bead shielding and capped with a concrete lid.

IV

DESCRIPTION AND SYSTEM OUTLINE SPECIFICATIONS

1. Siting and Orientation

The Linac Power Supply Gallery is nestled into the corner created by the existing Linac Gallery, Cross Gallery Southwest Addition, and Booster Gallery. Equipment access is through a series of overhead doors opening to the courtyard on the east. Personnel access is also available here and from each of the surrounding structures.

The building is oriented with its long axis parallel to the Linac Gallery. This provides maximum proximity of the power supply equipment to the accelerator components in the Linac enclosure.

The Linac/A-0 Assembly Area is sited to fill an existing opening between the A-0 Service Building to the north and the A-0 Lab to the south. Equipment access is through existing doors on either of the adjacent buildings. Personnel access from the parking area to the north is provided by a new walkway wrapping the existing Service Building. This walkway also ties into an existing personnel accessway that crosses over the accelerator berm to the west and links to the High Rise/Footprint areas.

The building is oriented to align its high bay area with the existing A-0 Lab high bay. This allows for extension of the existing crane rails and the utilization of the existing 10-Ton crane. New ground level tech areas and mezzanine spaces are extensions of similar existing spaces.

2. Radiation Shielding

a. Linac Enclosure: The new 400MeV side-coupled cavity Linac will be located inside the downstream section of the present Linac enclosure. After consultation with the Accelerator Division Safety Group, that group performed calculations which demonstrate that the existing shielding of the Linac Enclosure is adequate in all respects. Therefore no modification to the east side shield walls or the west or top side shielding berms will be required.

b. Power Supply Gallery: A portion of the Linac Power Supply Gallery will extend over the existing Booster enclosure. In consultation with the Accelerator Division Safety Group, a specification of 17' earth equivalent of shielding was set. This specification is equal to or greater than the existing Booster shielding at all other locations around the Booster. A very substantial part of the Booster enclosure is beneath occupied workspace, and the intention is that the small additional part of the Linac Power Supply Gallery extended over the Booster should also be available for occupation without restriction.

c. Linac/A-0 Assembly Area: The Linac/A-0 Assembly area is not over any accelerator enclosure containing any beamline, whether injection, extraction, or accelerator. It is over the A-0 Major Vehicle Access labyrinth. Calculations performed by the Accelerator Division Safety Group have demonstrated that at the proposed location a minimum of 32 feet of earth shielding will exist from the nearest accelerator or beamline component, and this is considerably in excess of any requirement at that area. No occupancy restrictions will be required. It is the intention of the Linac Upgrade Project Management to utilize part of the space of the high bay of the Linac/A-0 Assembly Area for the purpose of full-power testing and conditioning of the side-coupled cavity accelerator structures as they are completed. At full power, substantial X-rays are generated in the structures. It has been determined by the Accelerator Division Safety Group, both by direct measurement of X-ray emission from prototype structures and from calculations, that 18 inch concrete shielding will be needed on all sides of the structures for X-ray shielding during full-power testing.

d. Linac Beam Dumps: Two dumps exist at the end of the 200MeV Linac. Preliminary calculations by the Accelerator Division Safety Group have indicated that the existing dumps are adequate for 400MeV beam. A possibility that the earth shielding on one of the dumps may have to be increased by one foot exists and is being reviewed. If necessary, the extra earth will be added.

e. Penetrations for RF Wave Guides: New penetrations for the RF wave guides from the 12MWatt klystrons to the side-coupled Linac structure are required. After the penetrations are constructed and the RF wave guides inserted, the surrounding voids will be filled. The wave guide path follows a labyrinth route, and any direct line from the Linac enclosure is excluded. When completed, no reduction in the necessary shielding will have been introduced.

f. Shielding During the Time when the Linac Access Doors are Uncovered: In order to insert the new side-coupled Linac modules, and in order to remove the old drift tube Linac tanks, an existing access door, long buried in the shielding berm, will be uncovered. During this time two potential shielding problems could exist; 1) direct radiation from the operation of the 200MeV Linac until the 400MeV structure is installed, and 2) radiation from the nearest of the two dumps to the uncovered area. The intention is to open the access area by the removal of the shielding earth, and then to replace the shielding with concrete shielding blocks of the necessary equivalent earth shielding rating. In addition, the exposed area will be protected by interlocked detectors to control machine operation in the event that any leakage paths exist after the placement of the shield blocks in the excavated area.

3. Architecture

The Linac Power Supply Gallery is a single-story structure 29'-0" wide by 97'-0" long. The floor elevation (744'-0") matches the existing Linac Gallery to facilitate equipment moves. The new east wall is pre-finished, field assembled metal siding. The new structure abuts existing construction on the other three sides. Removal of window walls and precast concrete panels will simplify the new construction and better incorporate the new space into the existing. The roofing is a single-ply membrane over a concrete deck designed for use as a second floor in the future.

The Linac/A-0 Assembly Area is 61'-10" wide by 98'-6" long with a 36'-0" wide crane bay and 25'-10" side bay and mezzanine. The exterior skin is pre-finished field assembled metal siding with a parapet height to match the adjacent buildings. The ground floor (Elev. 747'-2") and mezzanine (Elev. 758'-8") are set flush with adjacent existing floor surfaces. The roof is of tar and gravel construction.

The crane bay is 36'-0" by 98'-6" and is serviced by a 10-Ton crane. The east and north walls are of reinforced concrete to a height of 7'-2". These will be used in conjunction with precast concrete shield blocks forming a cave to house the beamline component test station and shield the surrounding areas from X-rays produced during the testing. Equipment access is through existing doors on the adjacent buildings.

The 25'-10" by 98'-6" ground level side bay houses tech areas for inventory, assembly and quality control. The power supply, pulse forming network, and klystron, along with their LCW supply skid, are also located here.

The matching mezzanine above can be easily partitioned into offices using furniture dividers. A notch in the northeast corner leaves a space with adequate height for assembly and operation of the test klystron. Rigging beams are provided at the roof for this purpose.

All areas have exposed construction ceilings, sealed concrete floors and pre-finished metal siding liner panel walls.

4. Structure and Foundations

The Linac Power Supply Gallery will be founded on nine drilled concrete caissons consisting of 3'-0" diameter shafts with bells averaging 5'-6" in diameter bearing on a consolidated glacial till strata 20 feet below grade with an allowable capacity of 5,000 psf. This foundation scheme minimizes the impact upon the foundations of the existing structures while allowing the Linac Power Supply Gallery columns to be located proximate to the adjacent existing structures reducing unwieldy cantilever framing and expensive details. The one-story Linac Power Supply Gallery will consist of structural steel columns, wall framing and roof framing, metal roof decking with a composite cast-in-place concrete roof slab designed to support a possible future floor load. The exterior east wall will have a concrete

grade beam foundation with the end spans doweled into existing foundation walls. The floor will consist of a 6" concrete slab-on-grade at Elevation 744'-0" to match existing floors of adjacent buildings. At the southeastern area of the Linac Power Supply Gallery, the floor level will be raised 3'-6" to Elevation 747'-6" to provide the required 17 feet of radiation shielding between this area and the Booster enclosure below.

The Linac/A-0 Assembly Area, which connects with the existing A-0 Service Building on the north and the A-0 Lab on the south, will be constructed with a similar concrete spread footing foundation designed for an allowable bearing pressure of 4,000 psf and perimeter grade beams tied to the adjacent foundations. While this structure is located above an existing major vehicle access enclosure to the Main Accelerator, it has been determined that both the radiation shielding and the incremental additional soil pressure are within permissible limits. The framing will consist of structural steel columns, floor beams for the mezzanine, roof beams and wall girts and bracing. The majority of the framing is independent of the A-0 Service Building with its masonry bearing wall, but the A-0 Lab was designed to support both mezzanine and roof loads for the new building. The Linac/A-0 Assembly Area framing will include an extension of the crane beams for the A-0 Lab 10-Ton overhead crane and also provides a hoist beam for assembling klystron modules. A 7'-6" high by 1'-6" thick cast-in-place concrete wall will be constructed just inside the east wall with a 20'-0" return along the north wall as shielding against X-rays resulting from testing procedures and also as a provision for erecting future "caves" using precast shielding blocks. The 8" concrete slab-on-grade matches the adjacent building floors at Elevation 747'-2" while the mezzanine level consisting of a concrete composite slab over metal deck will match the A-0 Lab mezzanine at Elevation 758'-8". An 8 foot wide passageway and stair linking the northwest corner of the Linac/A-0 Assembly Area with the existing corridor to the Transfer Gallery will be constructed using masonry bearing walls on a concrete foundation with a cast-in-place 4" concrete roof slab partially supported by the A-0 Service Building walls.

5. Heating, Ventilation and Air Conditioning

a. Linac Power Supply Gallery: The heating systems for this area will be supplied from connections to the existing Linac dual temperature water system headers located just west of this area. This water will be used primarily for the tempering of ventilation air and for unit heaters to offset the effects of opening overhead doors. Most of the time, however, we will need cooling during the winter to offset power supply waste heat. This makes the existing dual temperature water system an unsuitable source to meet cooling requirements. To accommodate these needs connections will be made to the existing Central Utility Plant chilled water system in the lower level utility tunnels. In addition to routing these lines to air conditioning equipment in the Linac Power Supply Gallery, valved and capped outlets will be provided for use in Linac equipment cooling. Air

conditioning of the Linac Power Supply Gallery will cover the entire area of new construction, as well as the existing bay immediately north which is to be joined to this space by removal of one wall. Chilled water fan coil units will be employed to provide the air conditioning, and the condensate drains from these units and the ventilation supply unit will be connected to the existing Linac building fan coil drain system located just west of this area.

b. Linac/A-0 Assembly Area High Bay and Mezzanine: This site is essentially composed of two distinct areas; the High Bay Assembly Area, and the Office/Service Area. The cooling source for both areas is a new air-cooled chiller and all heating is from electric resistance heaters. The High Bay Assembly Area is heated, ventilated and air conditioned by a single air handling unit with economizer-free cooling for energy conservation. Additionally, electric unit heaters are used in the Assembly Area and Service Corridor. The Office/Service Area is ventilated by a single separate make-up air unit. Heating and air conditioning in this area is accomplished with fan coil units. Condensate drains for the units are combined into a single system which dumps into the building drains. Humidity control for the tuning area will be provided at a later date, when the scope and requirements of this room are more clearly defined.

6. Fire Detection and Suppression

Fire protection for both the Linac Power Supply Gallery and the Linac/A-0 Assembly High Bay and Mezzanine Area is provided by two systems; a fire suppression system, and a fire detection system. Both systems are tied into FIRUS, the site-wide supervisory system.

a. Linac Power Supply Gallery: Fire suppression is provided by an overhead wet sprinkler system in the area of new construction. The water supply for this system is from a connection to the existing fire protection riser located near Column 15.2-C2, about 60 feet east of this area. This riser presently serves the existing wet sprinkler system to remain in the bay just north of this area which will be combined with the new construction by removal of a wall. Fire detection for this area is provided in two ways. First, by a relocated manual pull station located at the new exterior exit; and second, through the existing sprinkler flow switch for the riser into which this sprinkler system is connected. The flow switch will be activated upon release of any sprinkler head in this area.

b. Linac/A-0 Assembly High Bay and Mezzanine: Fire suppression is provided by an overhead wet sprinkler system on all floors. The water supply for this system is from a connection to the existing fire protection riser located at the south end of the

existing A-0 Lab Building which is directly adjacent to the south end of this area. Manual pull stations are provided at each exterior exit and audible alarms on each floor. An area flow switch to be activated upon release of any sprinkler head in this area will be provided in the new main sprinkler supply line. All detection and annunciation devices will be tied into the existing fire alarm control panel in the north end of the existing adjacent A-0 Lab Building.

7. Primary Power and Substations

The additional electrical and mechanical loads to be installed in the new Linac Power Supply Gallery require the installation of a 1.5 MVA, 13800-480 Volt substation in the vicinity of these new loads. Unfortunately, the power line disturbances that will be created in the 480 Volt system feeding the klystron power supplies will be unlikely to be tolerated by any other load at that voltage level. Therefore, it will be necessary to install an additional 500 KVA, 13800-480 Volt substation to provide clean power for relay racks and other sensitive electrical equipment.

The primary 13.8 KV feeder for these two new substations will be tapped from an existing feeder that is installed in a rigid conduit system along the underground tunnel connecting the Cross Gallery with the Central Utility Plant.

To provide power for the Linac/A-0 Assembly Area, an existing 750 KVA, 13800-480 Volt substation behind the new building will be replaced by a 1.5 MVA substation.

8. Secondary Power Distribution and Lighting

From the new 1.5 MVA substation at the Linac Power Supply Gallery, a 480 Volt, 2,000 Amp feeder will be extended to a new 2,000 Amp switchboard to be installed inside the new Linac Power Supply Gallery, as close as possible to the klystron power supplies and related mechanical equipment. From the new 500 KVA clean power substation, one 480 Volt, 600 Amp feeder will be extended to a 600 Amp power distribution panelboard, also installed inside the new Linac Power Supply Gallery. This new 600 Amp panelboard will provide power for lighting and miscellaneous 277/480 Volt loads and, through a dry-type transformer, will provide 208/120 Volt power for relay racks and convenience outlets.

At the Linac/A-0 Assembly Area, a 900 Amp, 480 Volt feeder will be extended from the new 1.5 MVA substation to a 900 Amp power distribution switchboard. From there, power will be provided for lighting and miscellaneous 277/480 Volt loads and through a dry-type transformer and 208/120 Volt panelboards, power will be obtained for convenience outlets. Lighting for the Linac/A-0 Assembly Area will be provided by metal halide fixtures to an estimated level of 75 fc.

In the general areas of the Linac/A-0 Assembly Area and in the Linac Power Supply Gallery, industrial type fluorescent fixtures with energy saving ballasts and lamps will provide lighting levels of 50 fc or 30 fc depending on locations.

Outdoor type fixtures will also be installed around the perimeter of the new construction to provide a minimum of 2 fc level of illumination for pedestrian safety.

In addition, emergency lighting in the form of wall-mounted battery packs or fixtures with built-in batteries, will be provided for safe egress of the building in case of a power outage.

9. Wave Guide Penetrations

As part of the sequential installation for the new Linac modules, the wave guides between the power supplies in the Linac Power Supply Gallery and the modules in the Linac enclosure must also be installed. Each wave guide, along with one or more conduits for control cables, will be routed from a relatively high elevation in the Linac Power Supply Gallery (above the bottom of the roof trusses), horizontally through the west concrete wall, vertically downward through the earth shielding between the enclosures, and then horizontally through the east wall of the Linac enclosure at an elevation above the existing cavities, but below the existing crane bridge.

The access for installing the wave guides will be constructed from the top of the existing Linac shielding berm. Initially, a vertical 50" diameter shaft will be augered at each of the nine penetration locations. The shafts will be drilled tangent to the outside face of the east wall of the Linac enclosure and extend approximately 20 feet to an elevation nominally 3 feet below the centerline of the horizontal wave guide penetration into the Linac. A 48" diameter CMP will be dropped into each shaft and the annular space grouted. A trench can then be excavated between each shaft and the outside face of the west wall of the Linac equipment bay at a depth of approximately 4 feet below the top of berm. A 22" diameter hole will then be core-drilled eastward through the 18" thick concrete gallery wall, a hole will be flame cut in the CMP shaft, and a 20" diameter steel pipe sleeve will be installed between the gallery and the vertical 48" diameter CMP shaft. The horizontal trench can then be backfilled to grade. Another 22" diameter hole will be core-drilled westward from the bottom of the CMP shaft through the 15" thick concrete east wall of the Linac enclosure. The wave guide and conduit can then be installed by Fermilab in each accessway. At the conclusion of the installation work, the upper and lower horizontal penetrations will be sealed with closure plates and the 48" diameter vertical shafts and the 20" diameter horizontal sleeves will be filled with polyethylene beads, sand or other removable type of shielding material. The 48" CMP shafts will then be capped with a 12" thick concrete plug.

This method of penetration access to existing enclosures has been successfully employed in several past Fermilab projects. Based on experience and assuming two core drills in each operation, all nine accessways can be constructed during the initial shutdown period.

10. Sitework and Paving

The sitework at the Linac Power Supply Gallery area will principally be concerned with re-routing existing utilities. An existing sanitary manhole, located within the new building limits, will be abandoned and replaced by a sealed floor cleanout. An additional short segment of sanitary sewer will run northward to connect the new manhole with the existing system. Roof drainage and 2" diameter pump discharge lines will be re-routed to avoid the caisson foundations. Since the present storm drainage system discharges by gravity flow into the nearby Booster Pond, the water level in the storm system is normally within a few inches of the proposed pavement grade. To alleviate this problem, the existing catch basin just upstream of the discharge run to the pond will be re-built to house a storm water pump station. A new force main discharge with a check valve will be constructed to the Booster Pond. A fire hydrant and gate valve presently located at the toe of the Booster shielding berm will be relocated to the east, requiring a new 8" ICW pipe connection to the existing main.

Primary power for the two new substations will be routed from the underground utility enclosure which connects the Central Utility Building and the Cross Gallery. This enclosure rises to cross over the Booster Enclosure at a point approximately 70 feet east of the substation pad. The interior conduit will be routed southward along the east wall of the utility enclosure from an existing pull box, cross over to the west wall at the stairway over the Booster, and emerge through a cored hole at an elevation approximately 3 feet below grade. From that point, an underground 5" diameter PVC conduit encased in concrete will be routed along the toe of the Booster berm to the raised substation pad location. The concrete pad, measuring 12 by 20 feet will be set into the berm at Elevation 747'-6" to afford 17 feet of radiation shielding. A secondary duct bank consisting of 6-5" diameter PVC conduits encased in concrete will be extended underground from the pad to the switchboard and panelboards inside the Linac Power Supply Gallery.

The area immediately east of the new building will include a continuous concrete apron at the four truck doors, a concrete stoop at the personnel door, and bituminous paving to meet the existing courtyard paving.

Sitework at the Linac/A-0 Assembly Area will be minimal since most services are already available within the adjacent buildings. A 6' x 9' concrete pad will be provided along the west wall near the A-0 Lab for a chiller. At the existing substation pad where a 1.5 MVA substation will replace an existing 750 KVA unit, underground PVC conduits encased in concrete for the 480V secondary power will be routed approximately 25 feet to switchboards within the building. Along the east side of the new

building adjacent to the Ring Road, a paved swale will be constructed between the road edge and the building foundation to collect downspout run-off and direct it to one relocated existing catch basin and a new catch basin to be located in front of the A-0 Service Building. The latter will discharge into a storm sewer to be constructed across the Ring Road to the existing ditch system. Guard rail will be mounted on the entire length of the east foundation wall of the new building to match the existing protection on the adjacent buildings. A concrete stoop will be provided at the personnel door at the northwest access to the existing corridor.

An existing crushed stone hardstand located at the northwest quadrant of the Ring Road and South Booster Road intersection will be utilized as a subcontractor's area. At the conclusion of the work, the crushed stone base will be supplemented and regraded and bituminous pavement will be provided over an area of 900 SY for use as a parking lot for the A-0 buildings.

11. Demolition and Protection of Existing Facilities

Considerable demolition at the Linac Power Supply Gallery will precede the new construction. An existing 450 SF Linac office area west of Column Line A and south of Column Line 17 will be removed consisting of metal stud and drywall partitions. A section of the exterior Cross Gallery wall consisting of precast concrete sill, window wall, insulated aluminum soffit and sloped upper precast panel will be removed from Column A4 west along Column Line 15.2. The window wall and sill removal will extend 5'-0" east of Column A4 to correspond with the precast joints. Demolition in this area also includes removal of steel support bracket at Column A3 and removal of roofing, insulation and cant along the roof edge. Similarly, the precast concrete sill, window wall, soffit and sloped upper precast panel will be removed from the east wall of the Linac Gallery along Column Line A between Column Lines 16 and 17. This demolition work includes removal of structural steel framing above the windows, removal of the cast-in-place endwall and precast concrete sloping wall at the personnel door, removal of 240 SF of concrete apron, and removal of the upper portion of foundations at the door enclosure.

At the Booster Gallery mechanical room, the existing concrete retaining wall and footing west of the exterior passageway will be partially demolished to provide access for a caisson shaft, another portion of the same wall will be saw-cut horizontally to match the new floor elevation at 747'-6", and the north 4' of the retaining wall will be demolished to Elevation 743'-0". The sidewalk between the mechanical room and the retaining wall will be demolished. The north end of the companion retaining wall located east of the mechanical room will also be demolished. At the juncture of the Booster Gallery and Linac Power Supply Gallery, selective demolition of the roofing, timber blocking and sheet metal cap will be required at the roof and waterproofing will be removed from those exterior wall surfaces which will be exposed to interior view by the Linac Power Supply Gallery work. Bituminous pavement located within the

limits of the new work will be removed, hydrant bumper posts demolished, a sanitary manhole abandoned and filled, and an existing 2" ICW abandoned pipe formerly for filling the Booster sumps will be removed.

Demolition work at the Linac/A-0 Assembly Area includes removal of a concrete apron at both the A-0 Service Building and the A-0 Lab, removal of a support slab for a liquid nitrogen dewar at the A-0 Service Building, removal of bumper posts at apron and dewar slab, demolition of approximately 320 SF of sidewalk at the southwest corner of the A-0 Service Building, relocation of an existing catch basin and 20 feet of storm sewer near the northeast corner of the A-0 Lab, saw-cutting 100 LF of pavement at the edge of the Ring Road, and removal of approximately 925 SY of bituminous pavement between the two existing buildings.

Demolition of the north wall of the A-0 Lab will include removal of approximately 950 SF of metal siding, insulation and liner panel, 63 LF of cap flashing, cant, roofing and insulation, associated girts, door hood, concrete curb, and three existing exterior light fixtures. Demolition includes removal of structural Column D_4 (designed to be removed) and crane stops (to be relocated to new building).

Demolition at the A-0 Service Building includes removal of 550 SF of metal siding, sub-girts and insulation from masonry walls abutting new stair and accessway at the southwest corner, removal of 180 SF of metal siding, insulation, and liner panel with trim, girts, sub-girts, angles, one double door, hardware and frame at south wall, removal of 63 LF of aluminum gravel stop at roof edge, removal of one exterior light fixture, and removal of end closure at southeast building corner.

Demolition at the corridor linking A-0 Service Building and the Transfer Gallery includes removal of two doors with frames and hardware and removal of approximately 20 SF of 12" masonry wall for new door and sidelight.

Demolition work includes hauling of concrete and bituminous paving debris to the Meson Shielding Hill for disposal as well as off-site disposal of all other debris. Additionally, demolition of interior partitions or exterior wall elements will require temporary dust or weather barriers to protect adjacent occupied areas from weather and construction activities. Where new work abuts existing structures or utilities, the subcontractor will be required to erect protective barriers or structures. Interruption of existing services will be minimized by closely scheduled shutdowns or weekend outages.

V

COST ESTIMATE

1. Cost Estimate Overview

Civil construction costs for the Linac Upgrade Project are divided into four Work Breakdown Structure elements/construction phases as described in Section II and Section VI. Totals are listed below:

WBS No./Description	Construction Cost & EDIA	Contingency	Total w/Contingency
WBS 1.2.1 Linac Power Supply Gallery	$ 592,000	$ 119,000	$ 711,000
WBS 1.2.2 Linac/A-0 Assembly Area	861,000	172,000	1,033,000
WBS 1.2.3 Linac Utilities & Services	274,000	55,000	330,000
WBS 1.2.4 Linac Enclosure Access and Wave Guide Penetrations	368,000	74,000	442,000
SUBTOTAL	$ 2,096,000	$ 420,000	$ 2,516,000
ESCALATION	74,000	20,000	94,000
WBS 1.2 TOTAL WITH ESCALATION	$ 2,170,000	$ 440,000	$ 2,610,000

2. Basis of Cost Estimate - Methodology

The Cost Estimate is based on the following data sources, conditions, and assumptions:

Construction Costs: Construction costs are based on quantity take-offs from the Title 1 Drawings and unit costs derived from Means Construction Cost Data 1990 tempered with local construction experience.

Subcontractor's Overhead, Profit and Bonds: These items are included at 20% of the construction costs. These percentages are based on recent bid experience on similar type construction packages.

Engineering, Design, Inspection & Administration (EDIA): EDIA is estimated on the required drawings and specifications needed for final Title 2 construction packages. EDIA ranges from 20% to 26% of the bare construction costs including subcontractor's overhead, profit and bonds.

Fermilab Overhead: These items are included in the Linac Upgrade Project overall budgets.

Contingency: Contingency is applied to each civil WBS element, including EDIA at a rate of 20%. This percentage is appropriate for Title 1 civil design.

Escalation: Data from the DOE Departmental Price Change Index, FY 1991 Guidance, dated August 1989, is used for escalation rates. This data and the escalation computations for the civil WBS elements are shown in Appendix C.

3. Cost Estimate Summary Sheets

Civil Cost Estimate Summary Sheets including WBS elements, EDIA, Fiscal Year costs and construction discipline cost breakdowns are included on the following pages. Cost Estimate Detail Sheets are included in Appendix D.

FERMILAB COST ESTIMATE	PROJECT TITLE: FERMILAB LINAC UPGRADE - Title 1 CIVIL CONSTRUCTION COST OVERVIEW WITH CONTINGENCY	PROJECT NO.: 4-1-2	DATE: Feb. 1990	REVISION DATE:	PAGE / OF: 1/1

WBS No. Package & Name	Start Construction	Construction Cost	EDIA Cost	Total with EDIA	Contingency Cost	TOTAL with Conting.
WBS 1.2.1 LINAC POWER SUPPLY GALLERY	May, 1990	$ 482,000	$ 110,000	$ 592,000	$ 119,000	$ 711,000
WBS 1.2.2 LINAC/A-0 ASSEMBLY AREA	June 1990	716,000	145,000	861,000	172,000	$ 1,033,000
WBS 1.2.3 LINAC UTILITIES AND SERVICES	May 1990	220,000	55,000	274,000	55,000	330,000
WBS 1.2.4 LINAC ENCLOSURE ACCESS AND WAVEGUIDE PENETRATONS	March, 1991	292,000	76,000	368,000	74,000	442,000
WBS 1.2 TOTAL CIVIL CONSTRUCTION		$ 1,710,000	$ 386,000	$ 2,096,000	$ 420,000	$ 2,516,000
Escalation		65,000	9,000	74,000	20,000	94,000
TOTAL WITH ESCALATION		$ 1,775,000	$ 395,000	$ 2,170,000	$ 440,000	$ 2,610,000

FERMILAB COST ESTIMATE
4-1-2
FERMILAB LINAC UPGRADE
WBS 1.2.1 LINAC POWER SUPPLY GALLERY

CONSTRUCTION ENGINEERING SERVICES | Status: TITLE-1 | Issue Date: 2-14-90 | Rev. Date:

Project Engineer: E.C. | Quantities By: J.Q. | Priced By: J.Q. | Checked By: | Page 1 of 13

SUMMARY OF CONSTRUCTION COSTS

	TOTAL COSTS
02 SITE WORK	$173,000
03 CONCRETE	31,000
04 MASONRY	5,000
05 METALS	44,000
07 MOISTURE-THERMAL CONTROL	44,000
08 DOORS, WINDOWS & GLASS	7,000
09 FINISHES	15,000
15 MECHANICAL	37,000
16 ELECTRICAL	46,000
SUBTOTAL	402,000
CONTRACTOR'S OVERHEAD & PROFIT @ 20.000%,	80,400
SUBTOTAL	482,000
TOTAL CONSTRUCTION COST	$482,000

FERMILAB COST ESTIMATE
4-1-2
FERMILAB LINAC UPGRADE
WBS 1.2.2 LINAC/A-0 ASSEMBLY AREA

CONSTRUCTION ENGINEERING SERVICES | Status: TITLE-1 | Issue Date: 2-15-90 | Rev. Date:

Project Engineer: E.C. | Quantities By: J.G. | Priced By: J.G. | Checked By: | Page 1 of 17

SUMMARY OF CONSTRUCTION COSTS

	TOTAL COSTS
02 SITE WORK	$64,000
03 CONCRETE	83,000
04 MASONRY	13,000
05 METALS	110,000
07 MOISTURE-THERMAL CONTROL	70,000
08 DOORS, WINDOWS & GLASS	45,000
09 FINISHES	28,000
15 MECHANICAL	100,000
16 ELECTRICAL	84,000
SUBTOTAL	597,000
CONTRACTOR'S OVERHEAD & PROFIT @ 20.000%,	119,400
SUBTOTAL	716,000
TOTAL CONSTRUCTION COST	$716,000

FERMILAB COST ESTIMATE
4-1-2
FERMILAB LINAC UPGRADE
WBS 1.2.3 LINAC UTILITIES AND SERVICES

CONSTRUCTION ENGINEERING SERVICES | Status: TITLE-1 | Issue Date: 2-20-90 | Rev. Date:

Project Engineer: E.C. | Quantities By: J.G. | Priced By: J.G. | Checked By: | Page 1 of 4

SUMMARY OF CONSTRUCTION COSTS

	TOTAL COSTS
02 SITE WORK	$15,000
15 MECHANICAL	15,000
16 ELECTRICAL	153,000
SUBTOTAL	183,000
CONTRACTOR'S OVERHEAD & PROFIT @ 20.000%,	36,600
SUBTOTAL	220,000
TOTAL CONSTRUCTION COST	$220,000

FERMILAB COST ESTIMATE
4-1-2
FERMILAB LINAC UPGRADE
WBS 1.2.4 LINAC ENCLOSURE ACCESS & PENETRATIONS

CONSTRUCTION ENGINEERING SERVICES | Status: TITLE-1 | Issue Date: 2-19-90 | Rev. Date:

Project Engineer: E.C. | Quantities By: J.G. | Priced By: J.G. | Checked By: | Page 1 of 4

SUMMARY OF CONSTRUCTION COSTS

	TOTAL COSTS
02 SITE WORK	$243,000
SUBTOTAL	243,000
CONTRACTOR'S OVERHEAD & PROFIT @ 20.000%,	48,600
SUBTOTAL	292,000
TOTAL CONSTRUCTION COST	$292,000

VI

ENGINEERING AND CONSTRUCTION SCHEDULES

1. Construction Phases

Civil construction for the Fermilab Linac Upgrade project may be conveniently divided into four phases due to construction site separation and to construction sequences required by programmatic needs. Each of these phases is defined as a WBS element and will be a discrete construction package with some advance procurement of long lead building equipment items. The WBS numbers and the phase/packages are as follows:

WBS 1.2.1	Linac Power Supply Gallery
WBS 1.2.2	Linac/A-0 Assembly Area
WBS 1.2.3	Linac Utilities & Services
WBS 1.2.4	Linac Enclosure Access and Wave Guide Penetrations

The Linac Power Supply Gallery and the Linac/A-0 Assembly Area are both building additions that are constructed simultaneously, though at widely separated sites. The Utilities and Services package relates mainly to the Linac Power Supply Gallery, and extensions to existing cooling water systems are installed in this package. The Enclosure Access and Wave Guide Penetration work can occur only during an Accelerator shutdown period scheduled one year after the start of the first three packages.

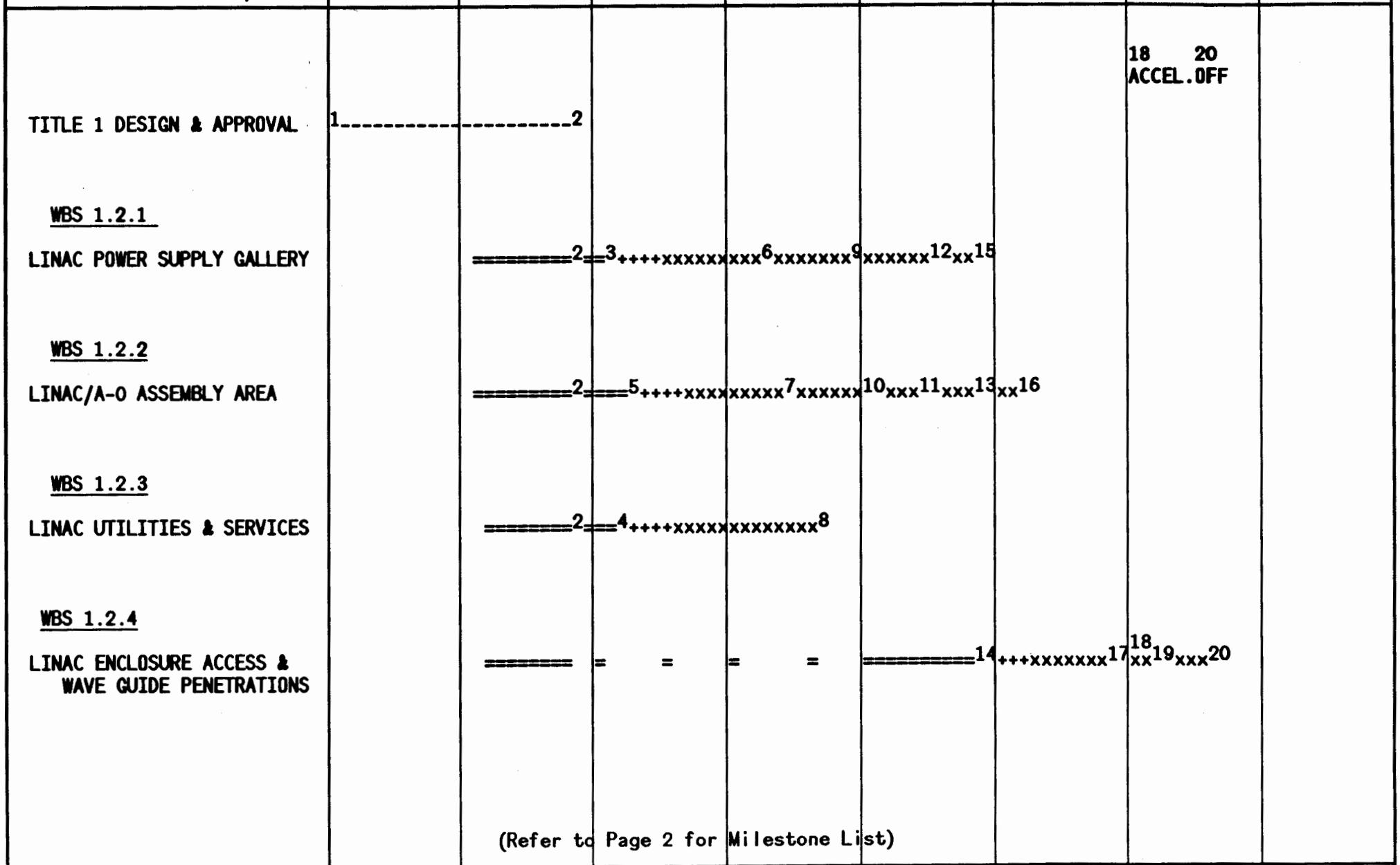
2. Construction Schedule

Critical Path Network diagrams have been developed for all four construction packages and included in Appendix F. These networks include all major construction tasks and related procurement items for each package. Construction times are estimated on standard 40 hour work weeks, using conventional construction techniques. Considerable Fermilab experience on similar past construction projects has been folded into all estimates.

A Construction Bar Chart Schedule and Milestone List is shown on the following pages. This Schedule is developed around key dates from the Linac Upgrade Project Master Schedule:

Mar. 15, 1990	Approval of Title 1 Design Report.
Dec. 15, 1990	Complete Construction of Linac Power Supply Gallery Addition.
Apr. 1, 1991	Accelerator Shutdown for Linac Enclosure Access and Wave Guide Penetrations (also Accelerator Separators and B-0/D-0 Low Beta Equipment).
Jul. 15, 1992	Start Conversion to 400 MeV.

FERMILAB CONSTRUCTION SCHEDULE	PROJECT TITLE: FERMILAB LINAC UPGRADE - Title 1 CIVIL CONSTRUCTION SCHEDULE AND MILESTONES	PROJECT NO.: 4-1-2	DATE: Feb. 1990	REVISION DATE:	PAGE: 1/2



(Refer to Page 2 for Milestone List)

LEGEND: OOOO ACCELERATOR OPERATIONS; - - - - CONCEPTUAL DESIGN/TITLE 1; ==== FINAL DESIGN/TITLE 2; ++++ BID & AWARD SUBCONTRACT; XXXX CONSTRUCTION & INSTALLATION; VVVV PROCUREMENT EQUIP./MAT'L.; BO BENEFICIAL OCCUPANCY; ==3++ MILESTONE NUMBER

SCHDFORM.OLCB

FERMILAB CONSTRUCTION SCHEDULE	PROJECT TITLE FERMILAB LINAC UPGRADE - Title 1 CIVIL CONSTRUCTION SCHEDULE AND MILESTONES	PROJECT NO. 4-1-2	DATE Feb. 1990	REVISION DATE	PAGE 2/2

Year	No.	Date	Description
1989	1	Oct. 1	Start Title 1 Design Report.
1990	2	Mar. 15	Title 1 Design Report Reviewed and Approved by DOE. Continue Title 2.
	3	Apr. 9	Release Bid Package for Linac Power Supply Gallery.
	4	Apr. 16	Release Bid Package for Linac Utilities and Services.
	5	Apr. 23	Release Bid Package for Linac/A-0 Assembly Area.
	6	Jul. 28	Power Supply Gallery Caissons Complete.
	7	Aug. 7	A-0 Assembly Area Foundations Complete.
	8	Aug. 18	Linac Utilities and Services PROJECT COMPLETE.
	9	Sep. 21	Power Supply Gallery Roof and Walls Complete.
	10	Oct. 1	A-0 Assembly Area Roof and Walls Complete.
1990	11	Nov. 5	A-0 Assembly Area High Bay BENEFICIAL OCCUPANCY.
	12	Nov. 20	Power Supply Gallery BENEFICIAL OCCUPANCY.
	13	Dec. 10	A-0 Assembly Area Side Bay and Mezzanine BENEFICIAL OCCUPANCY.
	14	Dec. 12	Release Bid Package for Linac Enclosure Access and Penetrations.
	15	Dec. 15	Power Supply Gallery PROJECT COMPLETE.
1991	16	Jan. 9	A-0 Assembly Area PROJECT COMPLETE.
	17	Mar. 17	Sheet Piling for Linac Enclosure Access Complete.
	18	Apr. 2	ACCELERATOR OFF. Start excavation for Linac Access and Penetrations.
	19	Apr. 12	First Linac Penetration and Linac Enclosure Access Complete.
	20	May 17	Linac Enclosure Access and Wave Guide Penetrations PROJECT COMPLETE.

(Refer to Page 1 for Construction Schedule)

Appendix A

SCHEDULE 44

CONSTRUCTION PROJECT DATA SHEETS

DEPARTMENT OF ENERGY
FY 1991 CONGRESSIONAL BUDGET REQUEST
CONSTRUCTION PROJECT DATA SHEETS
GENERAL SCIENCE AND RESEARCH - PLANT AND CAPITAL EQUIPMENT
HIGH ENERGY PHYSICS

(Tabular dollars in thousands. Narrative material in whole dollars.)

1. Title and location of project: Fermilab Linac Upgrade
Fermi National Accelerator Laboratory
Batavia, Illinois

2. Project No.: 90-R-104

3. Date A-E work initiated: 1st Qtr. FY 1990

3a. Date physical construction starts: 1st Qtr. FY 1990

4. Date construction ends: 2nd Qtr. FY 1993

5. Previous cost estimate: $
Date:

6. Current cost estimate: $ 22,800
Date: May 1988

7. Financial Schedule:

Fiscal Year	Authorization	Appropriations	Obligations	Costs
1990	$ 4,634	$ 4,634	$ 4,634	$ 2,500
1991	12,000	12,000	12,000	8,000
1992	6,166	6,166	6,166	7,400
1993	-	-	-	4,900

8. Brief Physical Description of Project

This project provides for the replacement of the downstream accelerating cavities and ancillary systems of the Linear Accelerator to increase the kinetic energy from 200 MeV to about 400 MeV. It also provides for the replacement of some of the elements in the beam analysis and transport system at the end of the Linac, and injection system into the 8-GeV Booster Accelerator in order to accommodate the higher energy. Cavities in the downstream end of the Linear Accelerator will be replaced with more efficient, higher accelerating gradient cavities and a matching section will be inserted between the existing Linac cavities and the higher accelerating gradient cavities. The downstream drift tube tanks will be replaced with new structures operating at a frequency of 800 MHz, four times the operating frequency of the present Linac. The higher frequency cavities will be operated at an accelerating gradient of 7 MV/m or more compared to the 2.5 MV/m in the present drift tube system. .They will be installed in the space made available by removing the old drift-tube tanks, and will be driven by 12 MW, 800 MHz klystron type

1. Title and location of project: Fermilab Linac Upgrade
Fermi National Accelerator Laboratory
Batavia, Illinois

2. Project No.: 90-R-104

8. Brief Physical Description of Project (continued)

radiofrequency power amplifiers. This new high frequency configuration will be capable of accelerating the beam from 116 MeV to about 400MeV.

In addition to the cavity structures and rf power sources, other components will be required. These include: focusing and steering elements in the Linac and along the transport line from the Linac to the Booster accelerator, an rf debunching cavity, Booster injection girder elements, and beam position, size, and bunch length monitors.

The scope of this project specifically provides for:

a) 800 MHz rf Linac cavities to accelerate the beam.
b) RF power sources and associated equipment.
c) A 200 MHz to 800 MHz matching section and power source.
d) Focusing and steering elements along the new Linac sections.
e) Diagnostic and vacuum equipment, and other associated power supplies and equipment along the new Linac sections.
f) Modifications to the beam analysis area, beam transport line to the Booster and Booster injection, consisting of changes to or replacement of magnetic or electrostatic components, rf debunching cavity, diagnostic devices and vacuum components, and other associated electronics equipment and power supplies.
g) Control system interface to integrate the new components into the Fermilab accelerator controls system.
h) Building and utility additions to the Linac gallery (about 14,000 sq ft).
i) Standby station.

9. Purpose, Justification of Need for, and Scope of Project

The overall purpose of this project is to increase the collision rate in the antiproton-proton collider. The beam emittances, longitudinal and transverse, are among the critical parameters which determine beam size and consequently transmission efficiency throughout the chain of accelerators and, therefore, the final luminosity and intensity of the collisions.

1. Title and location of project: Fermilab Linac Upgrade
Fermi National Accelerator Laboratory
Batavia, Illinois

2. Project No.: 90-R-104

9. Purpose, Justification of Need for, and Scope of Project (continued)

When either the beam emittance grows or intensity is lost at any stage in the acceleration chain, the growth cannot be reversed and the loss cannot be restored in subsequent steps in the chain. These limitations in early stages of the chain adversely affect performance of later stages. One such limitation occurs during the first few milliseconds after injection from the Linac to the Booster where the beam transverse emittance grows significantly. This emittance growth is due to the beam tune spread resulting from electromagnetic space charge forces of the beam acting on its own individual particles. This emittance growth can be reduced by increasing the injection energy of the beam going into the Booster. Specifically, by increasing the booster injection kinetic energy from 200 MeV to about 400 MeV, the betatron tune spread at injection due to space charge will be reduced by a factor of about 1.75 at the present intensities. The transverse emittance growth will be reduced as a consequence. If this gain at Booster injection is preserved in subsequent steps of acceleration in the Booster, Main Ring and Tevatron, as expected, there will be a gain in peak luminosity in the Collider, mode as well as in the extracted beam intensity in the Fixed Target mode, by 50 to 75 percent.

In addition to beam performance improvements, this project will replace the downstream end of the present Linac, which is outdated, with a new system based on modern technology. Design and fabrication of standing-wave Alvarez linear accelerators has advanced remarkably in the last 20 years since the Fermilab 200-MeV Linac was built. The present Linac relies upon a final radiofrequency power amplifier tube, which is no longer commercially available, for each of its nine stations. Though the repair and rebuilding of each failed tube can and has been done a number of times, it cannot go on indefinitely, and represents the single largest materials and services Linac operating expense. By replacing half of the existing stations with modern 800 MHz, 12 MW klystron power sources, half of the 200 MHz output tubes can be taken out of service, reducing the operating problem and creating 4 spares for the first part of the linac. Several vendors can now make 800MHz klystrons with this peak power rating.

10. Details of Cost Estimate

	Item Cost	Total Cost
a. Engineering, design and inspection at 16% of construction costs		$ 2,600
b. Construction costs		16,450
1. Conventional construction	$ 1,850	
2. Special facilities	14,600	
c. Contingency at about 19% of above costs		3,750
Total		$22,800

CONSTRUCTION PROJECT DATA SHEETS

1. Title and location of project: Fermilab Linac Upgrade
Fermi National Accelerator Laboratory
Batavia, Illinois

2. Project No.: 90-R-104

11. Method of Performance

Design of facilities will be by the operating contractor and subcontractors as appropriate. To the extent feasible, construction and procurement will be accomplished by fixed-price contracts awarded on the basis of competitive bids.

12. Funding Schedule of Project Funding and Other Related Funding Requirements

	Prior Years	FY 1990	FY 1991	FY 1992	FY 1993	Total
a. Total project costs						
1. Total facility costs						
(a) Construction line item	$ 0	$ 2,500	$ 8,000	$ 7,400	$ 4,900	$22,800
Total facility costs	$ 0	$ 2,500	$ 8,000	$ 7,400	$ 4,900	$22,800
2. Other project costs						
(a) R&D operating costs necessary to complete construction	2,470	2,100	800	300	0	5,670
(b) Pre-operating costs	0	0	0	420	690	1,110
(c) Capital Equipment	150	100	100	50	0	400
Total other project costs	2,620	2,200	900	770	690	7,180
Total project costs	$ 2,620	$ 4,700	$ 8,900	$ 8,170	$ 5,590	$29,980

b. Total related incremental annual funding requirements (estimated life of project: 15 years)
1. Facility operating cost-power..... $150
Total related incremental annual funding requirements..... $150

CONSTRUCTION PROJECT DATA SHEETS

1. Title and location of project: Fermilab Linac Upgrade
Fermi National Accelerator Laboratory
Batavia, Illinois

2. Project No.: 90-R-104

13. Narrative Explanation of Total Project Funding and Other Related Funding Requirements

a. Total project funding

1. Total facility costs (a) Construction line item - explained in items 8, 9, and 10.

2. Other project funding
(a) Direct R&D operating costs - This will provide for the design and development of components, and for the fabrication and testing of prototypes for the special facilities.

(b) Pre-operating costs - This will provide for funds to cover the initial run-in period of the new Linac structures and the beam commissioning period. The plan is to assemble the new rf structure beside the present Linac tanks during down days and short down periods. Then only when it is ready will there be a shutdown of 2-3 months to remove the old tanks and replace them with the new sections.

b. Total related incremental annual funding requirements (estimated life of the project 15 years)

There will be an increase in cost for power, utilities, and building maintenance required for the higher energy Linac of about $150K/year. The Linac will not require any additional people to maintain or operate the new equipment.

Appendix B

DESIGN CRITERIA, STANDARDS AND CODE REFERENCES

Appendix B

DESIGN CRITERIA, STANDARDS AND CODE REFERENCES

This design is in accordance with recognized architectural and engineering practice and complies with the applicable standards and referenced standards of the United States Department of Energy and the State of Illinois including, but not limited to, the latest edition of the following:

DOE Order 6430.1A, General Design Criteria

Uniform Building Code

NFPA 101, Life Safety Code

Building Code Requirements for Reinforced Concrete - ACI 318

Manual of Steel Construction - AISC

NFPA-13, Sprinkler Systems

NFPA-70 National Electric Code

ASHRAE Standard 90

Accessibility Standards, State of Illinois

Fermilab Engineering Standards, Safety Manual and Radiation Guide

Appendix C

DOE CONSTRUCTION PROJECT ESCALATION RATES

FERMILAB COST ESTIMATE	PROJECT TITLE FERMILAB LINAC UPGRADE - Title 1 ESCALATION RATES ON CIVIL COST & EDIA BY WBS	PROJECT NO. 4-1-2	DATE Feb. 1990	REVISION DATE	PAGE / OF 1/1

WBS No.	WBS Package Name	Fiscal Midpoint	Months Jan. 1990	Escalation Computation	Escalation Rate %
CONSTRUCTION					
WBS 1.2.1	LINAC POWER SUPPLY GALLERY	Oct. 90	10	$1.043^{10/12} - 1.000$ /100	3.57%
WBS 1.2.2	LINAC/A-0 ASSEMBLY AREA	Oct. 90	10	$1.043^{10/12} - 1.000$ /100	3.57%
WBS 1.2.3	LINAC UTILITIES AND SERVICES	Jul. 90	7	$1.043^{7/12} - 1.000$ /100	2.49%
WBS 1.2.4	LINAC ENCLOSURE ACCESS AND WAVE GUIDE PENETRATONS	Apr. 91	16	$1.043 + 1.047^{4/12} - 1.000$ /100	5.84%
E.D.I.A.					
WBS 1.2.1	LINAC POWER SUPPLY GALLERY	May 90	5	$1.043^{4/12} - 1.000$ /100	1.41%
WBS 1.2.2	LINAC/A-0 ASSEMBLY AREA	May 90	5	$1.043^{4/12} - 1.000$ /100	1.41%
WBS 1.2.3	LINAC UTILITIES AND SERVICES	May 90	5	$1.043^{4/12} - 1.000$ /100	1.41%
WBS 1.2.4	LINAC ENCLOSURE ACCESS AND WAVE GUIDE PENETRATIONS	Oct. 90	10	$1.043^{10/12} - 1.000$ /100	3.57%
CONTINGENCY					
WBS ALL	All Packages (Average)	Jan. 91	12	$1.043 - 1.000$ /100	4.30%

August 1989 Update

DEPARTMENTAL PRICE CHANGE INDEX

FY 1991 GUIDANCE

ANTICIPATED ECONOMIC ESCALATION RATES

DOE CONSTRUCTION PROJECTS

FISCAL YEAR	ENERGY RESEARCH AND NUCLEAR INDEX	ENERGY RESEARCH AND NUCLEAR % CHANGE	FOSSIL INDEX	FOSSIL % CHANGE	CONSERVATION/SOLAR INDEX	CONSERVATION/SOLAR % CHANGE	DEFENSE PROGRAMS, EP & GENERAL CONSTRUCTION INDEX	DEFENSE PROGRAMS, EP & GENERAL CONSTRUCTION %CHANGE
1989	1.000	NA	1.000	NA	1.000	NA	1.000	NA
1990	1.043	4.3	1.041	4.1	1.041	4.1	1.042	4.2
1991	1.092	4.7	1.089	4.6	1.089	4.6	1.090	4.6
1992	1.152	5.5	1.149	5.5	1.147	5.3	1.150	5.5
1993	1.217	5.7	1.214	5.7	1.209	5.4	1.215	5.7
1994	1.288	5.8	1.284	5.8	1.275	5.5	1.285	5.8
1995	1.365	6.0	1.360	5.9	1.348	5.7	1.358	5.7

APPENDIX C

Based on the materials and labor data contained in the Energy Supply Planning Model and appropriate escalation rates forecasted by Data Resources, Incorporated, it would be expected that DOE projects conform to those rates shown above. Should a submission reflect different escalation rates, supporting documentation should specifically delineate assumptions and the methodology used in developing the escalation rates. DOE Order 5700.3C requires that any local rates different from those above be submitted to the ICE Staff for approval, prior to their use. Additional advice and assistance can be obtained from the Independent Cost Estimating Staff (FTS 896-9697).

Appendix D

COST ESTIMATE DETAIL SHEETS

FERMILAB COST ESTIMATE
4-1-2
FERMILAB LINAC UPGRADE
WBS 1.2.1 LINAC POWER SUPPLY GALLERY

CONSTRUCTION ENGINEERING SERVICES | Status: TITLE-1 | Issue Date: 2-14-90 | Rev. Date:

Project Engineer: E.C. | Quantities By: J.G. | Priced By: J.G. | Checked By: |

SUMMARY OF CONSTRUCTION COSTS

	TOTAL COSTS
02 SITE WORK	$173,000
03 CONCRETE	31,000
04 MASONRY	5,000
05 METALS	44,000
07 MOISTURE-THERMAL CONTROL	44,000
08 DOORS, WINDOWS & GLASS	7,000
09 FINISHES	15,000
15 MECHANICAL	37,000
16 ELECTRICAL	46,000
SUBTOTAL	402,000
CONTRACTOR'S OVERHEAD & PROFIT @ 20.000%,	80,400
SUBTOTAL	482,000
TOTAL CONSTRUCTION COST	$482,000

CONSTRUCTION ENGINEERING SERVICES | Status: TITLE-1 | Issue Date: 2-14-90 | Rev. Date:

Project Engineer: E.C. | Quantities By: J.G. | Priced By: J.G. | Checked By: |

No.	ITEM - DESCRIPTION	UNIT Per Item	COST Per Unit	Total Costs Quantity	Amount
	02 SITE WORK				
	02.0 Subsurface				
	649 ASBESTOS REMOVAL				
0011	Set-Up & Mobilize	LOT	3,000	1.000	3,000
0012	Dust Protection Sheating, 20'x 120'	SF	2.00	2400	4,800
0013	Remove Sheating	LOT	500.00	1.000	500
0014	Remove Asbestos From Panels, 9'x 120'	HRS	35.00	200	7,000
0015	Remove Asbestos From Steel & Pipes	LOT	2,000	1.000	2,000
0016	Scaffolding	LOT	2,000	1.000	2,000
0017	Vacuum Work Area	LOT	3,000	1.000	3,000
0018	Dispose Of Asbestos	LOT	4,000	1.000	4,000
0019	Clean-Up All Areas	LOT	2,500	1.000	2,500
	Class 649 subtotal $28,800.00				
	650 FRAMING DEMOLITION				
0011	Mobilize Crane, 50 Ton	LOT	4,000	1.000	4,000
0012	Remove Fascia Panels w/ Crane & Crew	DAYS	3,000	4.000	12,000
0013	Remove Entry Panels & Walls	DAYS	3,000	2.000	6,000
0014	Saw Cut Concrete & Drill Holes	LOT	2,000	1.000	2,000
0015	Remove Steel Framing	HRS	45.00	40	1,800
0016	Remove Concrete Base Wall, 4'x 33'	SF	15.00	132	2,000
0017	Remove Concrete Base Sill, 1'-6"x 25'	SF	15.00	40	600
0018	Saw Cut Retaining Walls	LF	35.00	80	2,800

CONSTRUCTION ENGINEERING SERVICES | Status: TITLE-1 | Issue Date: 2-14-90 | Rev. Date:

Project Engineer: E.C. | Quantities By: J.G. | Priced By: J.G. | Checked By: |

No.	ITEM - DESCRIPTION			UNIT Per Item	COST Per Unit	Total Costs Quantity	Amount
	0019						
	Remove Concrete Walls, 1' Thick			LOT	1,500	1.000	1,500
	0020						
	Haul Away Concrete Panels			LOT	4,000	1.000	4,000
	0021						
	Load & Haul Misc. Concrete			LOT	2,000	1.000	2,000
		Class 650 subtotal	$38,700.00				
	651 EXTERIOR WALL DEMOLITION						
	0011						
	Remove Glass Walls, 4'x 30' & 7'x 24'			SF	12.00	340	4,100
	0012						
	Dispose Of All Glass			LOT	1,000	1.000	1,000
	0013						
	Build Temp. Steel Partition, 17'x 70'			SF	4.50	1200	5,400
	0014						
	Remove Temp. Steel Partition			SF	1.50	1200	1,800
		Class 651 subtotal	$12,300.00				
	652 INTERIOR DEMOLITION						
	0011						
	Remove Stl. Stud & D.W. Partition, 10'x 70'			SF	2.50	700	1,800
	0012						
	Dispose Of All Debris			LOT	500.00	1.000	500
		Class 652 subtotal	$2,300.00				
	653 SITE DEMOLITION						
	0011						
	Remove 4" D.S. Drain Line			LF	8.00	50	400
	0012						
	Remove Conc. Stoop, 8'x 30'			SF	12.00	240	2,900
	0013						
	Remove Paving, 30'x 60'			SF	1.50	1800	2,700
	0014						
	Misc. Demolition			LOT	2,000	1.000	2,000
	0015						
	Haul Debris To Dump			LOT	1,000	1.000	1,000
		Class 653 subtotal	$9,000.00				

02.0	SUBTOTAL						$91,100
02.2	Earthwork						

FERMILAB LINAC UPGRADE
WBS 1.2.1 LINAC POWER SUPPLY GALLERY

CONSTRUCTION ENGINEERING SERVICES | Status: TITLE-1 | Issue Date: 2-14-90 | Rev. Date:

Project Engineer: E.C. | Quantities By: J.Q. | Priced By: J.Q. | Checked By: |

No.	ITEM - DESCRIPTION			UNIT Per Item	COST Per Unit	Total Costs Quantity	Amount
	239 EXCAVATE FOR BUILDING						
	0011						
	Remove Exist. Berm			HRS	100.00	24	2,400
	0012						
	Trench For Footings			HRS	100.00	24	2,400
	0013						
	Handwork At Utilities			HRS	40.00	60	2,400
	0014						
	Haul Away Fill			HRS	60.00	16	1,000
	0015						
	Dispose Of Radio Active Soil			LOT	5,000	1.000	5,000
		Class 239 subtotal	$13,200.00				
	263 BACKFILL FOR BUILDING						
	0011						
	Backfill & Grade Earth			HRS	100.00	24	2,400
	0012						
	Granular Under Slab, 1'x 30'x 98'			CY	20.00	110	2,200
		Class 263 subtotal	$4,600.00				

	02.2 SUBTOTAL						$17,800
	02.3 Tunneling Piles & Caissons						
	805 CAISSONS						
	0011						
	Mobilize Equipment & Reset, Tight Working Area			LOT	6,000	1.000	6,000
	0012						
	36"Dia. Caissons, Wet Grounds, 25'Dp.x 9-Ea.			LF	90.00	225	20,300
	0013						
	Bell, 6' Dia.			EA	900.00	9.000	8,100
	0014						
	Steel Casing, 36"Dia. CMP, 25'x 9 Ea.			LF	45.00	225	10,100
	0015						
	Load & Haul Away Fill			CY	5.00	100	500
		Class 805 subtotal	$45,000.00				

	02.3 SUBTOTAL						$45,000
	02.5 Paving & Surfacing						

CONSTRUCTION ENGINEERING SERVICES | Status: TITLE-1 | Issue Date: 2-14-90 | Rev. Date:

Project Engineer: E.C. | Quantities By: J.Q. | Priced By: J.Q. | Checked By: |

No.	ITEM - DESCRIPTION		UNIT Per Item	COST Per Unit	Total Costs Quantity	Amount
	105 BITUMINOUS PAVING					
	0011					
	Regrade Lot, 45'x 60'		HRS	100.00	8.000	800
	0012					
	Pave Lot, 45'x 60'		SY	4.50	300	1,400
	0013					
	Patch Utility Trench To Lot, 3'x 100'		LOT	800.00	1.000	800
		Class 105 subtotal $3,000.00				
	02.5 SUBTOTAL					$3,000
	02.6 Piped Utilities					
	667 ICW MODIFICATIONS					
	0011					
	Relocate Fire Hydrant		LOT	2,000	1.000	2,000
	0012					
	Install Pipe Bumper Posts		EA	200.00	2.000	400
	0013					
	Abandon Exist. ICW Pipe		LOT	500.00	1.000	500
	0014					
	Excavate & Backfill		HRS	120.00	16	1,900
		Class 667 subtotal $4,800.00				
	02.6 SUBTOTAL					$4,800
	02.7 Sewerage and Drainage					
	668 SANITARY SEWER					
	0011					
	Install New Manhole, 4' Dia. x 6' Dp.		EA	1,800	1.000	1,800
	0012					
	Relocate Existing Frame & Cover		LOT	500.00	1.000	500
	0013					
	Abandon Existing Manhole & Fill w/ Sand		LOT	500.00	1.000	500
	0014					
	6" Dia. San. Pipe, Duct. Iron		LF	18.00	120	2,200
	0015					
	Trench & Backfill		HRS	120.00	16	1,900

CONSTRUCTION ENGINEERING SERVICES | Status: TITLE-1 | Issue Date: 2-14-90 | Rev. Date:

Project Engineer: E.C. | Quantities By: J.Q. | Priced By: J.Q. | Checked By: |

No.	ITEM - DESCRIPTION		UNIT Per Item	COST Per Unit	Total Costs Quantity	Amount
	0016					
	Granular Backfill At Lot		LOT	2,000	1.000	2,000
	0017					
	Protect Existing Utilities		LOT	2,000	1.000	2,000
	Class 668 subtotal	$10,900.00				
	02.7 SUBTOTAL					$10,900
	02 SUBTOTAL	$172,600.				
	03 CONCRETE					
	03.3 Cast-in-place Concrete					
	131 CONCRETE FOUNDATION					
	0011					
	Footing @ Raised Pad, 1'x 2'x 20'		CY	240.00	2.000	500
	0012					
	Wall @ Raised Pad, 1'x 4'x 20'		CY	300.00	3.000	900
	0013					
	Bldg. Front Perimeter Wall, 1'x 2'-6"x 60'		CY	300.00	7.000	2,100
	0014					
	Concrete Bldg. Slab, 6"x 30'x 70'		CY	230.00	40	9,200
	0015					
	Concrete Apron, 10"x 3'x 46'		CY	240.00	5.000	1,200
	0016					
	Concrete Stoop, 10"x 4'x 4'-6"		CY	240.00	1.000	200
	0017					
	Conc. Piers @ Stoop, 8" Dia. x 3'		EA	150.00	2.000	300
	0018					
	Concrete Slab @ Corridor, 4"x 4'x 22'		CY	240.00	1.500	400
	0019					
	Raised Concrete Slab, 4"x 26'-6"x 30'		CY	220.00	12	2,600
	Class 131 subtotal	$17,400.00				
	132 MISC. CONCRETE					
	0011					
	Concrete Roof Slab, 3"x 30'x 98'		CY	250.00	30	7,500
	0012					
	Substation Pad Walls, 1'x 4'x 41'		CY	300.00	7.000	2,100
	0013					
	Substation Pad Slab, 1'x 12'x 20'		CY	240.00	10	2,400

CONSTRUCTION ENGINEERING SERVICES | Status: TITLE-1 | Issue Date: 2-14-90 | Rev. Date:

Project Engineer: E.C. | Quantities By: J.G. | Priced By: J.G. | Checked By: |

No.	ITEM - DESCRIPTION			UNIT Per Item	COST Per Unit	Total Costs Quantity	Amount
	0014						
	Misc. Concrete			CY	300.00	5.000	1,500
		Class 132 subtotal	$13,500.00				

03.3 SUBTOTAL							$30,900
03 SUBTOTAL		$30,900.					
04 MASONRY							
04.2 Unit Masonry							
	233 CONCRETE BLOCK WALLS						
	0011						
	Retaining Wall Extension, 8"x 10'-2"x 26'			SF	5.00	275	1,400
	0012						
	Linac Roof Enclosure, 8"x 6'x 55'			SF	5.40	330	1,800
	0013						
	Booster Roof Enclosure, 8"x 3'x 77'			SF	5.40	240	1,300
		Class 233 subtotal	$4,500.00				

04.2 SUBTOTAL							$4,500
04 SUBTOTAL		$4,500.					
05 METALS							
05.1 Structural Metal Framing							
	251 STRUCTURAL STEEL						
	0011						
	Steel Columns, W8 x 31 x 15'x 7 Ea.			TON	1,600	1.700	2,700
	0012						
	Steel Column, W 10 x 49 x 11'-8"			TON	1,500	0.600	900
	0013						
	Girder, W 21 x 68 x 25'			TON	1,400	0.900	1,300
	0014						
	Girder, W 18 x 50 x 270'			TON	1,400	6.800	9,500

CONSTRUCTION ENGINEERING SERVICES | Status: TITLE-1 | Issue Date: 2-14-90 | Rev. Date:

Project Engineer: E.C. | Quantities By: J.G. | Priced By: J.G. | Checked By: |

No.	ITEM - DESCRIPTION		UNIT Per Item	COST Per Unit	Total Costs Quantity	Amount
	0015					
	Roof Beams, W 16 x 26 x 266'		TON	1,600	3.500	5,600
	0016					
	Roof Beams, W 10 x 15 x 47'		TON	1,800	0.400	700
	0017					
	Roof Angle, 4 x 4 x 1/4 @ 6.6# x 172'		TON	2,000	0.600	1,200
	0018					
	Roof Angle, 4 x 8 x 1/2 @ 19.6# x 30'		TON	2,000	0.300	600
	0019					
	Roof Angle, 3 x 3 x 1/4 @ 4.9 x 76'		TON	2,200	0.200	400
	0020					
	Roof Deck, 20 Ga. 2" "V" 30'x 105'		SF	1.40	3150	4,400
	0021					
	Wall Framing, C 11.5 x 151'		TON	2,000	0.900	1,800
	0022					
	Floor Angle, 4 x 3 x 1/4 @ 5.8# x 18'		TON	2,000	0.100	200
	0023					
	Beam Pockets In Block Walls		EA	80.00	5.000	400
	0024					
	Misc. Steel		TON	2,400	1.000	2,400
	0025					
	Modify Existing Steel Structures		LOT	10,000	1.000	10,000
		Class 251 subtotal $42,100.00				
	252 MISC. STEEL					
	0011					
	Steel Stairs, 3'-6" Wide		Risers	140.00	8.000	1,100
	0012					
	Steel Pipe Handrail		LF	30.00	16	500
		Class 252 subtotal $1,600.00				
	05.1 SUBTOTAL					$43,700
	05 SUBTOTAL $43,700.					
	07 MOISTURE-THERMAL CONTROL					
	07.2 Insulation					
	205 ROOF INSULATION					
	0011					
	Roof Insulation, Rigid, 30'x 98'		SF	3.00	2900	8,700

CONSTRUCTION ENGINEERING SERVICES | Status: TITLE-1 | Issue Date: 2-14-90 | Rev. Date:

Project Engineer: E.C. | Quantities By: J.G. | Priced By: J.G. | Checked By: |

No.	ITEM - DESCRIPTION			UNIT Per Item	COST Per Unit	Total Costs Quantity	Amount
	0012						
	Block Wall Insulation			SF	4.00	570	2,300
		Class 205 subtotal	$11,000.00				
07.2	SUBTOTAL						$11,000
07.4	Preformed Roofing & Siding						
	203 SIDING, Dbl. Face Insulated, 4 1/2"						
	0011						
	Front Wall, 14'x 49'			SF	12.00	520	6,200
	0012						
	Booster Cap, 3'x 13'			SF	15.00	50	800
	0013						
	Existing Wall, 5'x 10'			SF	15.00	50	800
	0013						
	Connections To Existing Walls			LOT	2,000	1.000	2,000
	0014						
	Wall Trim			LF	10.00	300	3,000
	0015						
	Caulking			LOT	2,000	1.000	2,000
		Class 203 subtotal	$14,800.00				
07.4	SUBTOTAL						$14,800
07.5	Membrane Roofing						
	303 ROOFING						
	0011						
	Single Ply Membrane, 30'x 96'			SF	2.20	2900	6,400
	0012						
	2" Stone Ballast			SF	1.00	2900	2,900
	0013						
	Blocking & Flashing			SF	12.00	280	3,400
	0014						
	Existing Roof Repair & Flashing			LOT	5,000	1.000	5,000
		Class 303 subtotal	$17,700.00				
07.5	SUBTOTAL						$17,700

CONSTRUCTION ENGINEERING SERVICES | Status: TITLE-1 | Issue Date: 2-14-90 | Rev. Date:

Project Engineer: E.C. | Quantities By: J.G. | Priced By: J.G. | Checked By: |

No.	ITEM - DESCRIPTION		UNIT Per Item	COST Per Unit	Total Costs Quantity	Amount
07	SUBTOTAL	$43,500.				
08	DOORS, WINDOWS & GLASS					
08.3	Special Doors					
	605 DOORS					
	0011					
	Roll-Up Steel Door, Insulated, 13'x 12'		EA	3,500	1.000	3,500
	0012					
	Sectional Metal Doors, Insulated, 7'x 8'		EA	1,000	3.000	3,000
	0013					
	Hollow Metal Door, 3'x 7'		EA	700.00	1.000	700
	Class 605 subtotal	$7,200.00				
08.3	SUBTOTAL					$7,200
08	SUBTOTAL	$7,200.				
09	FINISHES					
09.9	Painting & Wall Covering					
	200 PAINTING					
	0011					
	Structural Steel		LOT	7,000	1.000	7,000
	0012					
	Conc. Block Walls, 2-Sides		SF	0.80	1500	1,200
	0013					
	Existing Building Walls, Interior, 14'x 180'		SF	0.70	2500	1,800
	0014					
	Doors, Roll-Up		EA	300.00	4.000	1,200
	0015					
	Hollow Metal Door		EA	100.00	1.000	100
	0016					
	Seal All Conc. Floors		SF	0.50	2900	1,500
	0017					
	Misc. Painting		LOT	2,000	1.000	2,000
	Class 200 subtotal	$14,800.00				

CONSTRUCTION ENGINEERING SERVICES | Status: TITLE-1 | Issue Date: 2-14-90 | Rev. Date:

Project Engineer: E.C. | Quantities By: J.G. | Priced By: J.G. | Checked By: |

No.	ITEM - DESCRIPTION		UNIT Per Item	COST Per Unit	Total Costs Quantity	Amount
09.9 SUBTOTAL						$14,800
09 SUBTOTAL		$14,800.				
15 MECHANICAL						
15.4 Fire Extinguishing Systems						
	200 FIRE PROTECTION					
0011	Wet Sprinklers, 30'x 96'		SF	2.20	2900	6,400
0012	Extend 3" Header & Install Valve		LF	3,000	1.000	3,000
0013	Fire Detection & Annunciation		LOT	500.00	1.000	500
0014	Test System		LOT	600.00	1.000	600
0015	Shop Drawings		LOT	900.00	1.000	900
	Class 200 subtotal	$11,400.00				
15.4 SUBTOTAL						$11,400
15.7 Air Conditioning / Ventilation						
	200 HVAC SYSTEM					
0011	Relocate Existing Exhaust Fan		LOT	800.00	1.000	800
0012	Fan-Coil Units, 4-Ton		EA	1,500	4.000	6,000
0013	Fan-Coil Units, 2-Ton		EA	1,000	1.000	1,000
0014	Air Handler, 400 CFM		EA	2,500	1.000	2,500
0015	Unit Heaters, Water, 50 MBH		EA	700.00	2.000	1,400
0016	Ductwork & Registers		LOT	2,000	1.000	2,000
0017	Cond. Drain Line, 1" PVC Sch.40		LF	8.00	100	800

CONSTRUCTION ENGINEERING SERVICES | Status: TITLE-1 | Issue Date: 2-14-90 | Rev. Date:

Project Engineer: E.C. | Quantities By: J.G. | Priced By: J.G. | Checked By: |

No.	ITEM - DESCRIPTION			UNIT Per Item	COST Per Unit	Total Costs Quantity	Amount
	0018						
	Test & Balance			LOT	500.00	1.000	500
	0019						
	Shop Drawings			LOT	1,000	1.000	1,000
	0020						
	Controls			LOT	10,000	1.000	10,000
		Class 200 subtotal	$26,000.00				

15.7	SUBTOTAL						$26,000
15	SUBTOTAL	$37,400.					
16	ELECTRICAL						
16.2	Boxes & Wiring Devices						
	200 ELECTRICAL						
	0011						
	2000A Switchboard			EA	15,000	1.000	15,000
	0012						
	600A Panel, 480V			EA	4,000	1.000	4,000
	0013						
	100A Panel			EA	2,000	1.000	2,000
	0014						
	30 KVA Transformer			EA	2,500	1.000	2,500
	0015						
	Misc. Boxes & Switches			LOT	2,000	1.000	2,000
	0016						
	2" Cond. w/ 4# 6			LF	20.00	100	2,000
	0017						
	1" Cond. w/ 5# 10			LF	10.00	200	2,000
	0018						
	3/4" Cond. w/ 5# 12			LF	7.00	400	2,800
	0019						
	Grounding Rods w/ Wire			EA	300.00	4.000	1,200
	0020						
	Power to Mech. Units			EA	250.00	12	3,000
	0021						
	Outlets, 110/208			EA	100.00	10	1,000
	0022						
	Weld Outlets			EA	300.00	2.000	600
	0023						
	Fluor. Lights, 1'x 8'			EA	150.00	22	3,300

FERMILAB LINAC UPGRADE
WBS 1.2.1 LINAC POWER SUPPLY GALLERY

CONSTRUCTION ENGINEERING SERVICES | Status: TITLE-1 | Issue Date: 2-14-90 | Rev. Date:

Project Engineer: E.C. | Quantities By: J.G. | Priced By: J.G. | Checked By: |

No.	ITEM - DESCRIPTION			UNIT Per Item	COST Per Unit	Total Costs Quantity	Amount
	0024						
	Exit Lights			EA	140.00	2.000	300
	0025						
	Exterior Light			EA	600.00	1.000	600
	0026						
	Modify Electrical @ Exist. Bldg.			HRS	45.00	80	3,600
	0027						
	General Clean-Up			LOT	500.00	1.000	500
		Class 200 subtotal	$46,400.00				

16.2 SUBTOTAL							$46,400
16 SUBTOTAL		$46,400.					

FERMILAB COST ESTIMATE
4-1-2
FERMILAB LINAC UPGRADE
WBS 1.2.2 LINAC/A-0 ASSEMBLY AREA

CONSTRUCTION ENGINEERING SERVICES | Status: TITLE-1 | Issue Date: 2-15-90 | Rev. Date:

Project Engineer: E.C. | Quantities By: J.G. | Priced By: J.G. | Checked By: |

SUMMARY OF CONSTRUCTION COSTS

	TOTAL COSTS
02 SITE WORK	$64,000
03 CONCRETE	83,000
04 MASONRY	13,000
05 METALS	110,000
07 MOISTURE-THERMAL CONTROL	70,000
08 DOORS, WINDOWS & GLASS	45,000
09 FINISHES	28,000
15 MECHANICAL	100,000
16 ELECTRICAL	84,000
SUBTOTAL	597,000
CONTRACTOR'S OVERHEAD & PROFIT @ 20.000%,	119,400
SUBTOTAL	716,000
TOTAL CONSTRUCTION COST	$716,000

No.	ITEM - DESCRIPTION		UNIT Per Item	COST Per Unit	Total Quantity	Costs Amount
02	**SITE WORK**					
02.0	**Subsurface**					
650	BUILDING DEMOLITION, Phase-1					
0011	Remove Siding & Furring From A-0 Block Wall		SF	4.00	580	2,300
0012	Remove Gravel Stop @ A-0		LF	4.00	63	300
0013	Install Temp. Weather Seal @ A-0 Roof		LF	5.00	63	300
0014	Remove Top Of Siding @ S.B., 2'x 64'		SF	4.00	128	500
0015	Cut Openings For Crane & Wall Steel		EA	100.00	6.000	600
0016	Install Temp. Weather Seal		LOT	1,000	1.000	1,000
0017	Scaffolding or Lift		LOT	500.00	1.000	500
0018	Haul Away Debris		LOT	500.00	1.000	500
	Class 650 subtotal	$6,000.00				
651	BUILDING DEMOLITION, Phase-2,(Bldg. in Place)					
0011	Remove Steel Door, 6'x 7' & Salvage		EA	300.00	1.000	300
0012	Remove 12'x 14' Roll-Up Door & Salvage		LOT	1,500	1.000	1,500
0013	Remove Steel Siding @ A-0, 14'x 15'		SF	4.00	210	800
0014	Remove Steel Frame @ A-0		HRS	45.00	24	1,100
0015	Remove Siding @ S.B., 20'x 36'		SF	4.00	550	2,200
0016	Remove Steel Frame @ S.B.		HRS	45.00	48	2,200
0017	Crane For All Steel Demolition		DAYS	1,200	3.000	3,600
0018	Cut & Remove Siding @ S.B., 6'x 7'		SF	5.00	42	200
0019	Remove Exist. Exterior Lights		HRS	45.00	16	700

CONSTRUCTION ENGINEERING SERVICES | Status: TITLE-1 | Issue Date: 2-15-90 | Rev. Date:

Project Engineer: E.C. | Quantities By: J.G. | Priced By: J.G. | Checked By: |

No.	ITEM - DESCRIPTION			UNIT Per Item	COST Per Unit	Total Costs Quantity	Amount
	0020						
	Haul Away Debris			LOT	500.00	1.000	500
		Class 651 subtotal	$13,100.00				
	652 SITE DEMOLITION						
	0011						
	Remove Conc. Pad, 8"x 10'x 10'			SF	12.00	100	1,200
	0012						
	Remove Conc. Aprons, 6"x 4'x 50'			SF	8.00	200	1,600
	0013						
	Remove Conc. Walk, 6"x 50'			SF	8.00	300	2,400
	0014						
	Remove Paving, 3"x 60'x 98'			SF	0.80	5700	4,600
	0015						
	Remove Bumper Posts			EA	150.00	5.000	800
	0016						
	Load & Haul Away Conc.			LOT	500.00	1.000	500
		Class 652 subtotal	$11,100.00				

02.0	SUBTOTAL						$30,200
02.2	Earthwork						
	239 EXCAVATE						
	0011						
	Strip Building Area			HRS	100.00	16	1,600
	0012						
	Excavate For Footings			HRS	120.00	16	1,900
	0013						
	Handwork @ Utilities			HRS	40.00	32	1,300
		Class 239 subtotal	$4,800.00				
	263 BACKFILL						
	0011						
	Backfill Earth & Grade			HRS	120.00	24	2,900
	0012						
	Granular Around Foundation, 3'x 3'x 200'			CY	20.00	70	1,400
	0013						
	Granular Under Slab, 6"x 63'x 98'			CY	20.00	120	2,400
		Class 263 subtotal	$6,700.00				

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Project Engineer: E.C. | Quantities By: J.G. | Priced By: J.G. | Checked By: |

No.	ITEM - DESCRIPTION		UNIT Per Item	COST Per Unit	Total Costs Quantity	Amount
	309 NEW PARKING LOT, 65'x 125'					
	0011					
	Strip Area		HRS	120.00	16	1,900
	0012					
	Haul Away Fill		CY	2.50	300	800
	0013					
	Granular Base, 1'-6"x 65'x 125'		CY	18.00	460	8,300
	0014					
	18" CMP w/ Ends, 30'Lg.		LOT	1,000	1.000	1,000
	0015					
	Grade Hardstand		HRS	120.00	8.000	1,000
		Class 309 subtotal $13,000.00				

	02.2 SUBTOTAL					$24,500
	02.5 Paving & Surfacing					
	105 PAVING & GRADING					
	0011					
	Fill & Grade Behind Building		LOT	800.00	1.000	800
	0012					
	Fill & Grade At Road, 3'x 150'		LOT	400.00	1.000	400
	0013					
	Pave Swale Along Building, 3'x 150'		LOT	400.00	1.000	400
	0014					
	Pave New Parking Lot, 2"x 65'x 125'		SY	4.60	910	4,200
	0015					
	Paved Sidewalk, Lot to Bldg., 2"x 5'x 100'		SF	1.40	500	700
	0016					
	Misc. Striping		LOT	400.00	1.000	400
		Class 105 subtotal $6,900.00				

	02.5 SUBTOTAL					$6,900
	02.8 Site Improvements					
	405 GUARD RAIL					
	0011					
	Modify Existing Guard Rails		EA	200.00	2.000	400

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Project Engineer: E.C. | Quantities By: J.G. | Priced By: J.G. | Checked By: |

No.	ITEM - DESCRIPTION		UNIT Per Item	COST Per Unit	Total Costs Quantity	Amount
	0012					
	New Guard Rails		LF	13.00	100	1,300
	0013					
	Connect To Existing Rails		EA	200.00	2.000	400
	0014					
	Misc. Bumper Posts & Rails		LOT	500.00	1.000	500
		Class 405 subtotal $2,600.00				
						2,600
02.8 SUBTOTAL						$2,600
02 SUBTOTAL		$64,200.				
03 CONCRETE						
03.3 Cast-in-place Concrete						
	131 BUILDING FOUNDATION					
	0011					
	Column Footings, 1'-3"x 7'x 7'x 9 Ea.		CY	210.00	22	4,600
	0012					
	Column Piers, 1'-3"x 1'-3"x 4'-2"x 9 Ea.		CY	350.00	3.000	1,100
	0013					
	Retaining Wall Footings, 1'x 4'-6"x 115'		CY	210.00	22	4,600
	0014					
	Lower Retaining Wall, 2'-1"x 4'-2"x 98'		CY	240.00	35	8,400
	0015					
	Upper Retaining Wall, 1'-6"x 6'-6"x 117'		CY	280.00	48	13,400
	0016					
	Grade Beam, 8"x 4'-2"x 98'		CY	300.00	12	3,600
	0017					
	Building Floor Slab w/ W.W.F., 8"x 61'x 98'		CY	200.00	160	32,000
	0018					
	Column Inserts, 1'x 2'x 2'x 4 Ea.		CY	300.00	0.600	200
	0019					
	Elevated Mezz. Slab, 3"x 26'-6"x 98'		CY	220.00	28	6,200
	0020					
	Misc. Concrete		CY	300.00	5.000	1,500
		Class 131 subtotal $75,600.00				
	132 ACCESS FOUNDATION & MISC.					
	0011					
	Conc. Footings, 1'x 1'-6"x 52'		CY	220.00	4.000	900

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Project Engineer: E.C. | Quantities By: J.G. | Priced By: J.G. | Checked By: |

No.	ITEM - DESCRIPTION		UNIT Per Item	COST Per Unit	Total Costs Quantity	Total Costs Amount
	0012					
	Perimeter Wall, 8"x 3'x 52'		CY	300.00	4.000	1,200
	0013					
	Floor Slab w/ W.W.F., 5"x 6'x 44'		CY	220.00	6.000	1,300
	0014					
	Roof Slab on Deck, 6"x 8'-8"x 46'		CY	260.00	9.000	2,300
	0015					
	Form & Pour Sloped Roof		LOT	500.00	1.000	500
	0016					
	Concrete Stoop, 8"x 4'x 4'-8"		CY	400.00	0.500	200
	0017					
	Concrete Piers, 8" Dia. x 3' Dp.		EA	150.00	2.000	300
	0018					
	Utility Pad, 1'x 9'x 8'		CY	400.00	1.000	400
	0019					
	Caulk & Seal Conc. Roof, 9'x 46'		SF	1.00	400	400
		Class 132 subtotal	$7,500.00			
03.3 SUBTOTAL						$83,100
03 SUBTOTAL		$83,100.				
04 MASONRY						
04.2 Unit Masonry						
	233 CONCRETE BLOCK WALLS, 8" Reinforced					
	0011					
	Rear Wall, 1 St. Floor, 8'-8"x 98'		SF	5.00	850	4,300
	0012					
	Rear wall, Mezz., 8'-8"x 98' (-210)		SF	5.40	640	3,500
	0013					
	Access Walls, 7'-4"x 53'		SF	5.00	430	2,200
	0014					
	Fill Opening At S.B. Wall, 15'x 15'		SF	5.40	225	1,200
	0015					
	Scaffolding		LOT	2,000	1.000	2,000
		Class 233 subtotal	$13,200.00			
04.2 SUBTOTAL						$13,200

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No.	ITEM - DESCRIPTION		UNIT Per Item	COST Per Unit	Total Costs Quantity	Amount
04	SUBTOTAL	$13,200.				
05	METALS					
05.1	Structural Metal Framing					
251	BUILDING WALL FRAMING					
0011	Columns, W8 x 24 x 21'x 5 Ea.		TON	1,700	1.300	2,200
0012	Crane Columns, W8 x 40 x 21'x 4 Ea.		TON	1,500	1.700	2,600
0013	Crane Columns, W8 x 40 x 13'x 4 Ea.		TON	1,500	1.100	1,700
0014	Wall Girts, C8 x 11.5 x 98'x 3 Ea.		TON	1,800	1.700	3,100
0015	Window Framing, C8 x 11.5 x 100'		TON	2,000	0.600	1,200
0016	Wall Bracing, 3 x 3 x 1/4" @ 5# x 100'x 4 Ea.		TON	2,400	1.000	2,400
0017	Sag Rods, 1/2" Dia.		LOT	200.00	1.000	200
0018	Modify & Connect to Existing Steel		LOT	4,000	1.000	4,000
	Class 251 subtotal	$17,400.00				
252	ROOF FRAMING					
0011	Roof Girder, W18 x 60 x 36'x 4 Ea.		TON	1,400	4.400	6,200
0012	Roof Girder, W12 x 50 x 25'x 5 Ea.		TON	1,400	3.200	4,500
0013	Roof Beams, W12 x 26 x 98'x 2 Ea.		TON	1,600	2.600	4,200
0014	Roof Beams, W12 x 16 x 98'x 8 Ea.		TON	1,800	6.300	11,300
0015	Roof Angles, 6 x 3 1/2 x 5/16" @ 9.8# x 98'x 2 Ea.		TON	2,000	1.000	2,000
0016	Misc. Steel		TON	2,000	2.000	4,000
0017	Corr. Metal Roof Deck, 22 Ga. x 1 1/2"x 63'x 98'		SF	1.40	6200	8,700
	Class 252 subtotal	$40,900.00				
253	MEZZANINE FRAMING, 26'x 98'					

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No.	ITEM - DESCRIPTION		UNIT Per Item	COST Per Unit	Total Costs Quantity	Amount
	0011					
	Girder, W18 x 50 x 98'x 2 Ea.		TON	1,400	4.900	6,900
	0012					
	WT8 x 20 x 98'		TON	1,800	1.000	1,800
	0013					
	Angle, 4 x 4 x 1/4" @ 6.6# x 98'		TON	2,000	0.400	800
	0014					
	Floor Beams, W12 x 40 x 26'x 20 Ea.		TON	1,400	10	14,600
	0015					
	Misc. Steel		TON	2,000	1.000	2,000
	0016					
	Corr. Metal Deck, 22 Ga. x 1 1/2"x 26'x 98'		SF	1.40	2600	3,600
		Class 253 subtotal $29,700.00				
	254 CRANE BEAMS					
	0011					
	Beam, W18 x 55 x 98'x 2 Ea.		TON	1,300	5.400	7,000
	0012					
	Channel, C12 x 20.7 x 98'x 2 Ea.		TON	1,400	2.100	2,900
	0013					
	Crane Rail, 40#/ Yd. x 98'x 2 Ea.		TON	2,000	1.400	2,800
	0014					
	Beam Brackets, 250# x 10 Ea.		TON	2,400	1.300	3,100
		Class 254 subtotal $15,800.00				

05.1	SUBTOTAL					$103,800
05.5	Metal Fabrications					
	105 MISC. & ACCESSWAY STEEL					
	0011					
	Stairway, 3'-6" Wide		Risers	150.00	20	3,000
	0012					
	Accessway Roof Steel		TON	2,400	0.500	1,200
	0013					
	Accessway Roof Deck, 20 Ga. x 2"x 9'x 50'		SF	1.60	450	700
	0014					
	Misc. Steel & Fabrication		LOT	1,000	1.000	1,000
		Class 105 subtotal $5,900.00				

05.5	SUBTOTAL					$5,900

No.	ITEM - DESCRIPTION		UNIT Per Item	COST Per Unit	Total Costs Quantity	Amount
05	SUBTOTAL	$109,700.				
07	MOISTURE-THERMAL CONTROL					
07.4	Preformed Roofing & Siding					
203	METAL SIDING, Dbl. Face w/ Insul.					
0011	Front Wall, 22'x 98' (-760)		SF	11.00	1400	15,400
0012	Rear Wall, 22'x 98' (-300)		SF	11.00	1900	20,900
0013	Connect To Existing Siding		EA	400.00	4.000	1,600
0014	Trim & Flashing, Incl. Accessway		LOT	3,000	1.000	3,000
0015	Caulking		LOT	1,000	1.000	1,000
	Class 203 subtotal	$41,900.00				
07.4	SUBTOTAL					$41,900
07.5	Membrane Roofing					
105	PARAPIT WALL ROOF CONNECTION, 4'-8"x 53'					
0011	Stl. Stud & 3/4" Plywood 2-Sides, 4'-8"x 53'		SF	6.00	265	1,600
0012	Weather Proof Wall, 2-Sides		SF	2.00	530	1,100
	Class 105 subtotal	$2,700.00				
106	ROOFING, Built-Up 4-Ply, 63'x 98'					
0011	Rigid Insulation, 3 1/4"		SF	1.80	6200	11,200
0012 5	4-Ply Roofing		SF	1.40	6200	8,700
0013	Blocking & Flashing, New & Connection		LF	8.00	380	3,000
0014	Cap Flashing @ Parapit		LF	12.00	53	600
0015	Remove Temporary Weather Proofing		LOT	2,000	1.000	2,000

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Project Engineer: E.C. | Quantities By: J.G. | Priced By: J.G. | Checked By: |

No.	ITEM - DESCRIPTION		UNIT Per Item	COST Per Unit	Total Costs Quantity	Amount
	Class 106 subtotal	$25,500.00				
07.5 SUBTOTAL						$28,200
07 SUBTOTAL	$70,100.					
08 DOORS, WINDOWS & GLASS						
08.1 Metal Doors and Frames						
104 METAL DOORS						
0011						
Hollow Metal Doors, 3'x 7'			EA	650.00	5.000	3,300
0012						
Remove Existing Accessway Door			EA	300.00	1.000	300
0013						
Hollow Metal Door, Dbl., 6'x 7'			EA	800.00	1.000	800
0014						
Remove Exist. Door & Modify Conc. Block Wall			LOT	1,000	1.000	1,000
0015						
Install H.M. Door, 3'x 7' w/ Side Lite			EA	900.00	1.000	900
	Class 104 subtotal	$6,300.00				
08.1 SUBTOTAL						$6,300
08.5 Metal Windows						
205 ALUMINUM WINDOWS w/ 1" Insul. Glass						
0011						
Windows, 3'x 5'			EA	450.00	14	6,300
	Class 205 subtotal	$6,300.00				
08.5 SUBTOTAL						$6,300
08.9 Glazed Curtain Wall						
203 GLAZED CURTAIN WALL						

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Project Engineer: E.C. | Quantities By: J.Q. | Priced By: J.Q. | Checked By: |

No.	ITEM - DESCRIPTION		UNIT Per Item	COST Per Unit	Total Costs Quantity	Amount
	0011					
	Alum. Frame w/ 1" Insul. Glass, 20'-6"x 19'x 2-Ea.		SF	42.00	780	32,800
	Class 208 subtotal	$32,800.00				
08.9	SUBTOTAL					$32,800
08	SUBTOTAL	$45,400.				
09	FINISHES					
09.2	Lath, Plaster & Gypsum Board					
	621 STL. STUD PARTITION, Insulated w/ 5/8" D.W. 2-Sides					
	0011					
	Mezz. Edge Wall, 9'-6"x 98'		SF	4.50	940	4,200
	0012					
	Mezz. Partitions, 9'-6"x 65'		SF	3.50	620	2,200
	0013					
	Furring & 5/8" D.W. @ Parapit, 3'x 63'		SF	4.00	190	800
	0014					
	Misc. Trim & Partition Enclosures		LOT	1,000	1.000	1,000
	Class 621 subtotal	$8,200.00				
09.2	SUBTOTAL					$8,200
09.9	Painting & Wall Covering					
	100 PAINTING					
	0011					
	Structural Steel, 55 Tons @ 250		SF	0.65	14000	9,100
	0012					
	Concrete Wall, 7'-6"x 120'		SF	0.70	900	600
	0013					
	Concrete Block Walls		SF	0.70	2800	2,000
	0014					
	Drywall Partitions, 2-Sides		SF	0.50	2400	1,200
	0015					
	H.M. Doors & Frames		EA	120.00	7.000	800
	0016					
	Stair & Misc. Steel		LOT	1,500	1.000	1,500

CONSTRUCTION ENGINEERING SERVICES | Status: TITLE-1 | Issue Date: 2-15-90 | Rev. Date:

Project Engineer: E.C. | Quantities By: J.G. | Priced By: J.G. | Checked By: |

No.	ITEM - DESCRIPTION			UNIT Per Item	COST Per Unit	Total Costs Quantity	Amount
	0017						
	Steel Siding			SF	0.70	3300	2,300
	0018						
	Misc. Painting			LOT	2,000	1.000	2,000
		Class 100 subtotal	$19,500.00				

	09.9 SUBTOTAL						$19,500
	09 SUBTOTAL	$27,700.					
	15 MECHANICAL						
	15.1 Pipes & Fittings						
	126 PLUMBING & DRAINS						
	0011						
	Floor Drains, FD-1			EA	300.00	5.000	1,500
	0012						
	Clean-Outs			EA	250.00	5.000	1,300
	0013						
	Drain Pipe, 4" Dia. Cast Iron			LF	13.00	180	2,300
	0014						
	Fittings & Elbows			EA	80.00	12	1,000
	0015						
	Connect Pipe to Catch Basin			LOT	500.00	1.000	500
		Class 126 subtotal	$6,600.00				

	15.1 SUBTOTAL						$6,600
	15.4 Fire Extinguishing Systems						
	171 SPRINKLERS, Wet Pipe, Ord. Hazard						
	0011						
	New Header w/ Valve, 4"			LOT	2,500	1.000	2,500
	0012						
	Sprinklers, First Floor, 63'x 98'			SF	1.70	6200	10,500
	0013						
	Sprinklers, Accessway, 8'x 33'			SF	1.90	270	500
	0014						
	Sprinklers, Mezz., 26'x 98'			SF	1.40	2600	3,600

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No.	ITEM - DESCRIPTION		UNIT Per Item	COST Per Unit	Total Costs Quantity	Amount
	0015					
	Fire Detection / Annunciation System		LOT	1,000	1.000	1,000
	0016					
	Test System		LOT	600.00	1.000	600
	0017					
	Shop Drawings		HRS	38.00	24	900
	Class 171 subtotal	$19,600.00				
15.4	SUBTOTAL					$19,600
15.7	Air Conditioning / Ventilation					
	151 HVAC SYSTEM					
	0011					
	Fan Coil Units, 1-Ton		EA	750.00	9.000	6,800
	0012					
	Chiller, 30-Ton, Air Cooled		EA	19,000	1.000	19,000
	0013					
	Air Handler, 6000 CFM, 15-Ton		EA	4,500	1.000	4,500
	0014					
	Make-Up Air Unit, 1-Ton		EA	2,200	1.000	2,200
	0015					
	Roof Exhaust Fan, EF-1		EA	1,400	1.000	1,400
	0016					
	Duct Heaters, Electric, 25 KW		EA	600.00	2.000	1,200
	0017					
	Unit Heaters, 5 KW		EA	500.00	2.000	1,000
	0018					
	Chilled Water Pump w/ Tank		LOT	400.00	1.000	400
	0019					
	Louver, Motorized, 3'x 4'		EA	800.00	1.000	800
	0020					
	Louver, Motorized, 2'x 2'		EA	500.00	1.000	500
	0021					
	Duct, 34"x 12" avrg. x 70'		LBS	3.30	900	3,000
	0022					
	Duct Transitions		EA	700.00	2.000	1,400
	0023					
	Duct Insulation		SF	2.00	700	1,400
	0024					
	Grilles		EA	50.00	8.000	400
	0025					
	Misc. Dampers & Accessories		LOT	1,000	1.000	1,000

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No.	ITEM - DESCRIPTION			UNIT Per Item	COST Per Unit	Total Costs Quantity	Amount
	0026						
	Controls			LOT	19,000	1.000	19,000
	0027						
	Steel Piping w/ Insul. 1 1/2"Dia.			LF	13.00	200	2,600
	0028						
	Steel Piping w/ Insul. 1"Dia.			LF	10.50	150	1,600
	0029						
	Drain Pipe, 1" Dia. Copper			LF	6.00	100	600
	0030						
	Misc. Valves & Fittings			LOT	2,000	1.000	2,000
	0031						
	Glycol Fill			LOT	500.00	1.000	500
	0032						
	Testing & Balancing			LOT	800.00	1.000	800
	0033						
	Shop Drawings			HRS	45.00	24	1,100
	0034						
	Clean-Up			LOT	500.00	1.000	500
		Class 151 subtotal	$73,700.00				
15.7 SUBTOTAL							$73,700
15 SUBTOTAL		$99,900.					
16 ELECTRICAL							
16.0 Raceways							
	206 CONDUIT RUNS						
	0011						
	1"Cond. w/ 4 #6			LF	7.00	420	2,900
	0012						
	3/4"Cond. w/ 6 #12			LF	5.00	1900	9,500
	0013						
	1/2"Cond. w/ 4 #12			LF	4.00	1500	6,000
	0014						
	Grounding Rods @ Bldg. & Pad			EA	300.00	2.000	600
		Class 206 subtotal	$19,000.00				
16.0 SUBTOTAL							$19,000

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No.	ITEM - DESCRIPTION		UNIT Per Item	COST Per Unit	Total Costs Quantity	Amount
16.2	**Boxes & Wiring Devices**					
	111 RECEPTACLES & MISC. BOXES					
	0011					
	Outlets, 110/208		EA	80.00	66	5,300
	0012					
	Weld Outlets, 480v.		EA	350.00	4.000	1,400
	0013					
	Power to Mechanical Equipment		EA	250.00	15	3,800
	0014					
	Power to Unit Heaters		EA	150.00	2.000	300
	0015					
	Power to 10-Ton Crane Extension		LOT	1,000	1.000	1,000
		Class 111 subtotal $11,800.00				

16.2	SUBTOTAL					$11,800
16.3	**Starters, Boards, & Switches**					
	206 EQUIPMENT					
	0011					
	Transformers, 75 KVA		EA	3,000	2.000	6,000
	0012					
	Switchboard, 900A		EA	5,000	1.000	5,000
	0013					
	Power Panels, 225A		EA	2,500	3.000	7,500
	0014					
	Motor Starters & Accessories		LOT	2,000	1.000	2,000
		Class 206 subtotal $20,500.00				

16.3	SUBTOTAL					$20,500
16.6	**Lighting**					
	115 EXTERIOR LIGHTING					
	0011					
	100W Merc. Vapor		EA	400.00	1.000	400
	0012					
	175W Merc. Vapor		EA	500.00	4.000	2,000

CONSTRUCTION ENGINEERING SERVICES | Status: TITLE-1 | Issue Date: 2-15-90 | Rev. Date:

Project Engineer: E.C. | Quantities By: J.G. | Priced By: J.G. | Checked By: |

No.	ITEM - DESCRIPTION			UNIT Per Item	COST Per Unit	Total Costs Quantity	Amount
	0013						
	Existing Lighting Modifications			LOT	1,000	1.000	1,000
		Class 115 subtotal	$3,400.00				
	131 INTERIOR LIGHTS						
	0011						
	Metal Halide Fixtures, 400W			EA	450.00	31	14,000
	0012						
	Fluor. Fixture, 1'x 8'			EA	160.00	27	4,300
	0013						
	Fluor. Fixture, 1'x 4'			EA	150.00	13	2,000
	0014						
	Exit Lights			EA	120.00	6.000	700
	0015						
	Misc. Boxes & Switches			LOT	1,000	1.000	1,000
		Class 131 subtotal	$22,000.00				

16.6	SUBTOTAL						$25,400
16.7	Electric Utilities						
	111 SECONDARY FEEDER, Substation To Building						
	0011						
	3-5" PVC Ducts, EB,			LF	15.00	20	300
	0012						
	Trench & Backfill			HRS	100.00	16	1,600
	0013						
	Concrete, 8"x 1'-6"x 20'			LOT	200.00	1.000	200
	0014						
	Handwork at Utilities			HRS	40.00	16	600
	0015						
	Pull Wire, 350 MCM, 5 ea.x 20'x 3 ea.			LF	6.00	300	1,800
	0016						
	Terminations			EA	60.00	30	1,800
	0017						
	Misc. Equipment & Materials			LOT	1,000	1.000	1,000
		Class 111 subtotal	$7,300.00				

16.7	SUBTOTAL						$7,300

FERMILAB LINAC UPGRADE
WBS 1.2.2 LINAC/A-0 ASSEMBLY AREA

CONSTRUCTION ENGINEERING SERVICES | Status: TITLE-1 | Issue Date: 2-15-90 | Rev. Date:

Project Engineer: E.C. | Quantities By: J.G. | Priced By: J.G. | Checked By: |

No.	ITEM - DESCRIPTION		UNIT Per Item	COST Per Unit	Total Costs Quantity	Total Costs Amount
16	SUBTOTAL	$84,000.				

FERMILAB COST ESTIMATE
4-1-2
FERMILAB LINAC UPGRADE
WBS 1.2.3 LINAC UTILITIES AND SERVICES

CONSTRUCTION ENGINEERING SERVICES | Status: TITLE-1 | Issue Date: 2-20-90 | Rev. Date:

Project Engineer: E.C. | Quantities By: J.G. | Priced By: J.G. | Checked By: |

SUMMARY OF CONSTRUCTION COSTS

	TOTAL COSTS
02 SITE WORK	$15,000
15 MECHANICAL	15,000
16 ELECTRICAL	153,000
SUBTOTAL	183,000
CONTRACTOR'S OVERHEAD & PROFIT @ 20.000%,	36,600
SUBTOTAL	220,000
TOTAL CONSTRUCTION COST	$220,000

FERMILAB LINAC UPGRADE
WBS 1.2.3 LINAC UTILITIES AND SERVICES

CONSTRUCTION ENGINEERING SERVICES | Status: TITLE-1 | Issue Date: 2-20-90 | Rev. Date:

Project Engineer: E.C. | Quantities By: J.G. | Priced By: J.G. | Checked By: |

No.	ITEM - DESCRIPTION	UNIT Per Item	COST Per Unit	Total Costs Quantity	Amount
	02 SITE WORK				
	02.7 Sewerage and Drainage				
	667 STORM SEWER				
0011	Install S.S. Lift Station, 4' Dia. x 6' Dp.	EA	2,500	1.000	2,500
0012	Install Duplex Pump	EA	4,000	1.000	4,000
0013	Discharge Pipe, 4" Dia. Duct. Iron	LF	12.00	100	1,200
0014	Trench & Backfill	HRS	120.00	24	2,900
0015	Granular Backfill At Lot	LOT	2,000	1.000	2,000
0016	Protect Existing Utilities	LOT	2,000	1.000	2,000
	Class 667 subtotal $14,600.00				
	02.7 SUBTOTAL				$14,600
	02 SUBTOTAL $14,600.				
	15 MECHANICAL				
	15.7 Air Conditioning / Ventilation				
	200 HVAC SYSTEM PIPING, Power Supply Gallery				
0011	Chilled Wtr. Piping, Insul. 2 1/2" Stl.	LF	19.00	20	400
0012	Chilled Wtr. Piping, Insul. 2" Stl.	LF	15.00	300	4,500
0013	Chilled Wtr. Piping, Insul. 1" Stl.	LF	10.00	150	1,500
0014	Core 4" Holes In Conc. Floor	EA	200.00	2.000	400
0015	Hot Taps, 3"	EA	500.00	2.000	1,000
0016	Valves & Accessories	LOT	2,000	1.000	2,000

CONSTRUCTION ENGINEERING SERVICES | Status: TITLE-1 | Issue Date: 2-20-90 | Rev. Date:

Project Engineer: E.C. | Quantities By: J.G. | Priced By: J.G. | Checked By: |

No.	ITEM - DESCRIPTION			UNIT Per Item	COST Per Unit	Total Costs Quantity	Amount
	0017						
	Dual-Temp. Wtr. Piping, Insul. 1" Stl.			LF	10.00	150	1,500
	0018						
	Hot Taps, 1"			EA	250.00	4.000	1,000
	0019						
	Valves & Fittings			LOT	1,000	1.000	1,000
	0020						
	Test & Balance			LOT	500.00	1.000	500
	0021						
	Shop Drawings			LOT	1,000	1.000	1,000
		Class 200 subtotal	$14,800.00				

15.7	SUBTOTAL						$14,800
15	SUBTOTAL	$14,800.					
16	ELECTRICAL						
16.2	Boxes & Wiring Devices						
	200 POWER DISTRIBUTION TO R.T. SUPPLIES						
	0011						
	Connect 8-Power Supplies, 8-Units @ 32-Hrs.			HRS	47.00	256	12,000
	0012						
	Materials For Connections			LOT	12,000	1.000	12,000
		Class 200 subtotal	$24,000.00				
	201 DEBUNCHER CONNECTION						
	0011						
	Connect Debuncher			HRS	47.00	40	1,900
		Class 201 subtotal	$1,900.00				

16.2	SUBTOTAL						$25,900
16.7	Electric Utilities						
	110 SUBSTATION MODIFICATION						
	0011						
	Remove & Salvage 750 KVA Substation			LOT	3,000	1.000	3,000

FERMILAB LINAC UPGRADE
WBS 1.2.3 LINAC UTILITIES AND SERVICES

CONSTRUCTION ENGINEERING SERVICES | Status: TITLE-1 | Issue Date: 2-20-90 | Rev. Date:

Project Engineer: E.C. | Quantities By: J.G. | Priced By: J.G. | Checked By: |

No.	ITEM - DESCRIPTION		UNIT Per Item	COST Per Unit	Total Costs Quantity	Amount
	0012					
	Modify Existing Substation Pad		LOT	2,000	1.000	2,000
	0013					
	Install New 1500 KVA Substation		LOT	35,000	1.000	35,000
	Class 110 subtotal	$40,000.00				
	111 SUBSTATION & FEEDERS					
	0011					
	1500 KVA Transformer		EA	35,000	1.000	35,000
	0012					
	500 KVA Transformer		EA	15,000	1.000	15,000
	0013					
	4-5" Power Duct, PVC Conc. Enc. (25'+ 60')		LF	45.00	85	3,800
	0014					
	Wire, (3) 750 MCM, 85'x 3 x 4		LF	10.00	1100	11,000
	0015					
	Wire, (2) 350 MCM, 85'x 2 x 4		LF	4.50	700	3,200
	0016					
	2-5" Power Duct, PVC Conc. Enc.		LF	35.00	120	4,200
	0017					
	Steel Manhole, 3'x 3'x 3'		EA	2,500	1.000	2,500
	0018					
	Excavate & Backfill Parking Lot		LOT	3,500	1.000	3,500
	0019					
	Core & Seal Holes In Utility Tunnel		LOT	1,000	1.000	1,000
	0020					
	Wire,(3) 750 MCM, 120'x 3		LF	10.00	360	3,600
	0021					
	Terminations		EA	80.00	23	1,800
	0022					
	Misc. Conn.& Tunnel & Clean-Up		LOT	2,000	1.000	2,000
	Class 111 subtotal	$86,600.00				
	16.7 SUBTOTAL					$126,600
	16 SUBTOTAL	$152,500.				

FERMILAB COST ESTIMATE
4-1-2
FERMILAB LINAC UPGRADE
WBS 1.2.4 LINAC ENCLOSURE ACCESS & PENETRATIONS

CONSTRUCTION ENGINEERING SERVICES | Status: TITLE-1 | Issue Date: 2-19-90 | Rev. Date:

Project Engineer: E.C. | Quantities By: J.G. | Priced By: J.G. | Checked By: |

SUMMARY OF CONSTRUCTION COSTS

	TOTAL COSTS
02 SITE WORK	$243,000
SUBTOTAL	243,000
CONTRACTOR'S OVERHEAD & PROFIT @ 20.000%,	48,600
SUBTOTAL	292,000
TOTAL CONSTRUCTION COST	$292,000

CONSTRUCTION ENGINEERING SERVICES | Status: TITLE-1 | Issue Date: 2-19-90 | Rev. Date:

Project Engineer: E.C. | Quantities By: J.Q. | Priced By: J.Q. | Checked By: |

No.	ITEM - DESCRIPTION	UNIT Per Item	COST Per Unit	Total Costs Quantity	Amount
	02 SITE WORK				
	02.1 Site Preparation				
	615 LINAC ENCLOSURE ACCESS PIT (Phase-1)				
0011	Prepare Equipment Pad & Berm	HRS	125.00	8.000	1,000
0012	Mobilize Pile Driver	LOT	3,000	1.000	3,000
0013	Drive Sheet Piling, 38' Dp.x 100'	SF	16.00	3600	57,600
0014	Excavate Pit w/ Backhoe	HRS	125.00	16	2,000
0015	Handexcavate	HRS	40.00	16	600
0016	Dispose Of Radio Active Soil	LOT	5,000	1.000	5,000
0017	Remove Concrete End Cover w/ Mach.	LOT	2,000	1.000	2,000
0018	Install Steel Roll-Up Door, 10'x 12'	EA	3,000	1.000	3,000
0019	Install Gravel Drain, Sump Pit & Pump	LOT	2,000	1.000	2,000
0020	Install Concrete Pad, 6"x 9'x 28'	CY	240.00	5.000	1,200
0021	Place Steel Plates, 1"x 8'x 9'	TON	1,800	1.500	2,700
0022	Excavate Equipment Area In Berm	HRS	125.00	8.000	1,000
0023	Place Granular Pad, 1'x 20'x 30'	CY	25.00	30	800
0024	Haul-In 40 Conc. Shield Blocks	DAY	3,000	1.000	3,000
0025	Place 40-Shield Blocks w/ Crane	DAY	3,000	1.000	3,000
0026	Wood Cover Over Pit, 12'x 40'	LOT	3,000	1.000	3,000
0027	Farm Fence w/ Gate Around Pit	LOT	2,000	1.000	2,000
0028	Soil Borings	LOT	17,000	1.000	17,000
	Class 615 subtotal $109,900.00				

FERMILAB LINAC UPGRADE
WBS 1.2.4 LINAC ENCLOSURE ACCESS & PENETRATIONS

CONSTRUCTION ENGINEERING SERVICES | Status: TITLE-1 | Issue Date: 2-19-90 | Rev. Date:

Project Engineer: E.C. | Quantities By: J.G. | Priced By: J.G. | Checked By: |

No.	ITEM - DESCRIPTION		UNIT Per Item	COST Per Unit	Total Costs Quantity	Amount
	616 OPEN ACCESS & PLACE EQUIPMENT (5-Times), Phase-2					
0011	Remove Shield Blocks		DAY	3,000	1.000	
0012	Place Equipment in Pit		DAY	3,000	1.000	
0013	Replace Shield Blocks		DAY	3,000	1.000	
0014	Repeat Operation		TIMES	9,000	5.000	45,000
	Class 616 subtotal	$45,000.00				
	617 LINAC ENCLOSURE ACCESS RAMP, Phase-3					
0011	Remove Sheet Piling @ End		LOT	2,000	1.000	2,000
0012	Excavate Ramp		HRS	125.00	16	2,000
0013	Place Ramp Gravel Base, 1'x 12'x 60'		CY	25.00	40	1,000
0014	Dispose Of All Debris & Clean-Up		LOT	1,000	1.000	1,000
	Class 617 subtotal	$6,000.00				
	618 LINAC ENCLOSURE ACCESS PIT BACKFILL, Phase-4					
0011	Uncover Top of Sht. Piling w/ Mach.		HRS	125.00	8.000	1,000
0012	Burn-Off Top of Sht. Piling		HRS	50.00	16	800
0013	Remove Shielding Blocks		DAY	3,000	1.000	3,000
0014	Haul Shield Blocks to R.R.		DAY	3,000	1.000	3,000
0015	Remove Roll-Up Door & Salvage		LOT	1,000	1.000	1,000
0016	Remove Sump Pump		LOT	500.00	1.000	500
0017	Replace Conc. Access Enclosure & Seal		LOT	2,000	1.000	2,000
0018	Backfill Ramp		HRS	125.00	16	2,000
0019	Place Topsoil & Grade		HRS	125.00	8.000	1,000
	Class 618 subtotal	$14,300.00				

FERMILAB LINAC UPGRADE
WBS 1.2.4 LINAC ENCLOSURE ACCESS & PENETRATIONS

CONSTRUCTION ENGINEERING SERVICES | Status: TITLE-1 | Issue Date: 2-19-90 | Rev. Date:

Project Engineer: E.C. | Quantities By: J.Q. | Priced By: J.Q. | Checked By: |

No.	ITEM - DESCRIPTION		UNIT Per Item	COST Per Unit	Total Costs Quantity	Amount
02.1	SUBTOTAL					$175,200
02.3	Tunneling Piles & Caissons					
	805 LINAC WAVE GUIDE PENETRATIONS, 9-Ea.					
0011	Mobilize Equipment		LOT	3,000	1.000	3,000
0012	Drill 4'Dia. Penetrations w/o Conc., 20'Dp.x 9 Ea.		VLF	65.00	180	11,700
0013	Place CMP Casings, 20'Dp.x 9 Ea.		LF	70.00	180	12,600
0014	Core Drill 22"Dia. Holes In 12" Conc. Walls		EA	300.00	18	5,400
0015	Fabricate 20" Dia. Stl. Pipe w/ Flange, 8'Lg.		EA	700.00	9.000	6,300
0016	Excavate @ Linac For 20" Pipes		HRS	125.00	16	2,000
0017	Place 20" Steel Pipes & Seal		EA	500.00	9.000	4,500
0018	Backfill 20" Pipes		HRS	125.00	16	2,000
0019	Install 4" PVC Pipes, Sched. 40, 4 Ea. @ 30'		LF	12.00	1100	13,200
0020	PVC Elbows		EA	80.00	18	1,400
0021	Fill Pipes w/ Polyethelene Beads		HRS	45.00	72	3,200
0022	Fabricate & Place Conc. Pipe Covers		EA	300.00	9.000	2,700
	Class 805 subtotal	$68,000.00				
02.3	SUBTOTAL					$68,000
02	SUBTOTAL	$243,200.				

Appendix E

TITLE 1 DRAWING LIST

Appendix E

TITLE 1 DRAWING LIST

4-1-2 General

G-1	Location Plan
G-2	Site Plan

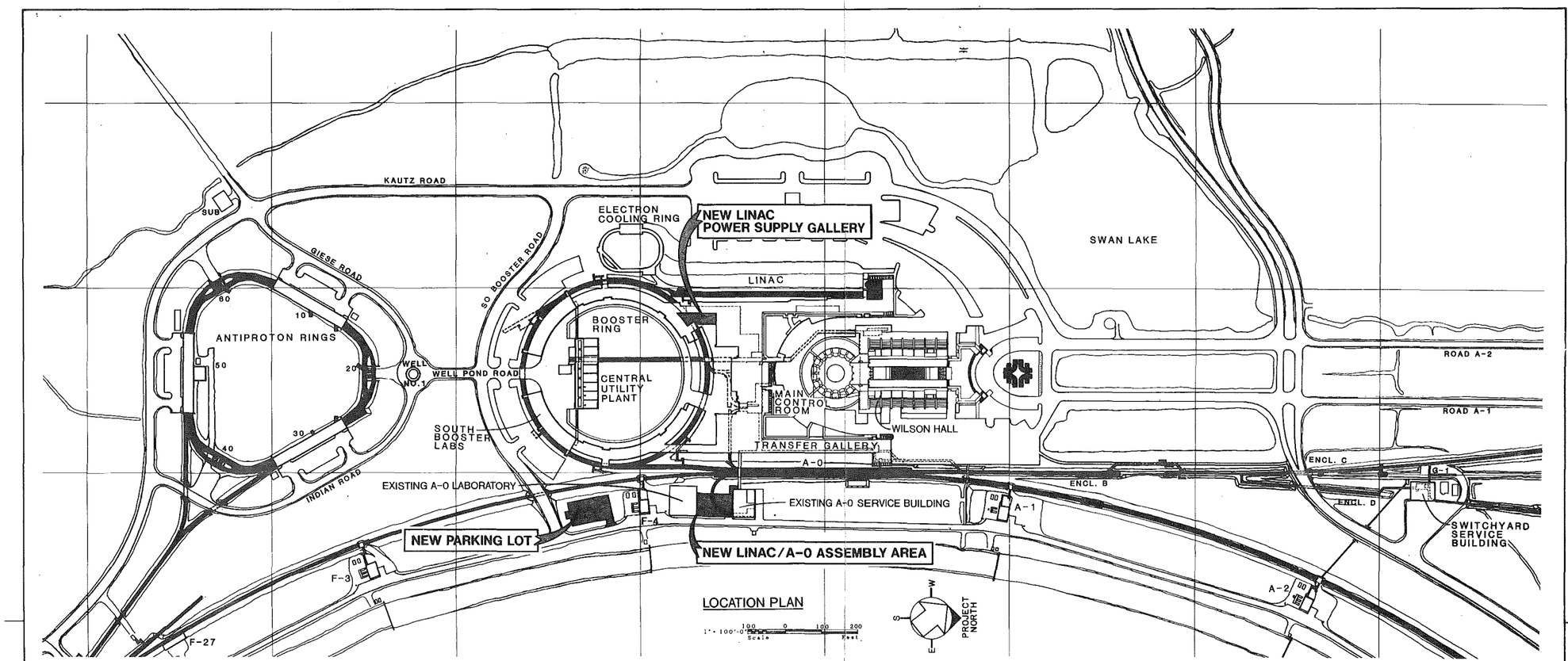
4-1-2A Linac Power Supply Gallery

EQ-1	Equipment Plan & Sections
C-1	Site Plan for Linac Access
C-2	Site Plan at Penetrations
C-3	Grading and Utility Plans
D-1	Plan and Sections
A-1	Architectural Floor Plan
A-2	Building Sections
A-3	Wall Sections
S-1	Caisson Plan
S-2	Plan at El. 744'-0"
S-3	Sections
S-4	Plan at El. 758'-0"
S-5	Elevations and Sections
M-1	Mechanical Floor Plan & Criteria
E-1	Electrical Power Distribution Plan
E-2	Electrical Plan

4-1-2B Linac/A-0 Assembly Area

EQ-1	Equipment Plan
C-1	Site and Demolition Plan
D-1	Demolition Plans, Elevations
A-1	Ground Floor Plan
A-2	Mezzanine and Roof Plans-Section
A-3	Elevations and Section
A-4	Wall Sections and Details
A-5	Details
S-1	Foundation Plan
S-2	Concrete Sections and Details
S-3	Passageway Plans and Sections
S-4	Mezzanine Framing Plan
S-5	Roof Framing Plan
S-6	Steel Sections and Details

M-1	HVAC Ground Floor Plan & Criteria
M-2	HVAC Mezzanine Plan & Criteria
FP-1	Fire Protection Plan and Criteria
E-1	Electrical Ground Floor Plan
E-2	Electrical Mezzanine Floor Plan



FERMILAB LINAC UPGRADE

4-1-2

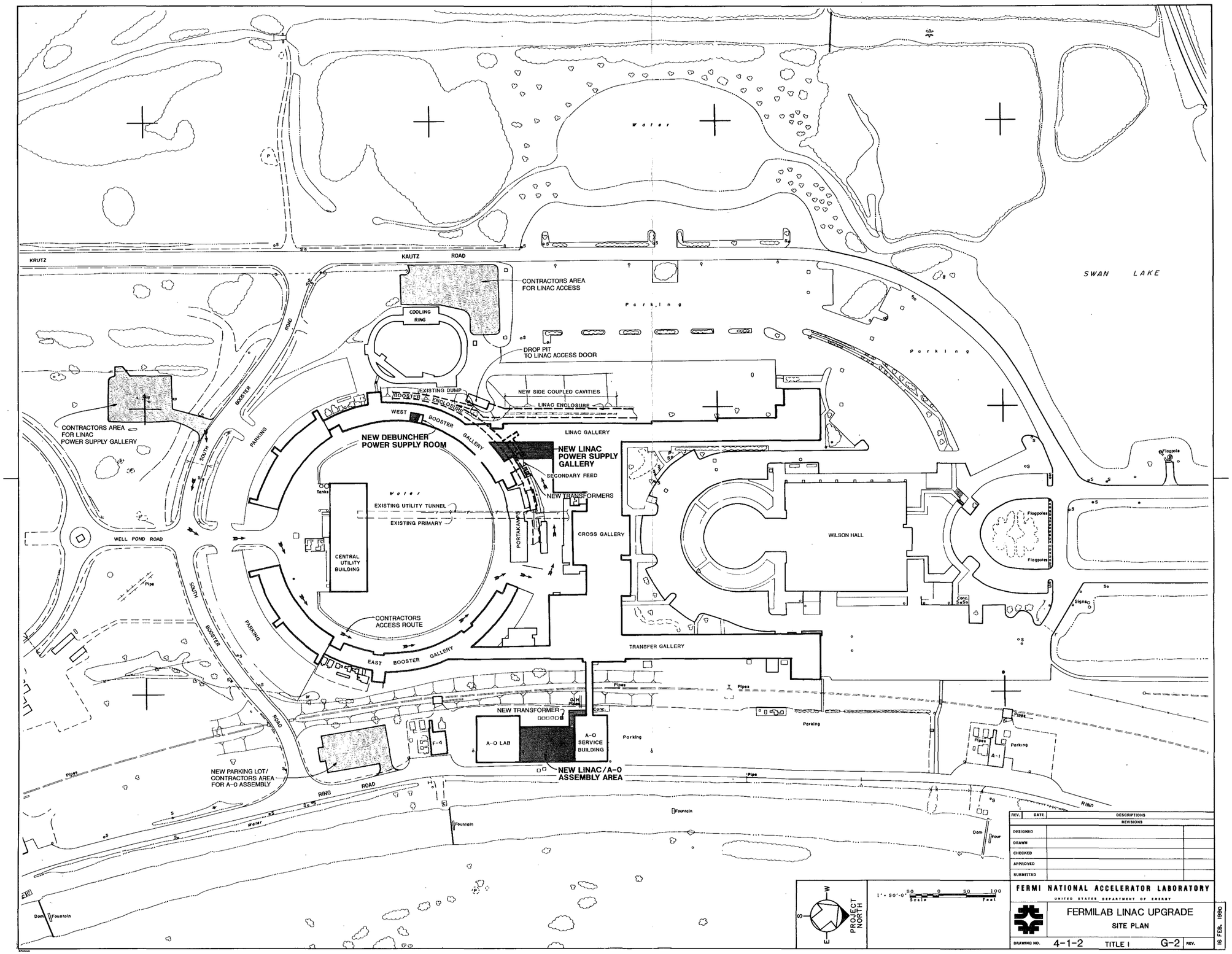
REV.	DATE	DESCRIPTIONS
		REVISIONS
DESIGNED		
DRAWN		
CHECKED		
APPROVED		
SUBMITTED		

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

FERMILAB LINAC UPGRADE
LOCATION PLAN

DRAWING NO. 4-1-2 TITLE I G-1 REV.

16 FEB. 1990



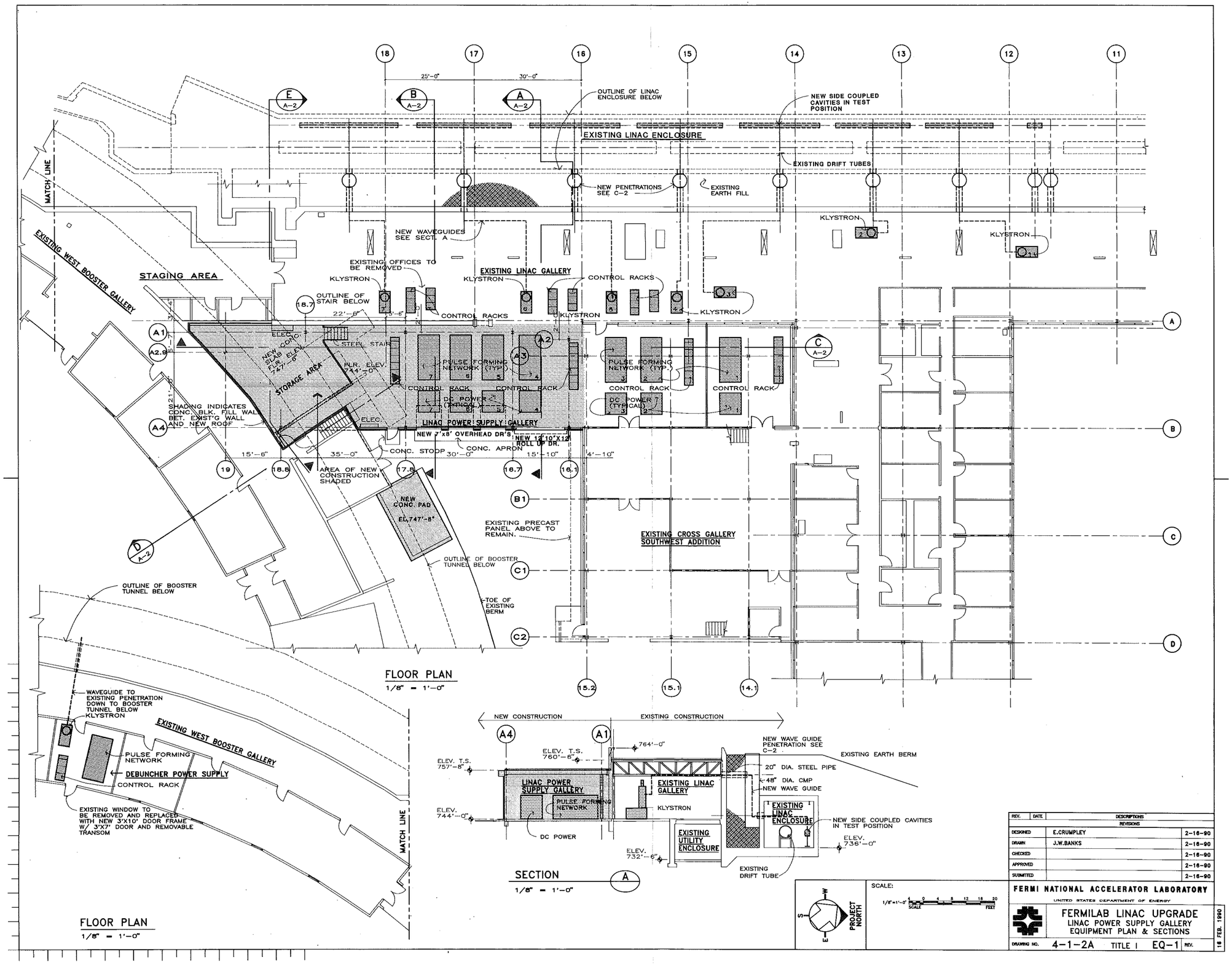
REV.	DATE	DESCRIPTIONS
		REVISIONS
DESIGNED		
DRAWN		
CHECKED		
APPROVED		
SUBMITTED		

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

FERMILAB LINAC UPGRADE
SITE PLAN

DRAWING NO.	4-1-2	TITLE I	G-2	REV.

16 FEB. 1990



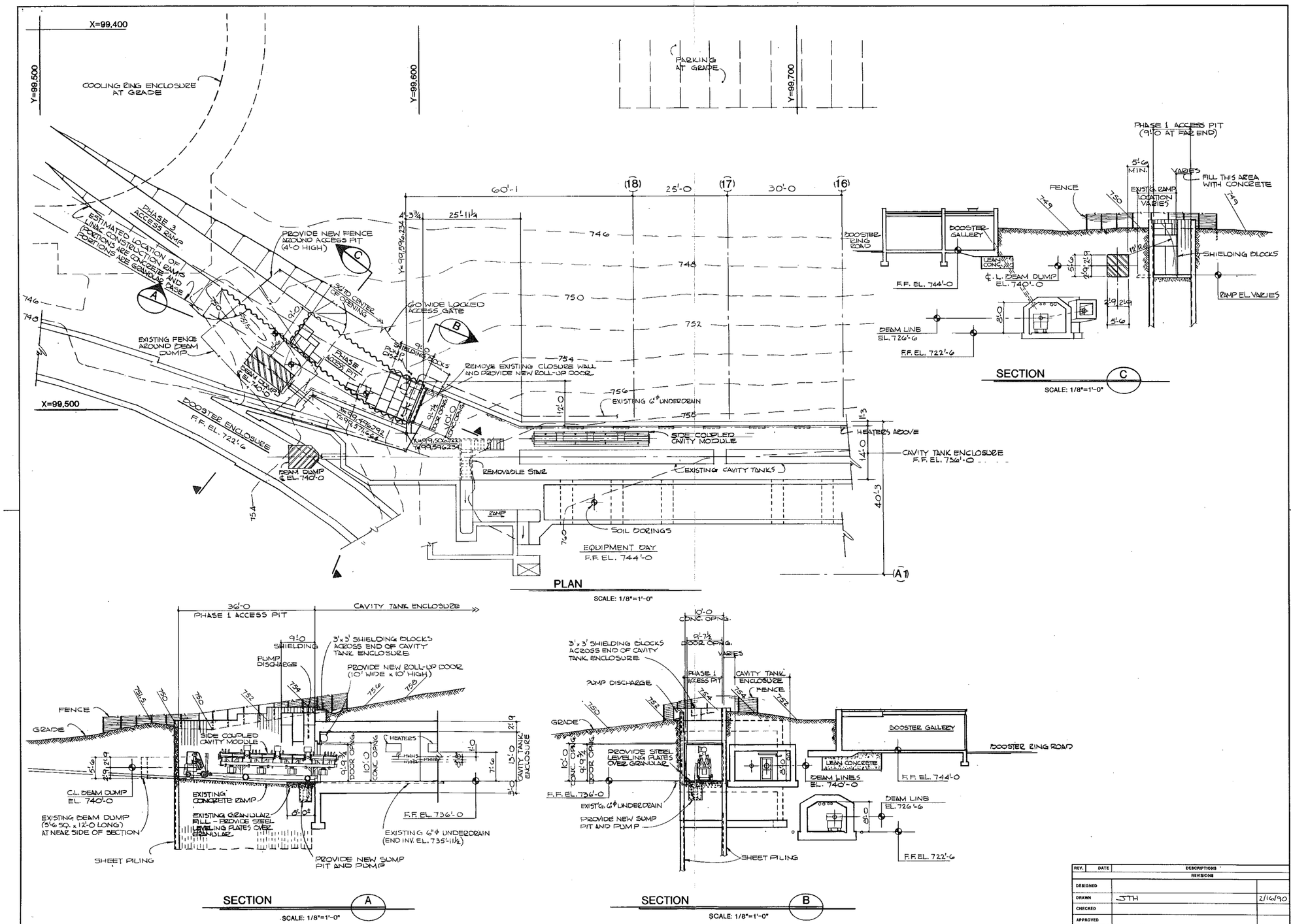
REV.	DATE	DESCRIPTIONS
		REVISIONS
DESIGNED	E.CRUMPLEY	2-16-90
DRAWN	J.W.BANKS	2-16-90
CHECKED		2-16-90
APPROVED		2-16-90
SUBMITTED		2-16-90

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

FERMILAB LINAC UPGRADE
LINAC POWER SUPPLY GALLERY EQUIPMENT PLAN & SECTIONS

DRAWING NO. 4-1-2A TITLE I EQ-1 REV.

16 FEB. 1990



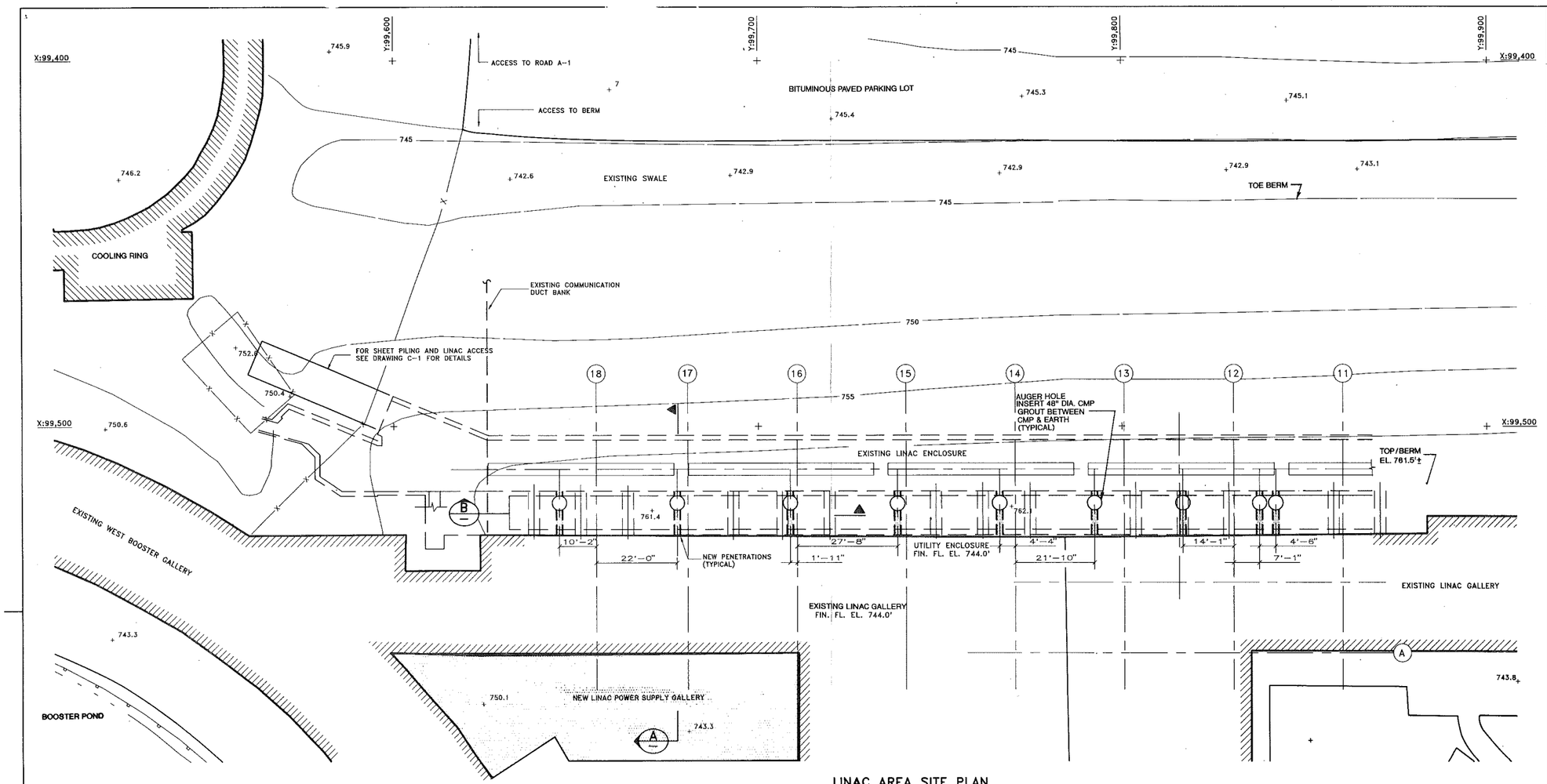
REV.	DATE	DESCRIPTIONS REVISIONS	
DESIGNED			
DRAWN		STH	2/16/90
CHECKED			
APPROVED			
SUBMITTED			2-16-90

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

FERMILAB LINAC UPGRADE
LINAC POWER SUPPLY GALLERY
SITE PLAN FOR LINAC ACCESS

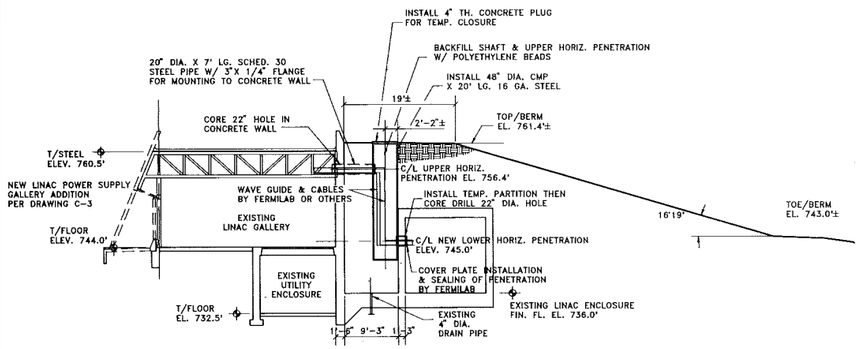
DRAWING NO. 4-1-2A TITLE I C-1 REV.

18 FEB. 1990



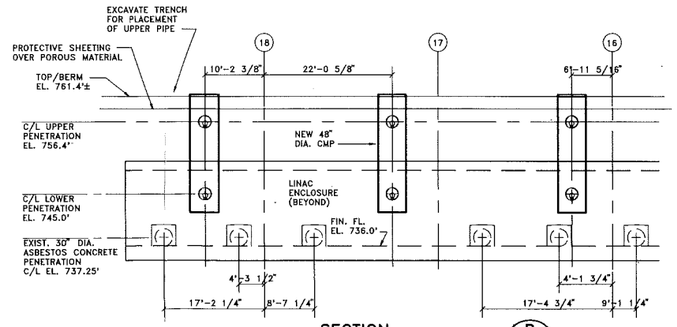
LINAC AREA SITE PLAN

SCALE: 1" = 10'-0"



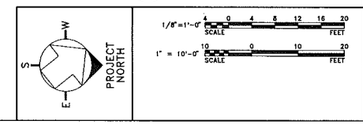
SECTION A

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



SECTION B

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



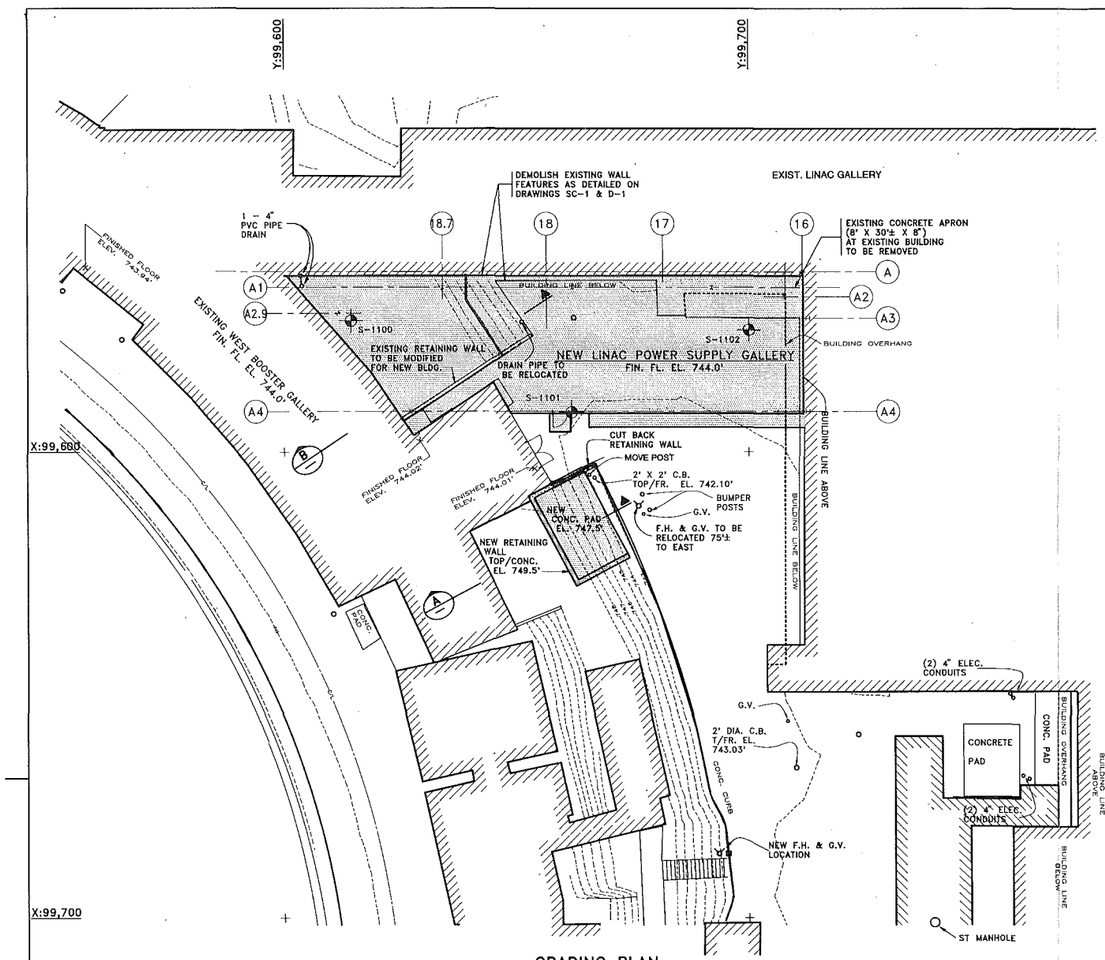
REV.	DATE	DESCRIPTIONS / REVISIONS	
DESIGNED		LINDA EVEN	2-16-90
DRAWN		LINDA EVEN	2-16-90
CHECKED			2-16-90
APPROVED			2-16-90
SUBMITTED			2-16-90

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

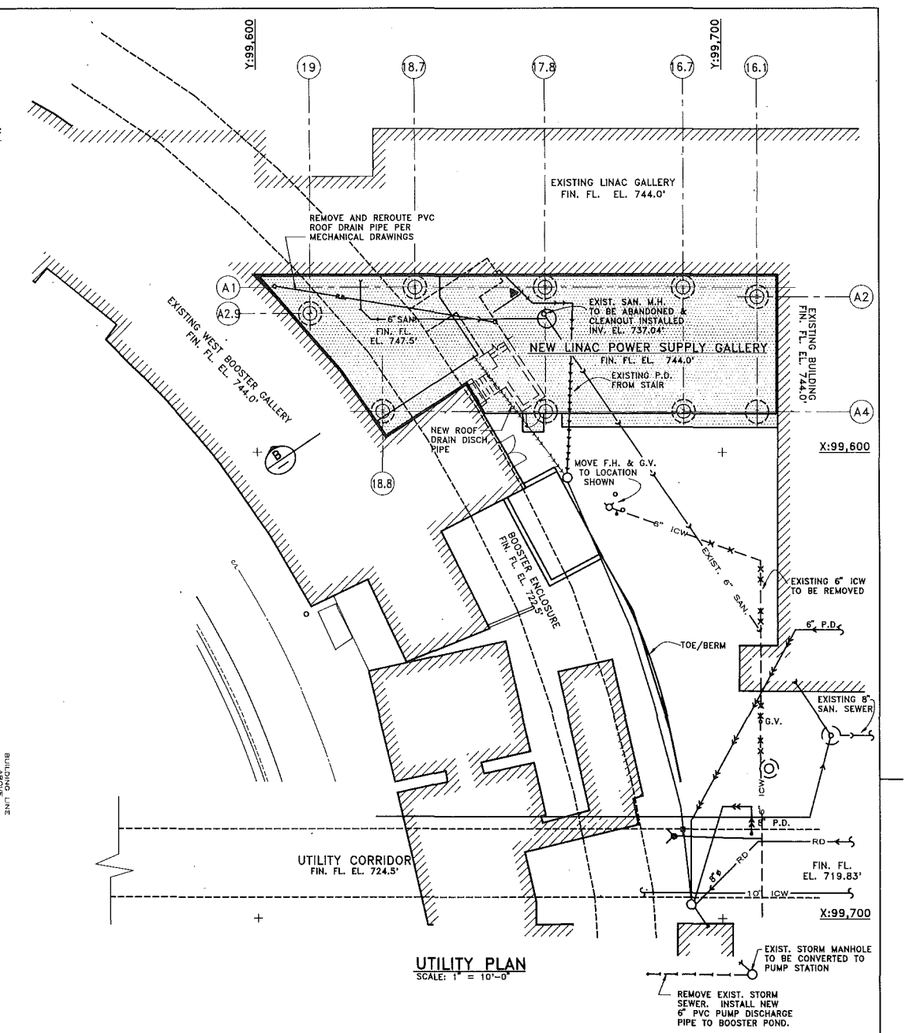
FERMILAB LINAC UPGRADE
LINAC POWER SUPPLY GALLERY SITE PLAN AT PENETRATIONS

DRAWING NO. 4-1-2A TITLE I C-2 REV.

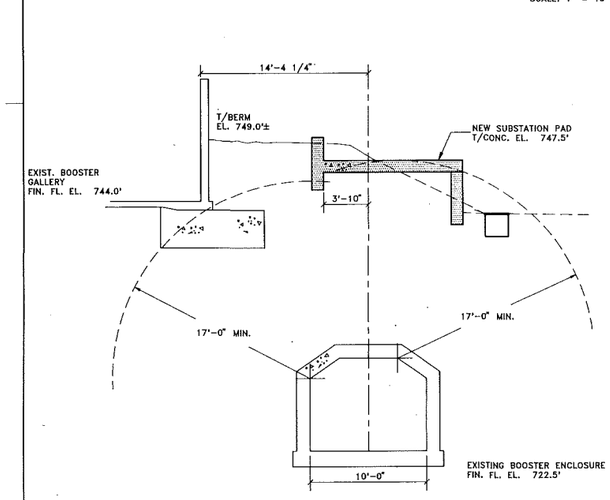
16 FEB. 1990



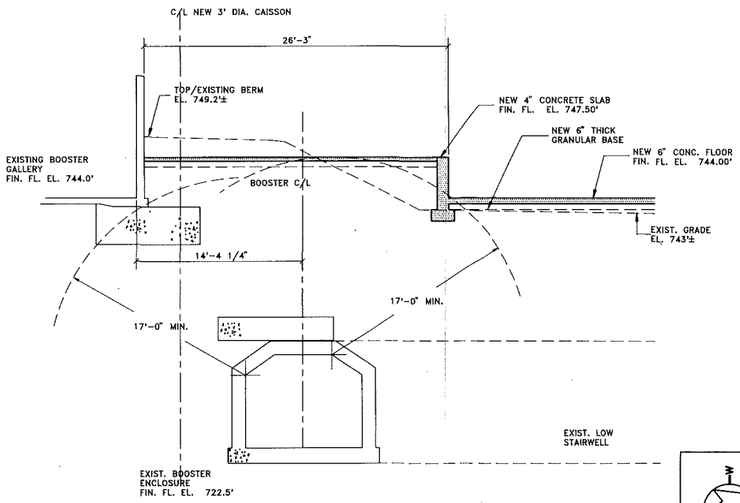
GRADING PLAN
SCALE: 1" = 10'-0"



UTILITY PLAN
SCALE: 1" = 10'-0"



SECTION A
SCALE: 1/4" = 1'-0"



SECTION B
SCALE: 1/4" = 1'-0"

PROJECT NORTH

1/4"=1'-0" SCALE 4 0 4 8 FEET
1" = 10'-0" SCALE 10 0 10 20 FEET

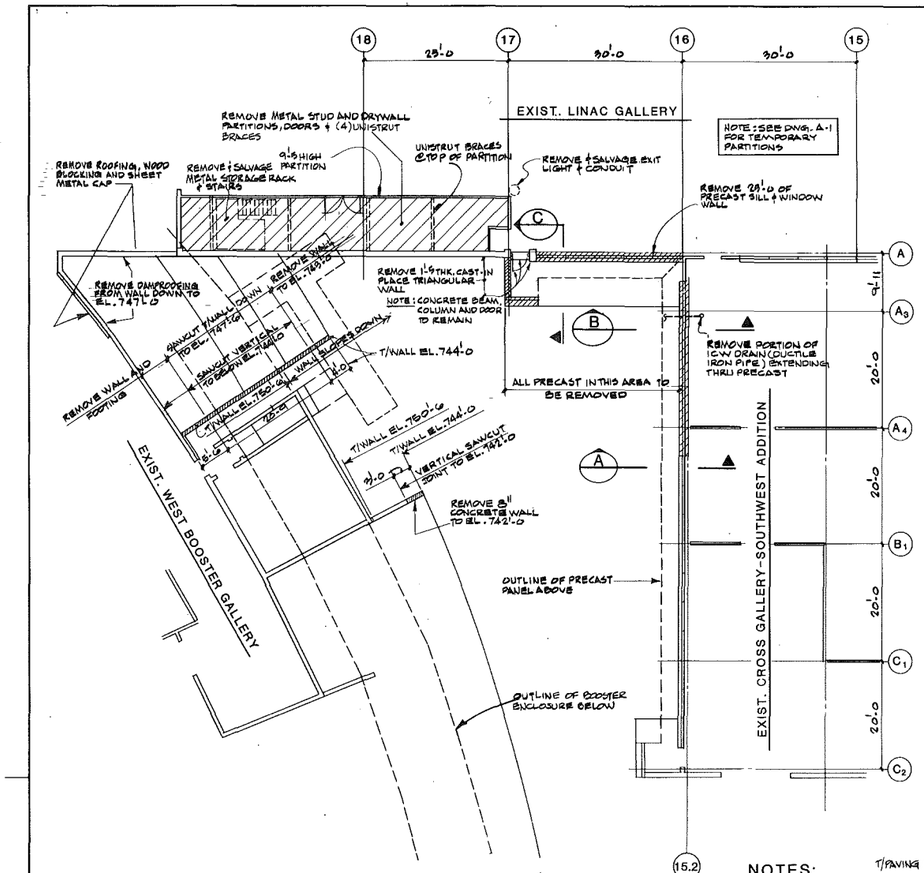
REV.	DATE	DESCRIPTIONS
		REVISIONS
DESIGNED		L. L. EVEN — 2-16-90
DRAWN		L. L. EVEN, A. SCHMITT — 2-16-90
CHECKED		— 2-16-90
APPROVED		— 2-16-90
SUBMITTED		— 2-16-90

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

FERMILAB LINAC UPGRADE
LINAC POWER SUPPLY GALLERY
GRADING AND UTILITY PLANS

DRAWING NO. 4-1-2A TITLE I C-3 REV.

16 FEB. 1990

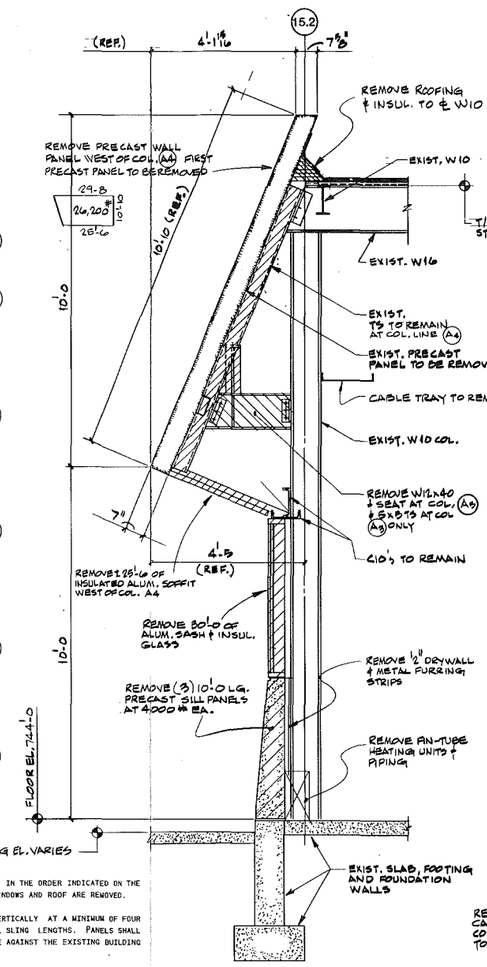


DEMOLITION PLAN

3/8" = 1'-0

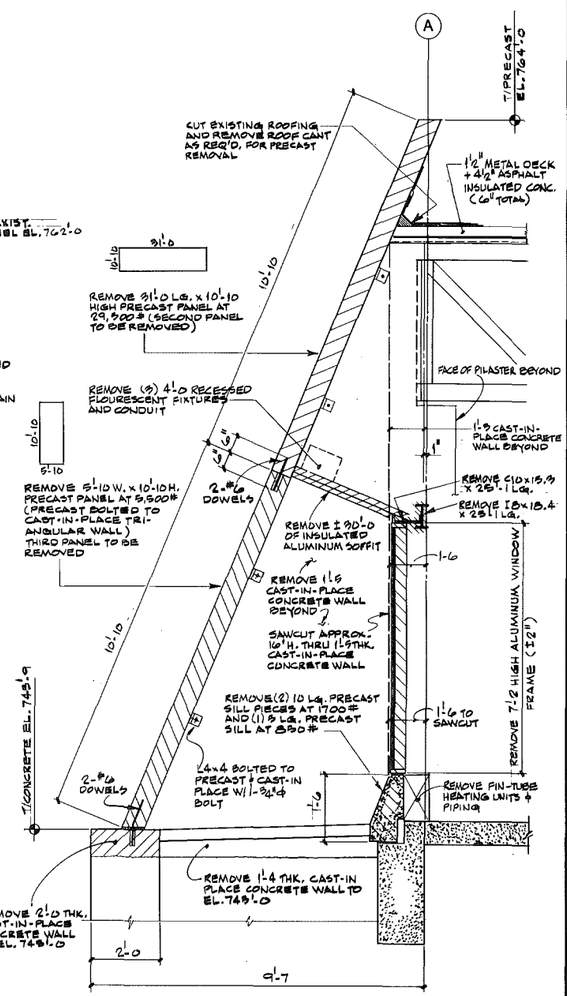
NOTES:

1. PANELS ARE TO BE REMOVED IN THE ORDER INDICATED ON THE DRAWINGS AFTER SOFFIT, WINDOWS AND ROOF ARE REMOVED.
2. PANELS SHALL BE LIFTED VERTICALLY AT A MINIMUM OF FOUR POINTS, REQUIRING UNEQUAL SLING LENGTHS. PANELS SHALL NOT BE ALLOWED TO ROTATE AGAINST THE EXISTING BUILDING STRUCTURE.
3. THE PANELS ARE TO BE COMPLETELY RIGGED AND HELD BY A MOBILE CRANE PRIOR TO REMOVING ANY OF THE EXISTING ATTACHMENT HARDWARE.
4. PANEL CONNECTION AT STEEL FRAME CAN BE REMOVED BY REMOVING THE TWO THREADED CONNECTORS AT EACH END. THE VERTICAL SEAT CONNECTION HAS NO HARDWARE THAT REQUIRES UNFASTENING.
5. PANELS CONNECTED TO CAST-IN-PLACE CONCRETE OR PRECAST CONCRETE SHALL BE REMOVED BY FLAME CUTTING CONNECTOR PLATES AS REQUIRED.



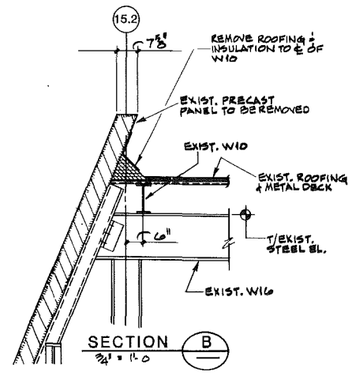
SECTION A

3/4" = 1'-0



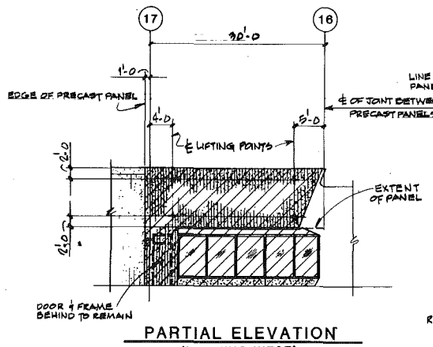
SECTION C

3/4" = 1'-0



SECTION B

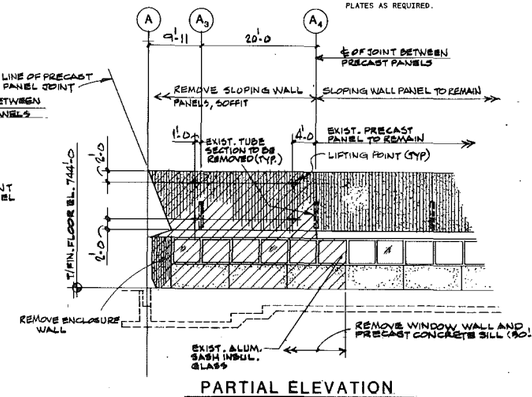
3/4" = 1'-0



PARTIAL ELEVATION

(LOOKING WEST)

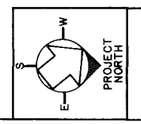
1/8" = 1'-0



PARTIAL ELEVATION

(LOOKING NORTH)

1/8" = 1'-0



3/4"=1'-0 SCALE FEET

1/8"=1'-0 Scale Feet

REV.	DATE	DESCRIPTIONS
		REVISIONS
DESIGNED		
DRAWN		Rick Kilcoyne
CHECKED		
APPROVED		
SUBMITTED		2-16-90

FERMI NATIONAL ACCELERATOR LABORATORY

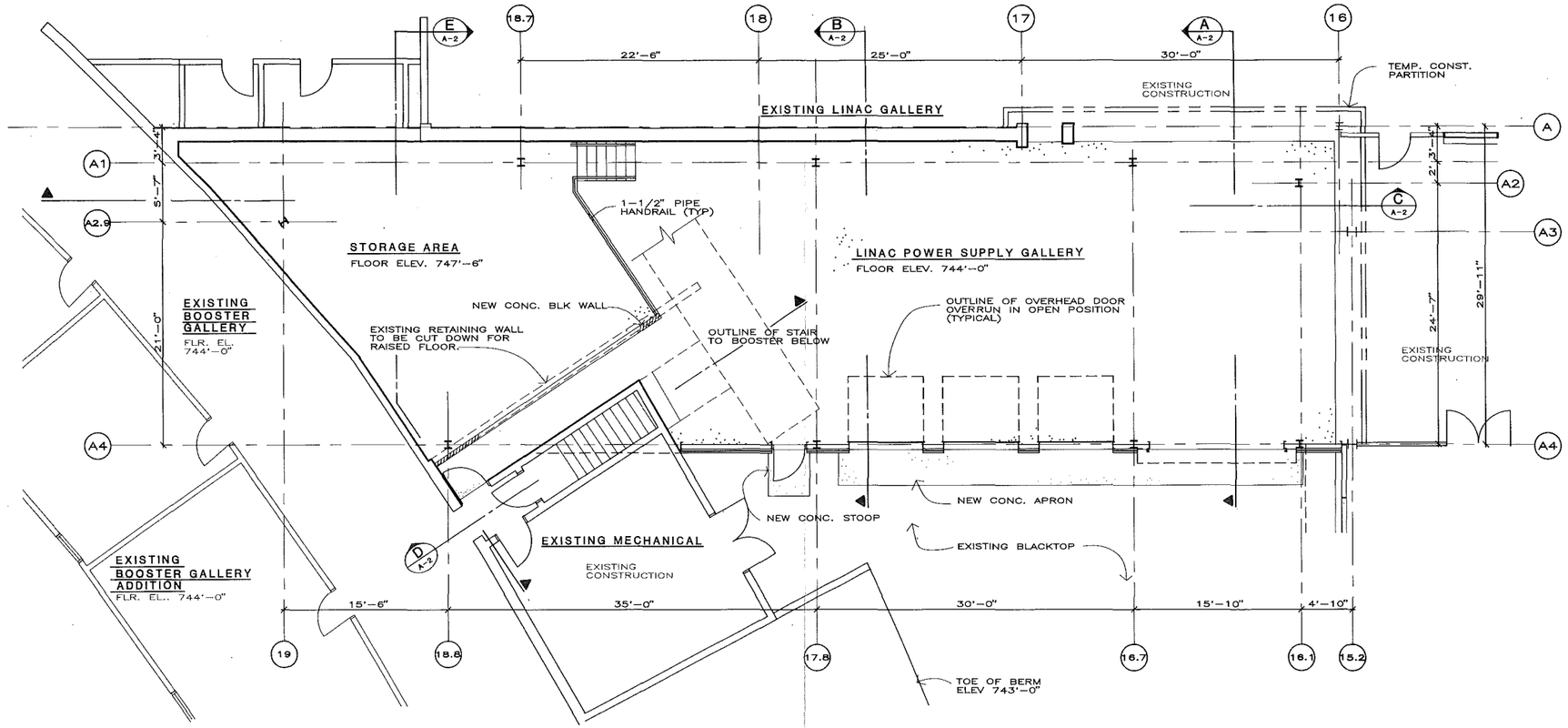
UNITED STATES DEPARTMENT OF ENERGY

FERMILAB LINAC UPGRADE I

LINAC POWER SUPPLY GALLERY PLAN AND SECTIONS

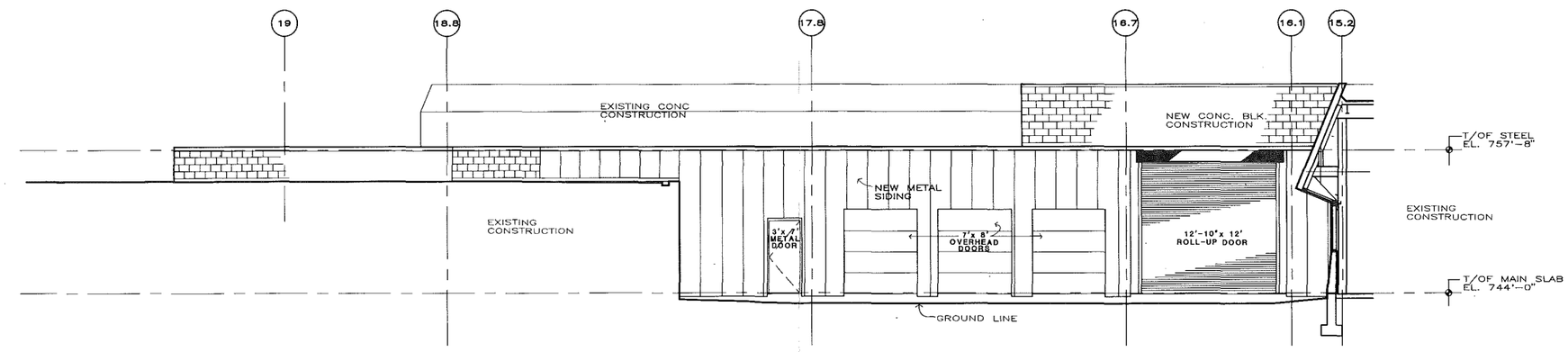
DRAWING NO. 4-1-2A TITLE I D-1 REV.

16 FEB. 1990



FLOOR PLAN

SCALE: 1/4"=1'-0"



EAST ELEVATION

SCALE: 1/4"=1'-0"

REV.	DATE	DESCRIPTIONS
		REVISIONS
DESIGNED	E. CRUMPLEY	2-16-90
DRAWN	J.W.BANKS	2-16-90
CHECKED		2-16-90
APPROVED		2-16-90
SUBMITTED		2-16-90

PROJECT NORTH

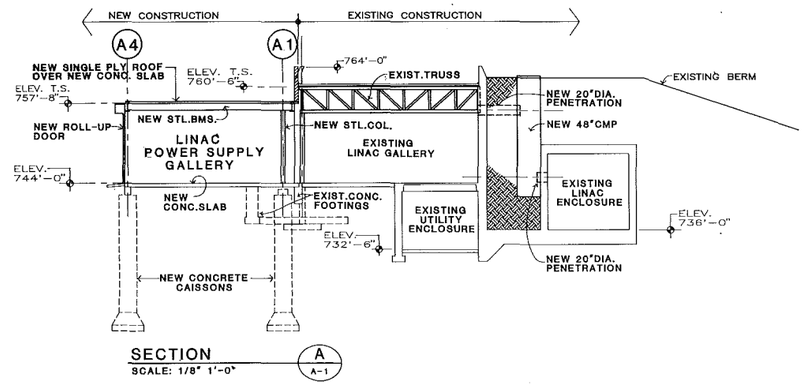
SCALE: 1/4"=1'-0" (4 0 4 8 SCALE FEET)

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

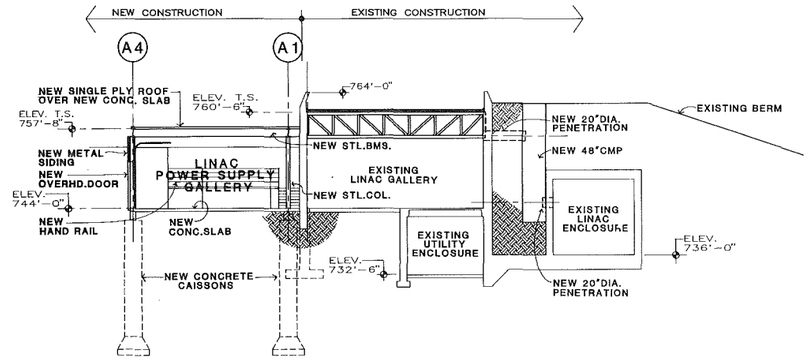
FERMILAB LINAC UPGRADE
LINAC POWER SUPPLY GALLERY
ARCHITECTURAL FLOOR PLAN

DRAWING NO. 4-1-2A TITLE I A-1 REV.

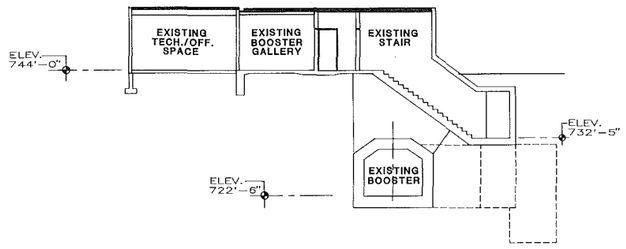
16 FEB. 1990



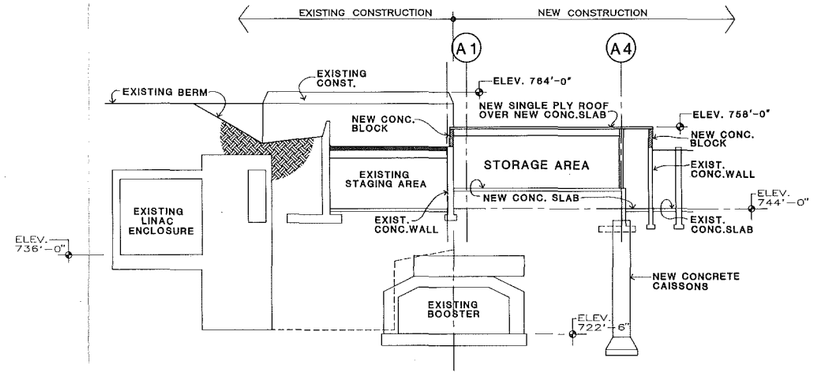
SECTION A
SCALE: 1/8" 1'-0"
A-1



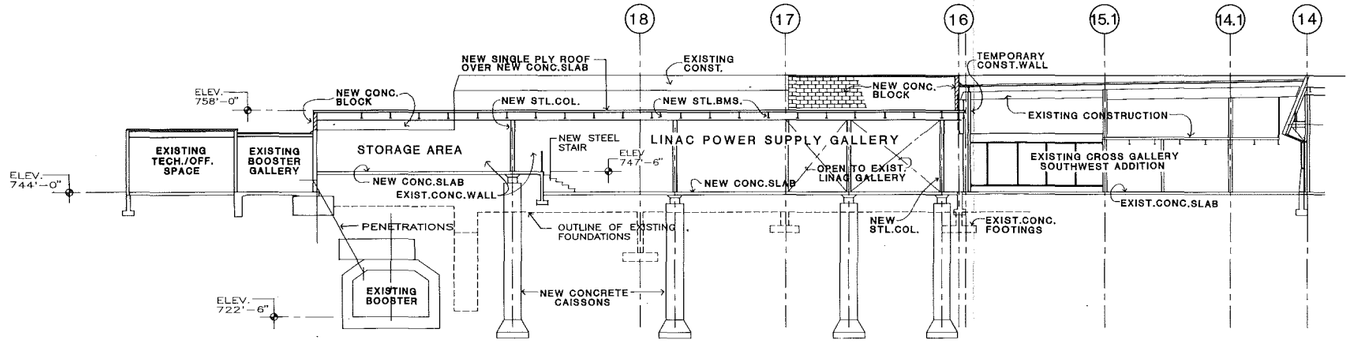
SECTION B
SCALE: 1/8" 1'-0"
A-1



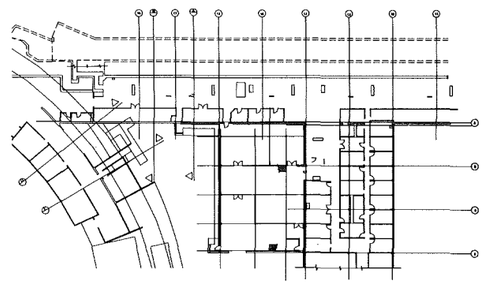
SECTION D
SCALE: 1/8" 1'-0"
A-1



SECTION E
SCALE: 1/8" 1'-0"
A-1



SECTION C
SCALE: 1/8" 1'-0"
A-1



REV.	DATE	DESCRIPTIONS
		REVISIONS
DESIGNED	E.CRUMPLEY	2-16-90
DRAWN	J.W.BANKS	2-16-90
CHECKED		2-16-90
APPROVED		2-16-90
SUBMITTED		2-16-90

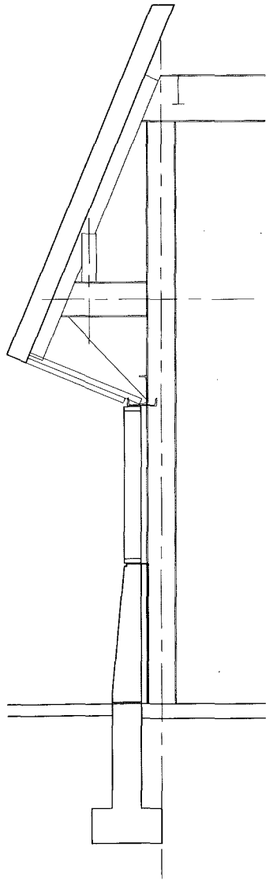
SCALE:
1/8"=1'-0" 4 0 4 8 12 16 20
SCALE FEET

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

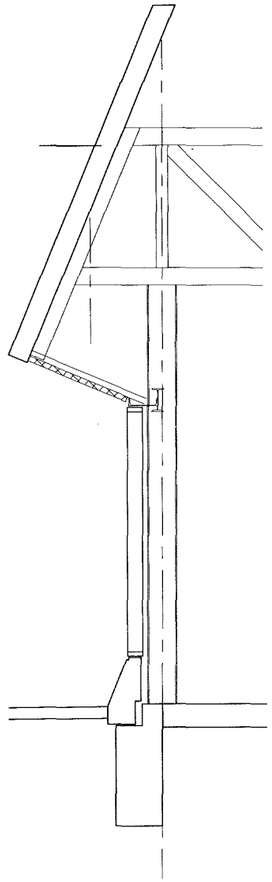
FERMILAB LINAC UPGRADE
LINAC POWER SUPPLY GALLERY
BUILDING SECTIONS

DRAWING NO. 4-1-2A TITLE I A-2 REV.

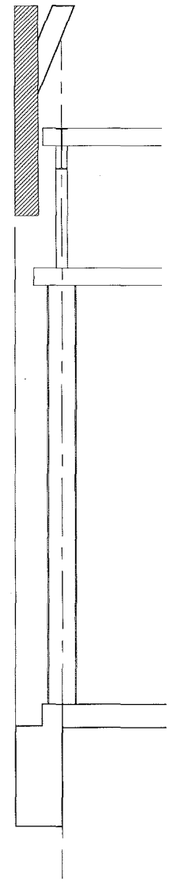
16 FEB. 1990



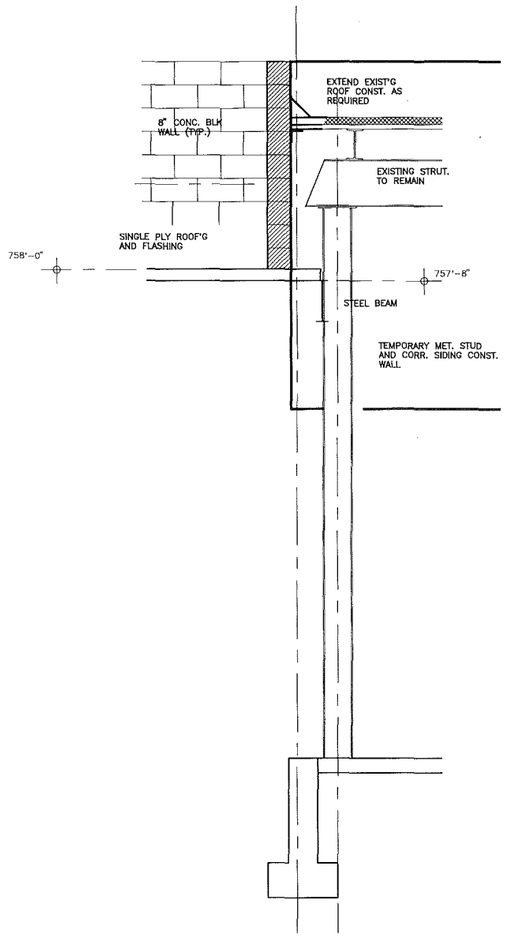
WALL SECTION
3/4" = 1'-0"



WALL SECTION
3/4" = 1'-0"



WALL SECTION
3/4" = 1'-0"



WALL SECTION
3/4" = 1'-0"

REV.	DATE	DESCRIPTIONS
		REVISIONS
DESIGNED		E. CRUMPLEY 2-16-90
DRAWN		J.W.BANKS 2-16-90
CHECKED		2-16-90
APPROVED		2-16-90
SUBMITTED		2-16-90

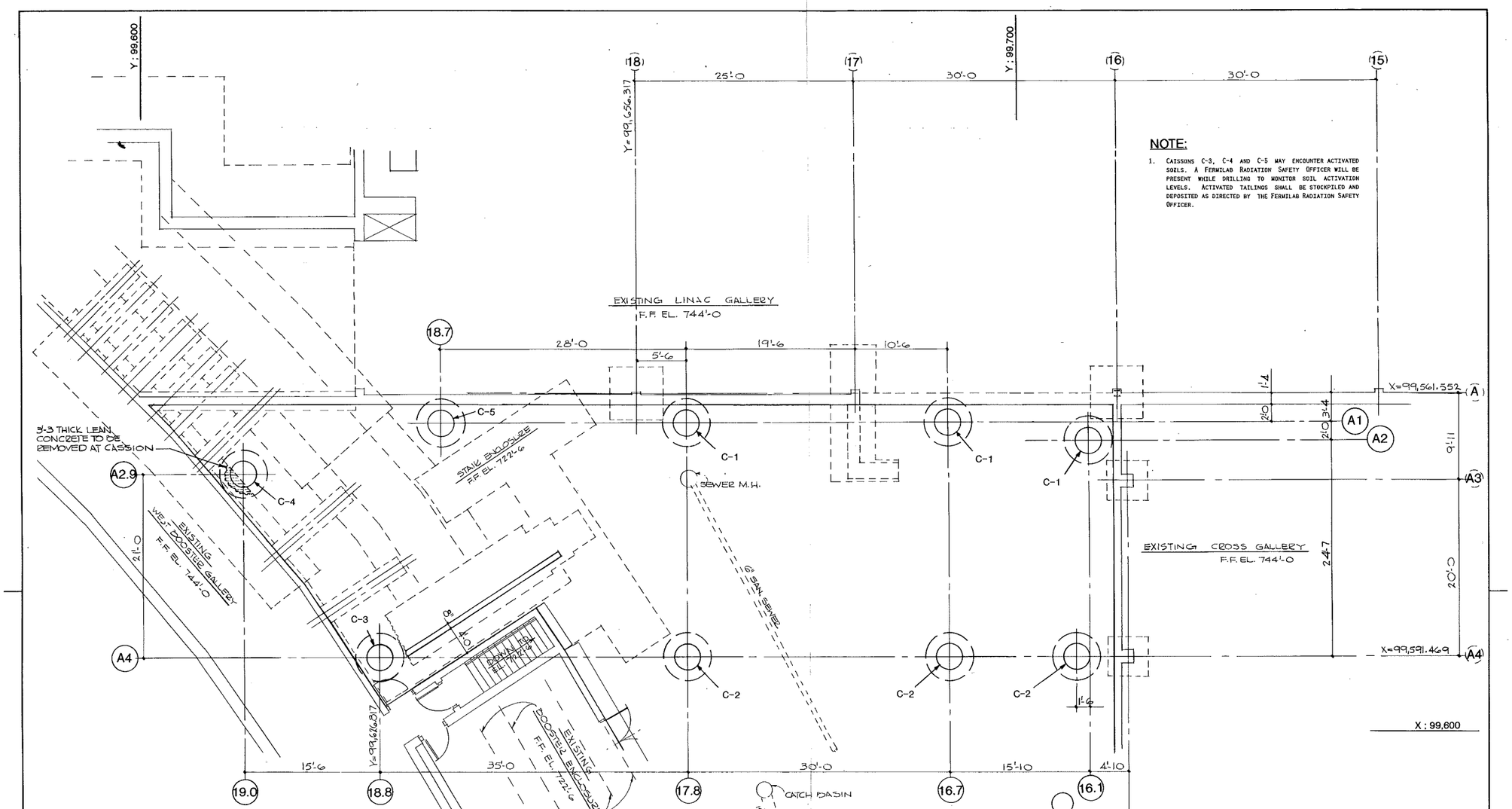
3/4"=1'-0" Scale 0 1 2 3 Feet

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

FERMILAB LINAC UPGRADE
LINAC POWER SUPPLY GALLERY
WALL SECTIONS

DRAWING NO. 4-1-2A TITLE ! A-3 REV.

16 FEB. 1990



PLAN

SCALE 1/4" = 1'-0

CAISSON SCHEDULE

MARK	CAP TYPE	BELL DIAMETER	T/SHAFT ELEVATION	B/BELL* ELEVATION	DOWELS	REMARKS
C-1	1		742'-0			
C-2	2		740'-10			
C-3	1B		742'-0			
C-4	1A		745'-6			
C-5	1A		745'-6			

* FOR BIDDING PURPOSES ONLY - MINIMUM 4 KSF SAFE BEARING PRESSURE REQUIRED.

REV.	DATE	DESCRIPTIONS
		REVISIONS
DESIGNED		
DRAWN	JTH	1/11/90
CHECKED		
APPROVED		
SUBMITTED		2-16-90

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

FERMILAB LINAC UPGRADE
LINAC POWER SUPPLY GALLERY
CAISSON PLAN

DRAWING NO. 4-1-2A TITLE I S-1 REV.

16 FEB. 1990

Y: 99,600

Y: 99,700

Y=99,656.317

(18) (17) (16)

25'-0 30'-0

EXISTING LINAC GALLERY
F.F. EL. 744'-0

18.7

28'-0 19'-6 10'-6

4'-6 1'-0 5'-6

N K

X=99,561.552

(A) (A1) (A2) (A3)

2'-0 3'-4 9'-11

EXISTING CROSS GALLERY
F.F. EL. 744'-0

A2.9

EXISTING WEST BOOSTER GALLERY
F.F. EL. 744'-0

4" CONCRETE SLAB
ON 6" GRANULAR FILL
T/SLAB EL. 747'-6

L

1'-0

T/GRADE BM.
EL. 743'-8

6" CONCRETE SLAB
ON 6" GRANULAR FILL
T/SLAB EL. 744'-0

T/GRADE BM.
EL. 743'-4

C G

21'-0 24'-7 20'-0

25'-3

4" SLAB @ SLAP

M

5'-6

R 10

F E

3'-4½ 1'-4 2'-4 7'-0 2'-0 7'-0 2'-0 7'-0 1'-4 10" 12'-10 10"

8" 8" 8" 8" 8" 8"

L 2x3 L 2x3 L 2x3 L 2x3

A4 1 A N

DOWN
EL. 722'-7½

T/GRADE BEAM
EL. 744'-0

L.P. CONC. APRON
EL. 743'-7½

H.P. CONC. APRON
EL. 743'-10½

4'-6 2'-6 1'-6

B D

3'

X=99,591.469 (A4)

X=99,636.817

X ; 99,600

CAISSON

15'-6 35'-0 30'-0 15'-10 4'-10

19.0 18.8 17.8 16.7 16.1 15

PLAN
SCALE 1/4' = 1'-0

REV.	DATE	DESCRIPTIONS
		REVISIONS
DESIGNED		
DRAWN	J TH	1/17/90
CHECKED		
APPROVED		
SUBMITTED		2-16-90

PROJECT NORTH

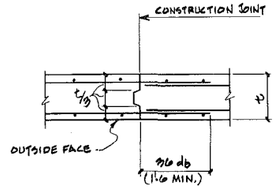
1/4"=1'-0 SCALE 0 4 8 FEET

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

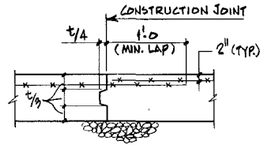
FERMILAB LINAC UPGRADE
LINAC POWER SUPPLY GALLERY
PLAN AT EL. 744'-0"

DRAWING NO. 4-1-2A TITLE I S-2 REV.

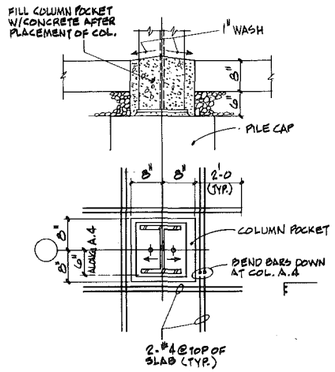
16 FEB. 1990



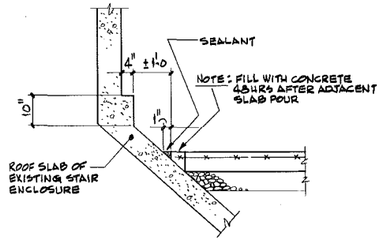
TYPICAL WALL GRADE BEAM
CONSTRUCTION JOINT DETAIL



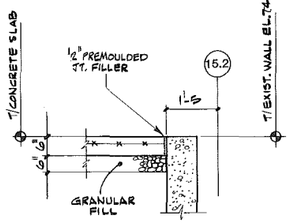
TYPICAL SLAB ON GRADE
CONSTRUCTION JOINT DETAIL



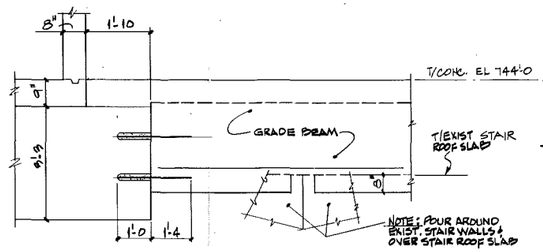
TYPICAL COLUMN POCKET DETAIL

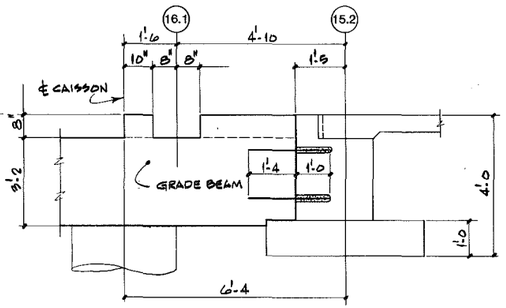


SECTION F
3/4" = 1'-0

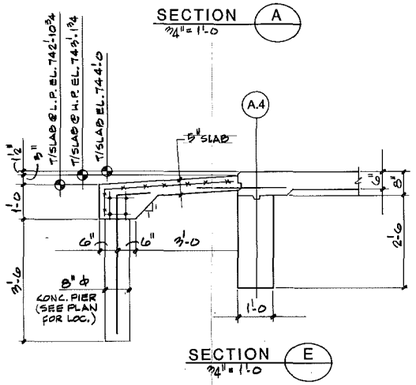


SECTION G
3/4" = 1'-0



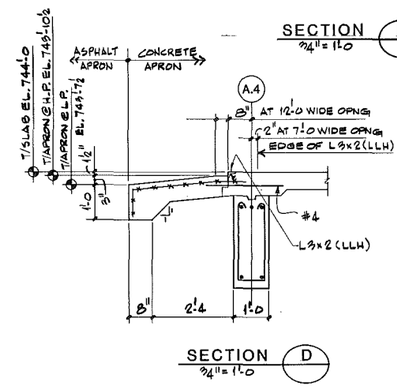


SECTION B
3/4" = 1'-0

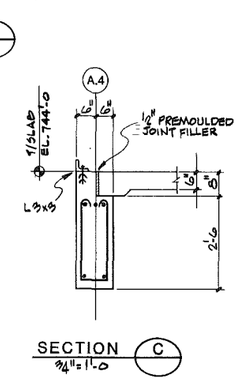


SECTION E
3/4" = 1'-0

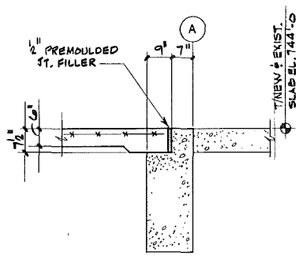
SECTION AT MAN DOOR STOOP



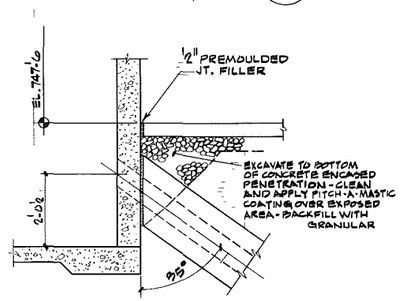
SECTION D
3/4" = 1'-0



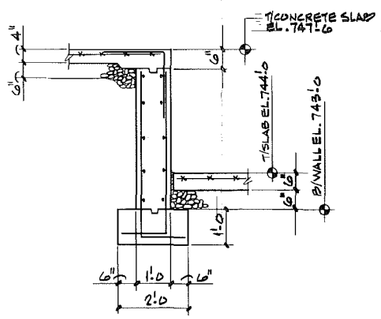
SECTION C
3/4" = 1'-0



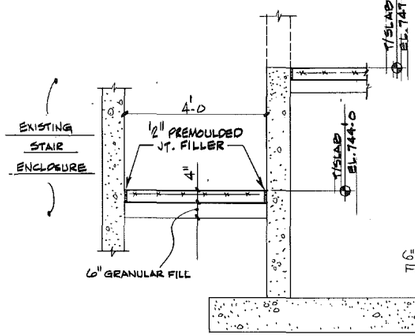
SECTION K
3/4" = 1'-0



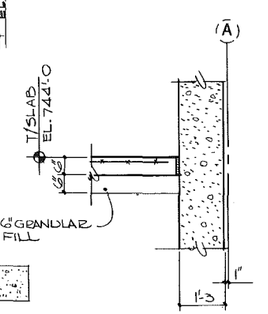
SECTION J
3/4" = 1'-0



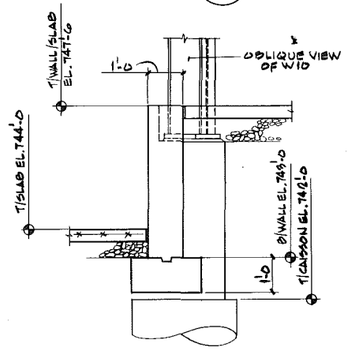
SECTION L
3/4" = 1'-0



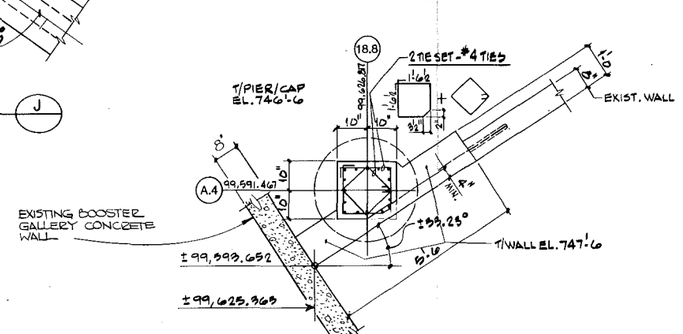
SECTION M
3/4" = 1'-0



SECTION N
3/4" = 1'-0



SECTION H
3/4" = 1'-0



PLAN DETAIL 1
3/4" = 1'-0

REV.	DATE	DESCRIPTIONS
		REVISIONS
DESIGNED		
DRAWN		Don Killian
CHECKED		
APPROVED		
SUBMITTED		2-16-90

3/4" : 1'-0 Scale 0 1 2 3 Feet

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

FERMILAB LINAC UPGRADE
LINAC POWER SUPPLY GALLERY
SECTIONS

DRAWING NO. 4-1-2A TITLE I S-3 REV.

15 FEB. 1990

Y : 99.600

Y : 99.700

(18) (17) (16)

25'-0 30'-0

DESIGN LIVE LOAD = 175 P.S.F.
(FUTURE MECHANICAL FLOOR LOADING)

DESIGN LIVE LOAD = 75 P.S.F.
FUTURE OFFICE LOADING + CONCRETE BLOCK PARTITION

E-1 S-5 F S-5 18.7 J

21'-0 28'-0 19'-6 10'-6

7'-0 3-SPA. @ 7'-0 4-SPA. @ 7'-0 4-SPA. @ 7'-6 = 30'-0 2-SPA. @ 7'-11

11'-6 L3x4 B T/EXIST'G. CONC. WALL EL. L3x4 L8x4 A

11'-0 EXIST'G. CONC. WALL T/WALL EL.

6" CONCRETE MASONRY WALL

EDGE OF CONC. 1 S-5

T/RM. EL. 757'-8

A2.9

1½" 22 GA. TYPE 'B' MTL. ROOF DECK

6" CONCRETE MASONRY WALL

T/EXISTING CONCRETE WALL EL. 754'-6

T/CONC. MASONRY WALL EL. 757'-10

EDGE OF NEW CONCRETE SLAB

2'-0 8'-1 2'-1 4'-1'-0 10'-6

W10 W18 W16 W18 + L4x4 TOP & L4x3 BOT.

END OF L 4x3 BOT.

2" CONCRETE + 2" TYPE "V" 20 GA. METAL DECK (4" TOTAL) T/STL. EL. 757'-8

W18 + L4x4 TOP & L4x3 BOT.

W16 + L4x4 TOP & L4x3 BOT.

FRAME INTO EXISTING SLOPING PRECAST CONCRETE WALL PANEL

1'-2 3'-4 W16 + L4x3

2 S-5 3 S-5 4 G S-5 A S-5 B S-5

5½" 6" 6'-4 1'-5 GIET LINE

A A1 A2 A3 A4

24'-7 20'-0 9'-11

X : 99.600

15'-6 35'-0 30'-0 15'-10 4'-10

19.0 18.8 17.8 16.7 16.1 15

COLUMN SCHEDULE

MARK	A2-16.1, A1-16.7, A1-17.8	A4-16.1, A4-16.7, A4-17.8	A2.9-18.9 A4-18.8	A1-18.7
CAP PL				
EL. 758'-0				
	W8	W8	W10	W8
EL. 747'-6				
EL. 744'-0				
BASE PL	9 x 0'-9	9 x 0'-9	12 x 1'-0	9 x 0'-9
SETTING PL				

ROOF FRAMING PLAN

SCALE 1/4" = 1'-0

A1 T/STL. EL. 757'-8 T/CAP PLATE T/CONC. EL. 758'-0 9½" PC. W8 W/ PL L4x8 W18 W16 STIFFENER PL'S

SECTION A

SCALE 1" = 1'-0

A1 2'-0 1'-4 (A) 1'-3 1" L3x4 SHIP LOOSE W18 W10 W18 W8 COL. EXIST'G. CONC. WALL BOARD FINISH EXISTING CONC. WALL

SECTION B

SCALE 1" = 1'-0

PROJECT NORTH

1/4"-1'-0" SCALE FEET

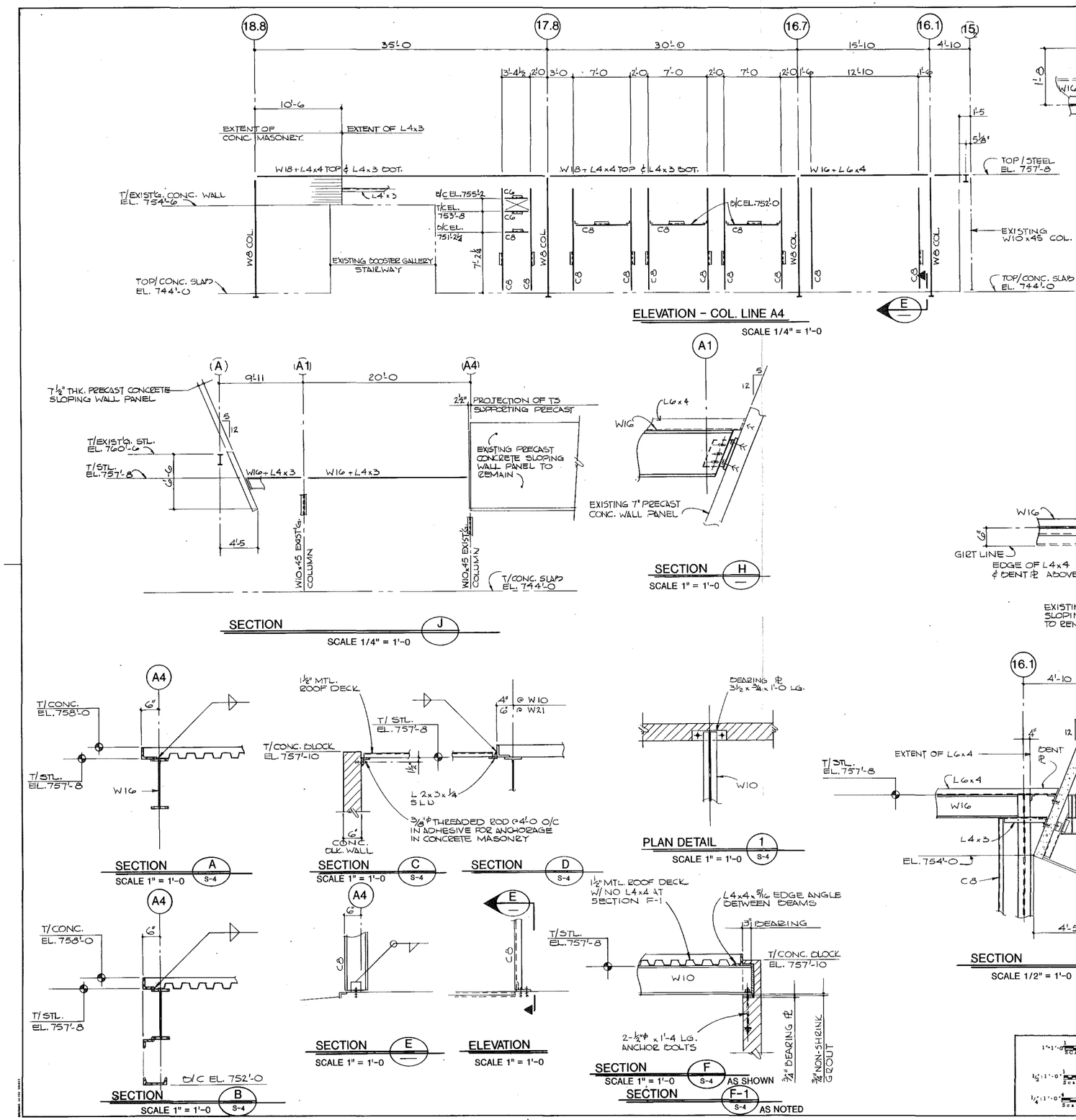
1"-1'-0" SCALE FEET

REV.	DATE	DESCRIPTIONS
		REVISIONS
DESIGNED		
DRAWN	JTH	
CHECKED		
APPROVED		
SUBMITTED		2-16-90

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

FERMILAB LINAC UPGRADE
LINAC POWER SUPPLY GALLERY
PLAN AT EL. 758'-0"

DRAWING NO. 4-1-2A TITLE I S-4 REV. 16 FEB. 1990

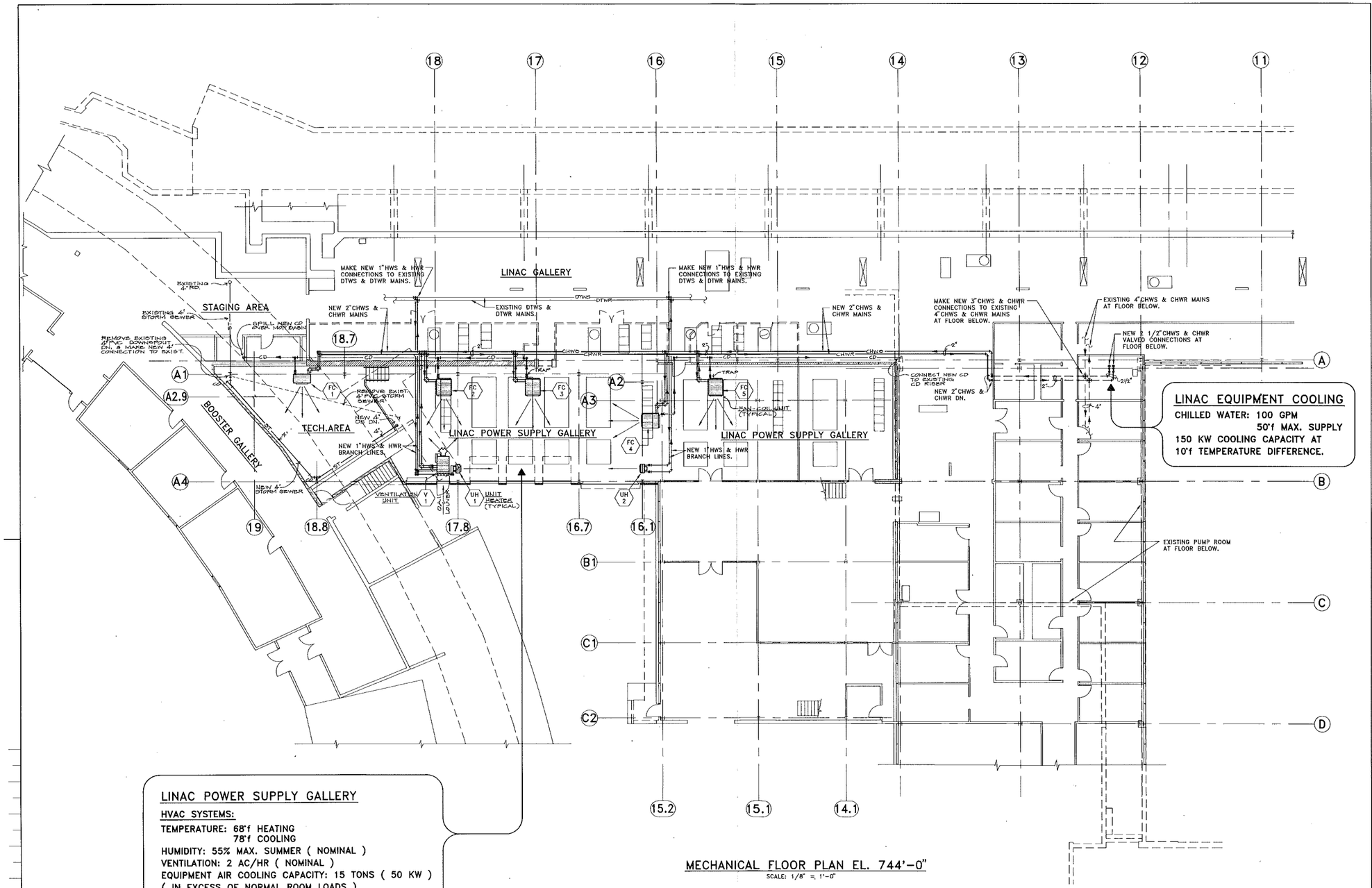


REV.	DATE	DESCRIPTIONS
		REVISIONS
DESIGNED		
DRAWN	JTH	
CHECKED		
APPROVED		
SUBMITTED		2-16-90

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

FERMILAB LINAC UPGRADE
LINAC POWER SUPPLY GALLERY
ELEVATIONS AND SECTIONS

DRAWING NO. 4-1-2A TITLE I S-5 REV. 16 FEB. 1990



LINAC POWER SUPPLY GALLERY

HVAC SYSTEMS:

TEMPERATURE: 68'f HEATING
78'f COOLING
HUMIDITY: 55% MAX. SUMMER (NOMINAL)
VENTILATION: 2 AC/HR (NOMINAL)
EQUIPMENT AIR COOLING CAPACITY: 15 TONS (50 KW)
(IN EXCESS OF NORMAL ROOM LOADS)

FIRE PROTECTION:

DETECTION: PULL STATION AND FLOW SWITCH
SUPPRESSION: OVERHEAD WET SPRINKLER SYSTEM
DESIGNED FOR NFPA STANDARD 13,
ORDINARY HAZARD OCCUPANCY GROUP 2,
0.19 GPM PER SQ.FT. DENSITY
OVER THE MOST REMOTE 1500 SQ.FT.

MECHANICAL FLOOR PLAN EL. 744'-0"

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

REV.	DATE	DESCRIPTIONS
		REVISIONS
DESIGNED	S.KRSTULOVICH	2-16-90
DRAWN	M.OLSON	2-16-90
CHECKED		2-16-90
APPROVED		2-16-90
SUBMITTED		2-16-90

PROJECT NORTH

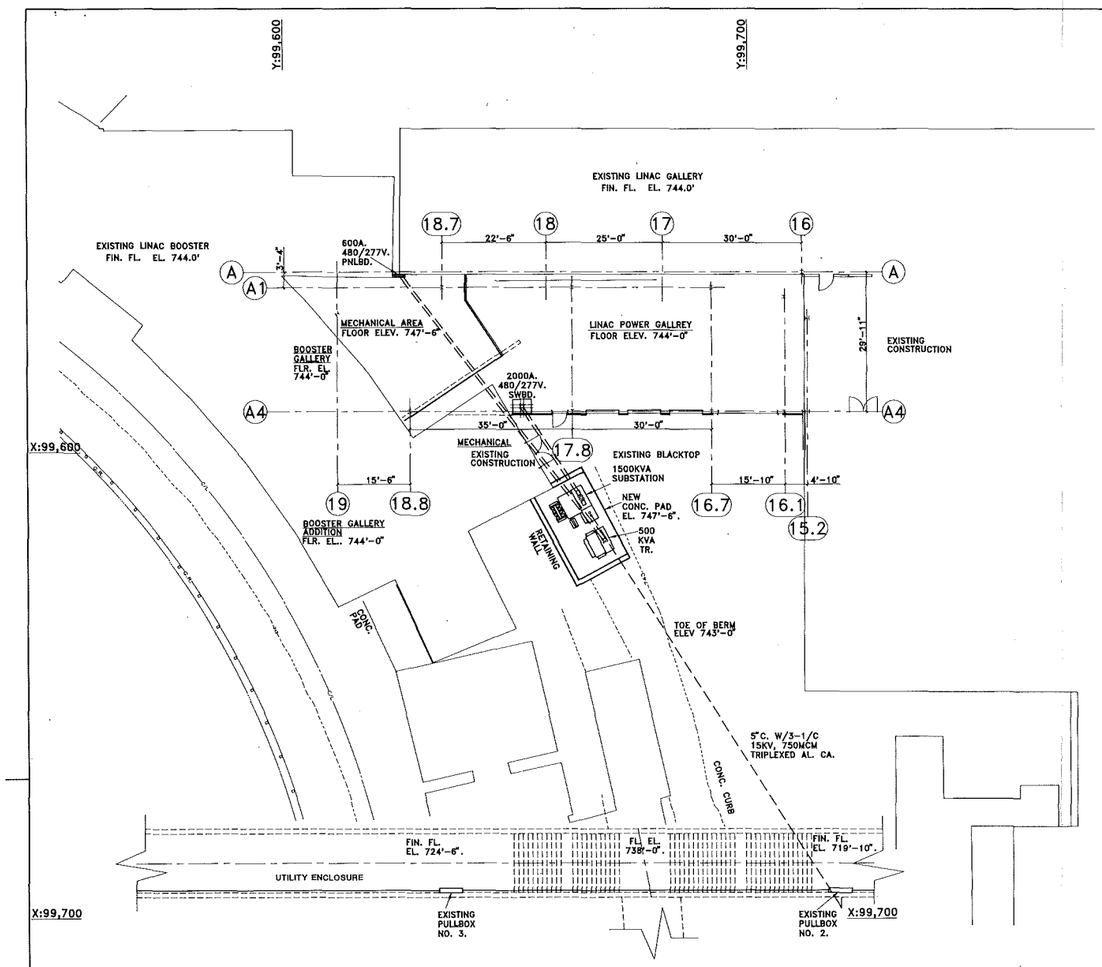
SCALE: 1/8"=1'-0" 0 4 8 12 16 20 SCALE FEET

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

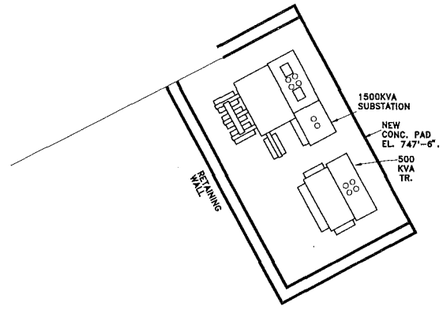
FERMILAB LINAC UPGRADE
LINAC POWER SUPPLY GALLERY
MECHANICAL FLOOR PLAN & CRITERIA

DRAWING NO. 4-1-2A TITLE I M-1 REV.

16 FEB. 1990



POWER DISTRIBUTION PLAN
SCALE: 1" = 10'-0".



ENLARGED SUBSTATION PLAN
SCALE: 1/4" = 1'-0".

REV.	DATE	DESCRIPTIONS
		REVISIONS
DESIGNED		A.R.FLOWERS 2-16-90
DRAWN		L.L.EVEN/A.R.FLOWERS 2-16-90
CHECKED		2-16-90
APPROVED		2-16-90
SUBMITTED		2-16-90

PROJECT NORTH

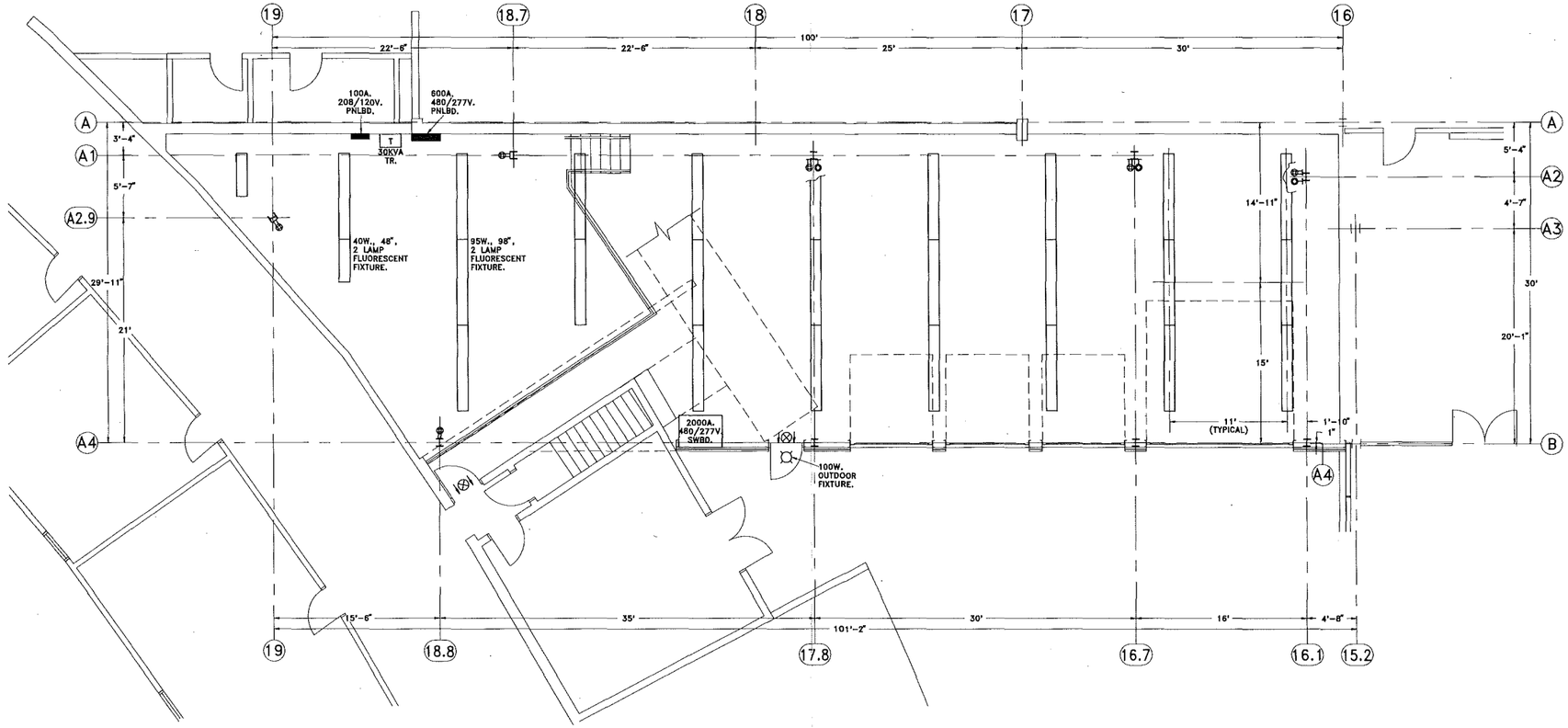
SCALES:
1" = 10'-0" SCALE 10 0 10 20 FEET
1/4"=1'-0" SCALE 0 4 8 FEET

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

FERMILAB LINAC UPGRADE
LINAC POWER SUPPLY GALLERY
ELECTRICAL POWER DISTRIBUTION PLAN

DRAWING NO. 4-1-2A TITLE 1 E-1 REV.

15 FEB. 1990



ELECTRICAL GROUND FLOOR PLAN
SCALE: 1/4" = 1'-0"

TOP MAIN SLAB EL.744'-0"
TOP RAISED SLAB EL.747'-6"
TOP ROOF SLAB EL.758'-0"
TYP. ROOF BM. W16

REV.	DATE	DESCRIPTIONS
		REVISIONS
DESIGNED	A.R.FLOWERS	2-16-90
DRAWN	J.BANKS/A.R.FLOWERS	2-16-90
CHECKED		2-16-90
APPROVED		2-16-90
SUBMITTED		2-16-90

PROJECT NORTH

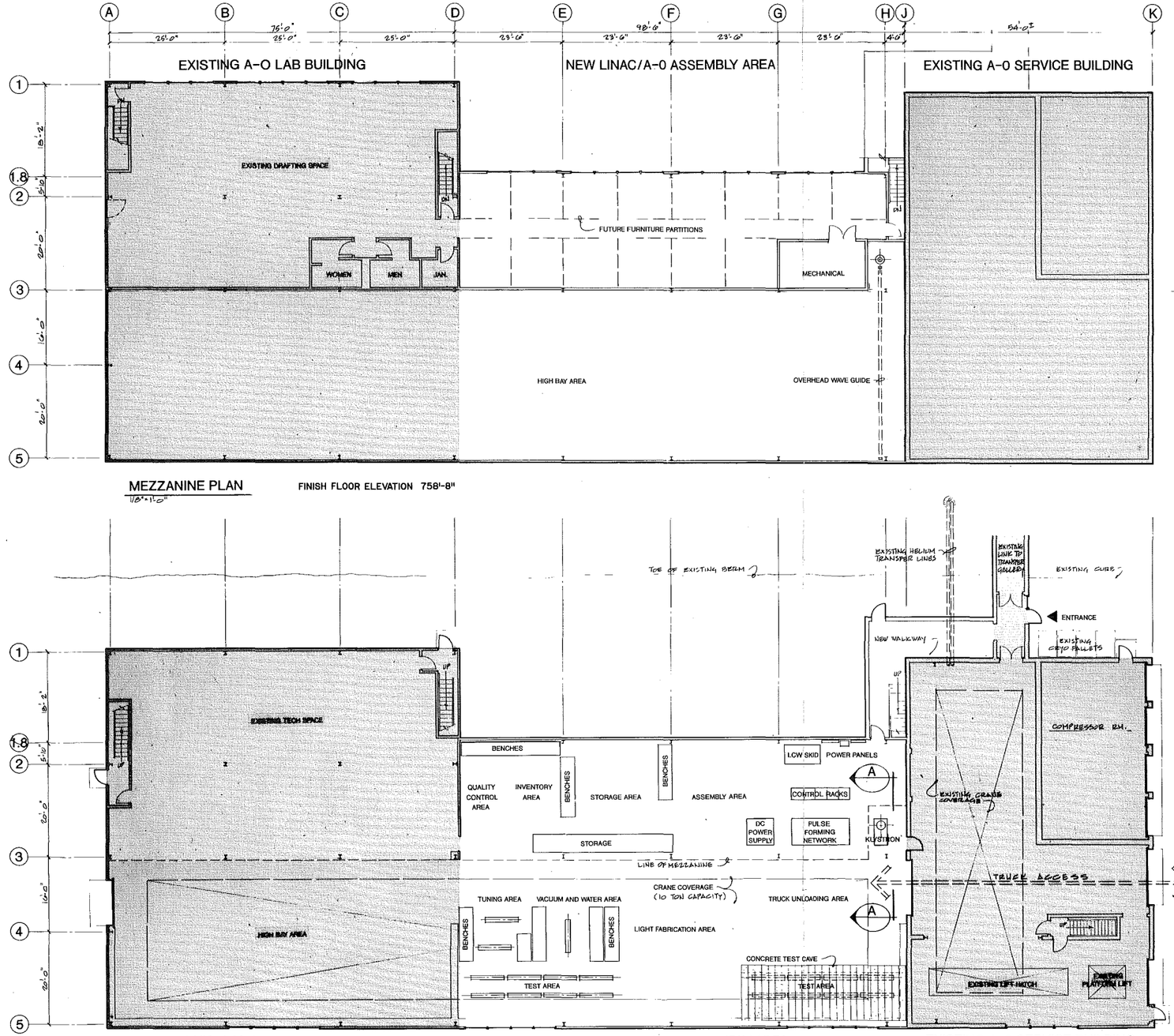
SCALE: 1/4"=1'-0" SCALE 4 0 4 8 FEET

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

FERMILAB LINAC UPGRADE
LINAC POWER SUPPLY GALLERY
ELECTRICAL PLAN

DRAWING NO. 4-1-2A TITLE 1 E-2 REV.

16 FEB. 1990



REV.	DATE	DESCRIPTIONS
		REVISIONS
DESIGNED		
DRAWN		
CHECKED		
APPROVED		
SUBMITTED		

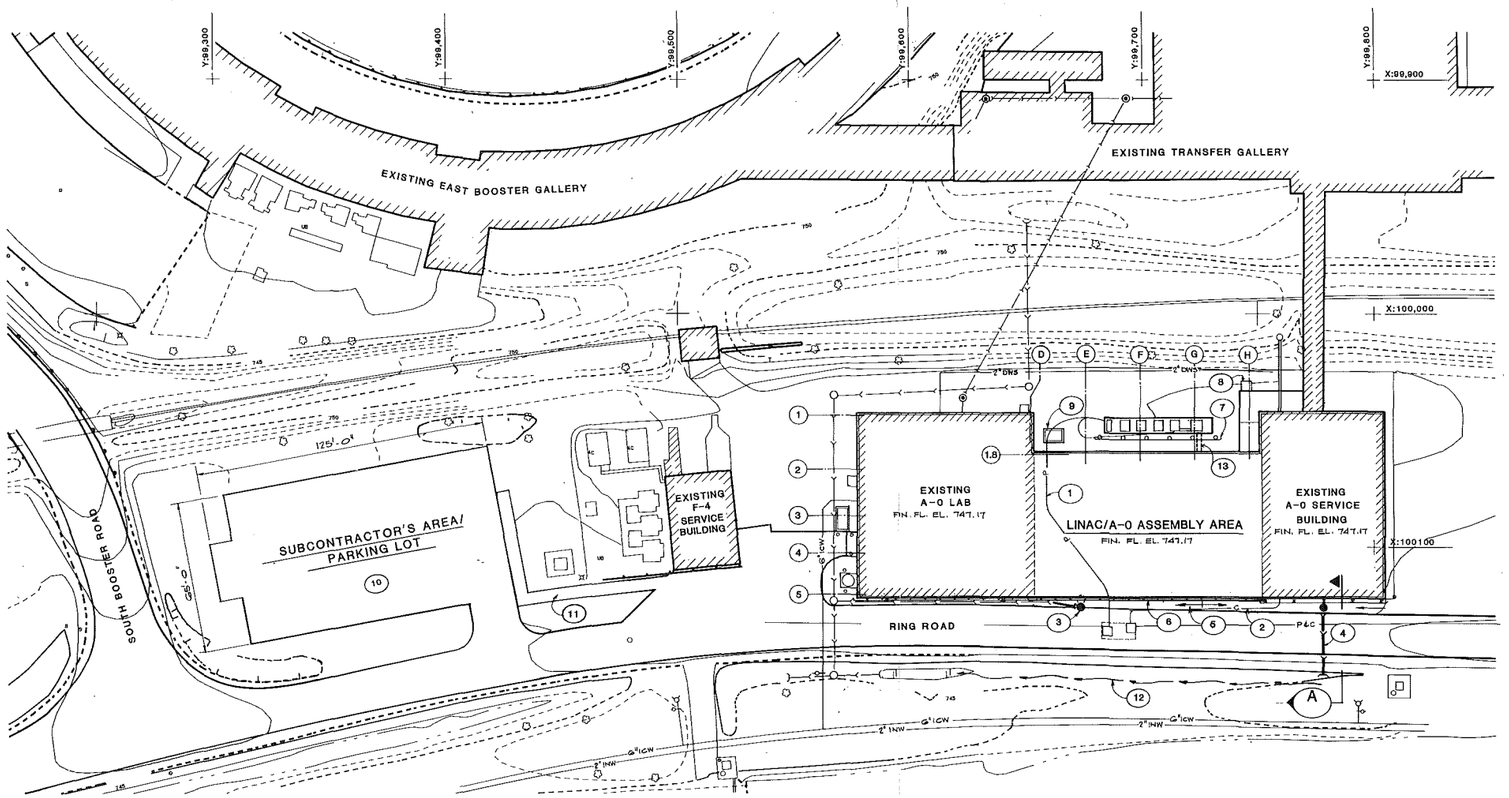
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

FERMILAB LINAC UPGRADE

LINAC/A-O ASSEMBLY AREA EQUIPMENT PLAN

DRAWING NO. 4-1-2B TITLE I EQ-1 REV.

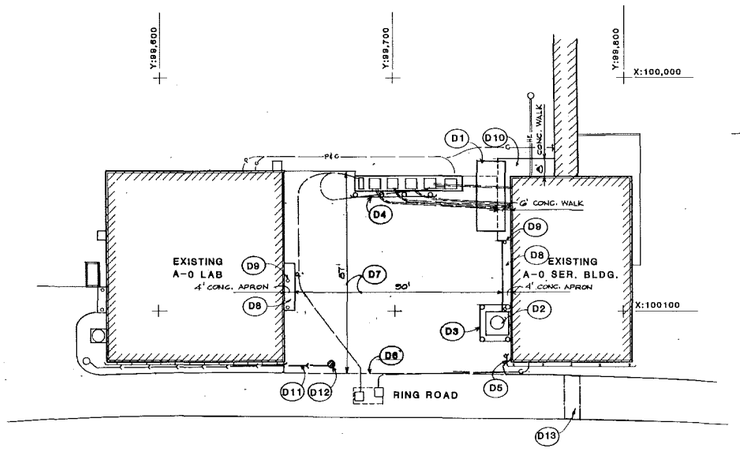
18 FEB. 1990



SITEWORK:

1. PROTECT EXISTING UNDERGROUND CONCRETE ENCASED 13.8K POWER DUCT.
2. PROTECT UNDERGROUND CONCRETE ENCASED COMMUNICATION DUCT.
3. PROVIDE 20 L.F. OF 10" CMP STORM SEWER AND REINSTALL CATCH BASIN TO INTERCEPT PAVED SWALE.
4. PROVIDE CATCH BASIN TO INTERCEPT PAVED SWALE AND 30 L.F. OF 12" CMP STORM SEWER WITH END SECTION. REPAIR RING ROAD.
5. CONSTRUCT 150 L.F. OF PAVED SWALE BETWEEN EDGE OF RING ROAD PAVEMENT AND BUILDING FOUNDATIONS.
6. PROVIDE 100 L.F. OF GUARDRAIL WOUNTED TO FOUNDATION WALL.
7. REINSTALL GUARDRAIL AND CONCRETE SUPPORTS. ADD 12.5 L.F. OF NEW GUARDRAIL AND ONE CONCRETE SUPPORT.
8. CONSTRUCT 4' x 4' CONCRETE STOOP AT PERSONNEL DOOR.
9. CONSTRUCT 5' X 9' CONCRETE PAD FOR CHILLER.
10. EXTEND EXISTING HARDSTAND WITH 18" THICK CRUSHED STONE. PROVIDE 3" THICK BITUMINOUS PAVING AT CONCLUSION OF WORK.
11. PROVIDE 5' WIDE WALK CONSISTING OF 8" CRUSHED STONE BASE AND 2" BITUMINOUS PAVEMENT.
12. REGRADE 150 L.F. OF EXISTING DITCH.
13. CONSTRUCT 3-5" PVC CONDUITS ENCASED IN CONCRETE.

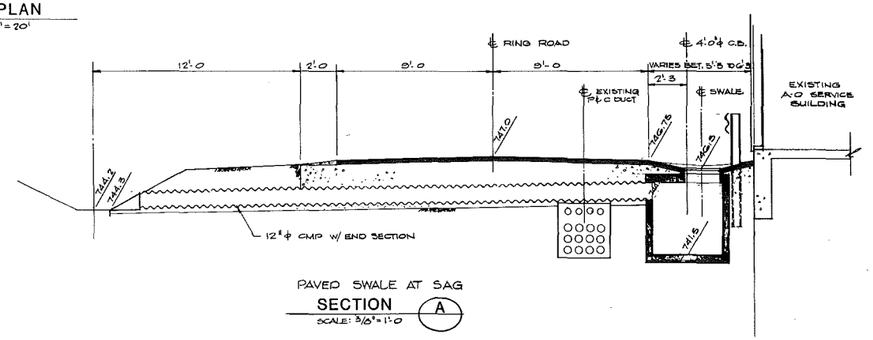
SITE PLAN
SCALE: 1"=20'



DEMOLITION WORK:

- D1 TRAILER RELOCATED BY FERMILAB.
- D2 NITROGEN DEWAR RELOCATED BY FERMILAB.
- D3 REMOVE 36' OF GUARDRAIL AND 4 CONCRETE SUPPORTS.
- D4 TEMPORARILY REMOVE 38' OF GUARDRAIL AND 4 CONCRETE SUPPORTS.
- D5 REMOVE 5' OF GUARDRAIL AND 3 POSTS.
- D6 SAWCUT 100' OF BITUMINOUS PAVEMENT.
- D7 DEMOLISH 925 S.Y. OF BITUMINOUS PAVEMENT (SHADED).
- D8 DEMOLISH CONCRETE APRONS.
- D9 REMOVE 5 BUMPER POSTS.
- D10 DEMOLISH CONCRETE WALK.
- D11 REMOVE 20' OF 10" CMP.
- D12 REMOVE CATCH BASIN, FRAME AND GRATE.
- D13 REMOVE BITUMINOUS PAVEMENT AT STORM SEWER CROSSING (SHADED).

DEMOLITION PLAN
SCALE: 1"=20'



PAVED SWALE AT SAG
SECTION A
SCALE: 3/8"=1'-0

REV.	DATE	DESCRIPTIONS
		REVISIONS
DESIGNED		T. PAWLAK
DRAWN		T. PAWLAK
CHECKED		
APPROVED		
SUBMITTED		

PROJECT NORTH

1"- 20'-0" Scale 20 0 20 40 Feet

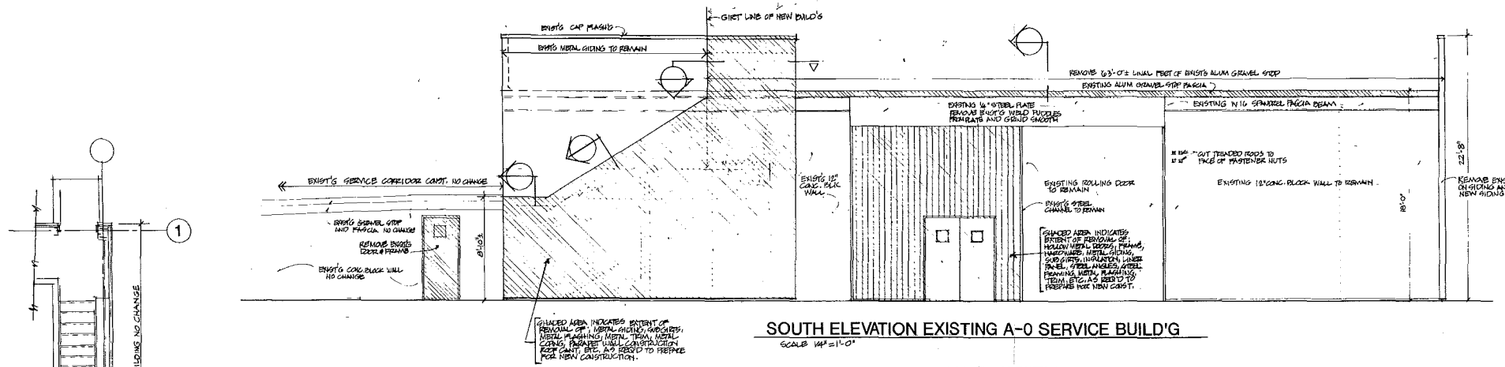
3/8":1'-0" Scale 0 2 4 6 Feet

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

FERMILAB LINAC UPGRADE
LINAC/A-0 ASSEMBLY AREA
SITE AND DEMOLITION PLAN

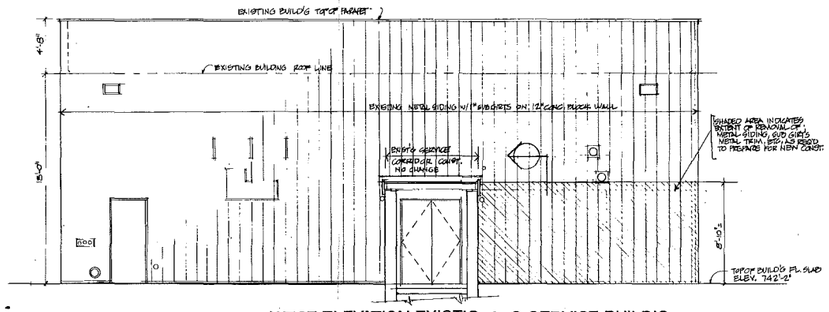
DRAWING NO. 4-1-2B TITLE I C-1 REV.

16 FEB. 1990



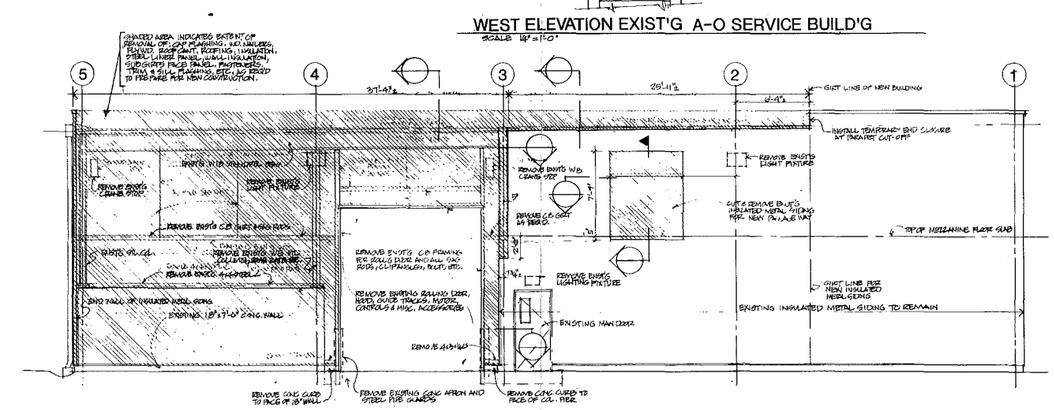
SOUTH ELEVATION EXISTING A-0 SERVICE BUILD'G

SCALE 1/8" = 1'-0"



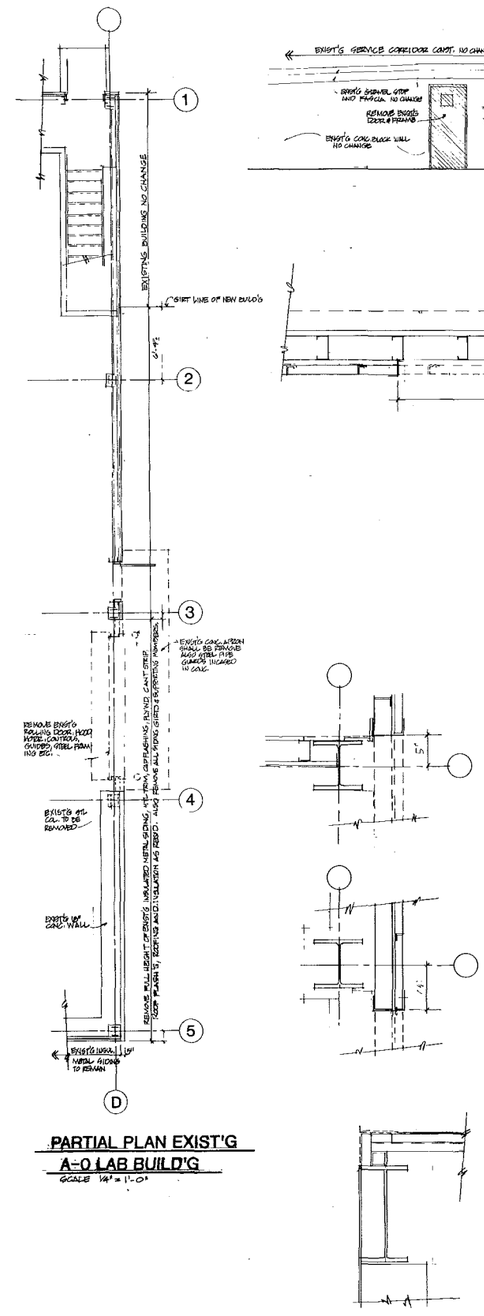
WEST ELEVATION EXIST'G A-0 SERVICE BUILD'G

SCALE 1/8" = 1'-0"



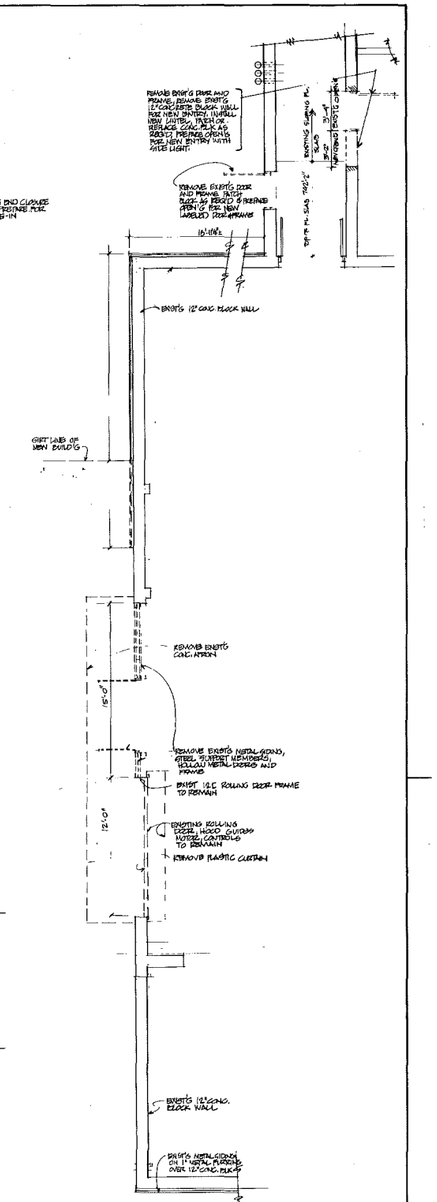
NORTH ELEVATION EXIST'G A-0 LAB BUILD'G

SCALE 1/8" = 1'-0"



PARTIAL PLAN EXIST'G A-0 LAB BUILD'G

SCALE 1/4" = 1'-0"



PARTIAL PLAN EXIST'G A-0 SERVICE BUILD'G

SCALE 1/4" = 1'-0"

REV.	DATE	DESCRIPTIONS
		REVISIONS
DESIGNED		
DRAWN		
CHECKED		
APPROVED		
SUBMITTED		

PROJECT NORTH

1/4"=1'-0" Scale 0 4 8 Feet

1/2"=1'-0" Scale 0 Feet

FERMI NATIONAL ACCELERATOR LABORATORY

UNITED STATES DEPARTMENT OF ENERGY

FERMILAB LINAC UPGRADE

LINAC/A-0 ASSEMBLY AREA

DEMOLITION PLANS, ELEVATIONS

DRAWING NO. 4-1-2B TITLE I D-1 REV.

EXIST'G SERVICE CORRIDOR TO CROSS GALLERY

EXIST'G A-0 LAB BUILD'G

EXISTING A-0 SERVICE BUILD'G

NEW PASSAGEWAY

SERVICE AREA

KLYSTRON AREA

HIGH BAY ASSEMBLY AREA

EXISTS 8" HIGH CURB

EXISTING STEEL EQUIP. PADS.

NEW 8" CONCRETE BLOCK INFILL WALL

EDGE OF MEZZANINE FLOOR SLAB ABOVE

CRANE (TYP.)

CRANE HOOK @ EL. 747'-0" (TYP.)

EXIST'G 1'-0" WIDE BY 7'-0" HIGH CONC. WALL

EXISTING COLUMN AND EDGE PLATES

EXIST'G METAL INSULATED SIDING

NEW 1'-0" WIDE BY 7'-0" HIGH CONC. WALL

EXISTING 12" CONC. BLOCK WALL

EXISTS STEEL COLUMN

EXISTING 2½" DEEP METAL SIDING WITH BACKING ON EXIST'G CONC. BLOCK WALL

GROUND FLOOR PLAN OF ASSEMBLY AREA

PROJECT NORTH

1/4"=1'-0" Scale

0 4 8 Feet

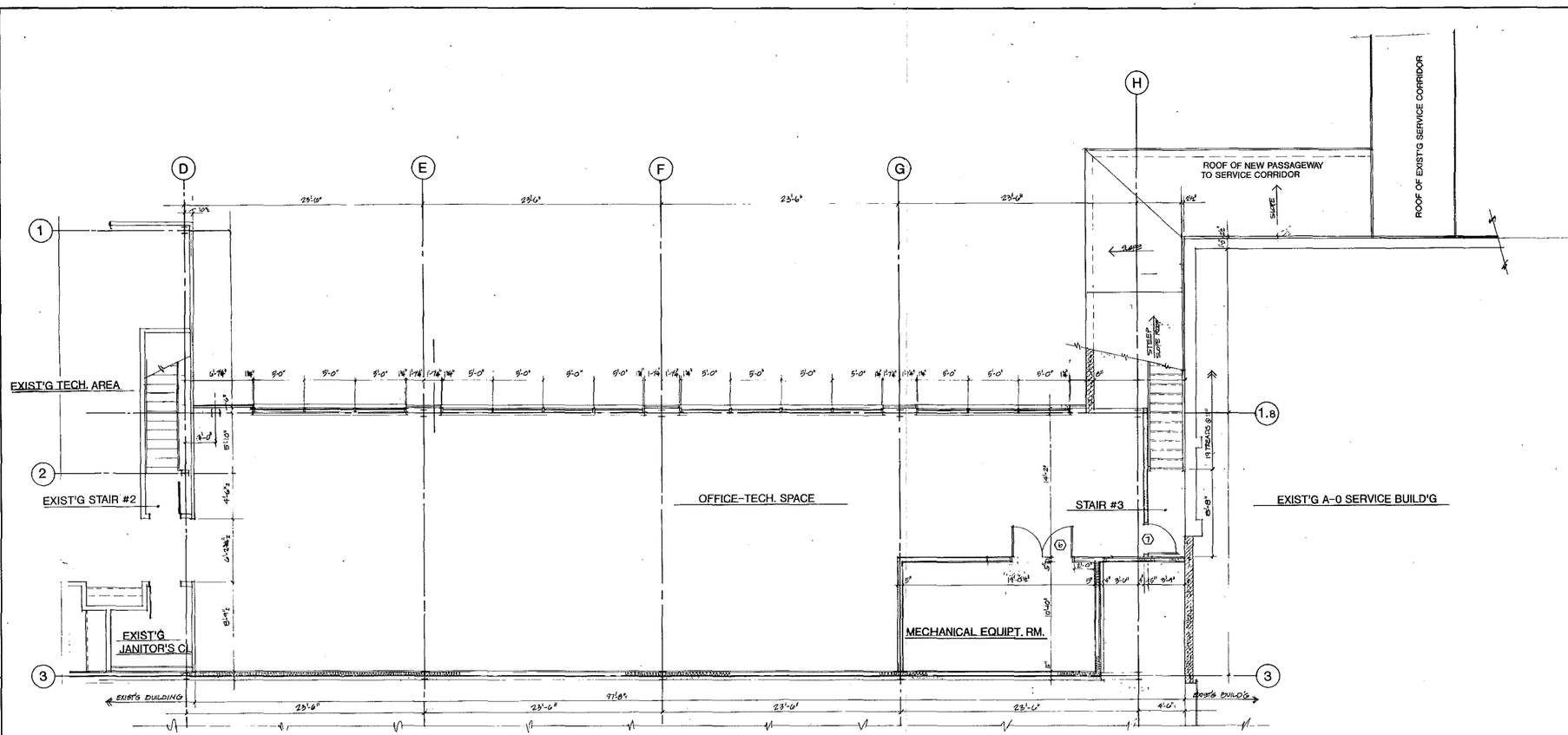
REV.	DATE	DESCRIPTIONS
		REVISIONS
DESIGNED		
DRAWN		
CHECKED		
APPROVED		
SUBMITTED		

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

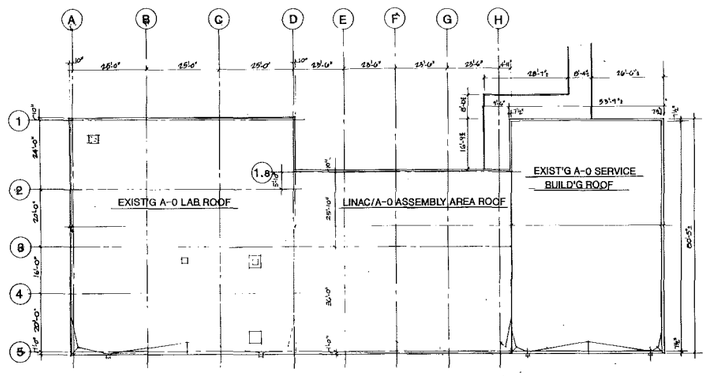
FERMILAB LINAC UPGRADE
LINAC/A-0 ASSEMBLY AREA
GROUND FLOOR PLAN

DRAWING NO. 4-1-2B TITLE I A-1 REV.

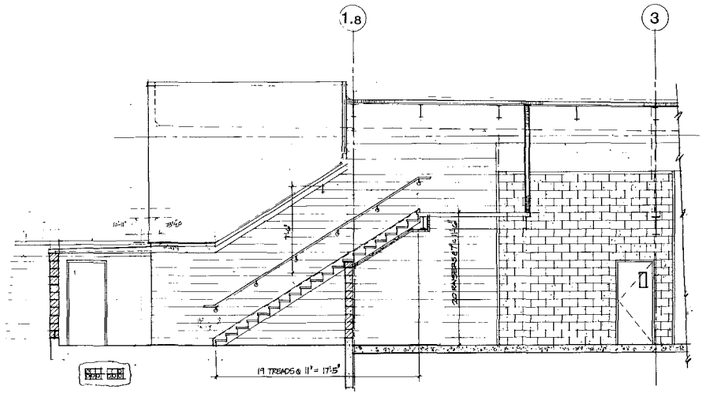
16 FEB. 1990



MEZZANINE PLAN
SCALE 1/8" = 1'-0"



ROOF PLAN OF A-0 BUILDINGS
SCALE 1/16" = 1'-0"



SECTION THRU STAIR #3
SCALE 1/4" = 1'-0"

PROJECT NORTH

1/4"=1'-0" Scale 0 4 8 Feet

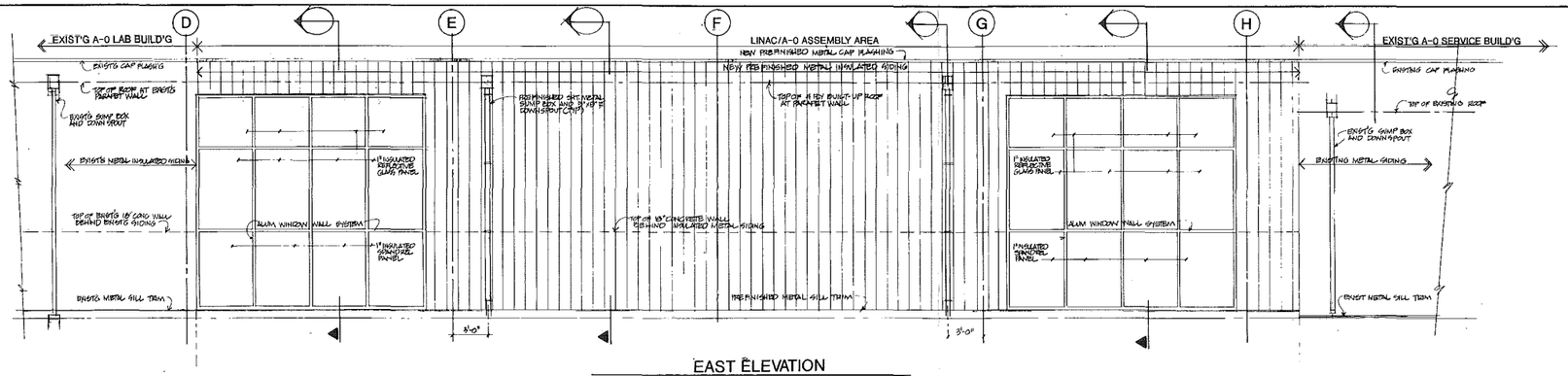
REV.	DATE	DESCRIPTIONS
		REVISIONS
DESIGNED		
DRAWN		
CHECKED		
APPROVED		
SUBMITTED		

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

FERMILAB LINAC UPGRADE
LINAC/A-0 ASSEMBLY AREA
MEZZANINE AND ROOF PLANS-SECTION

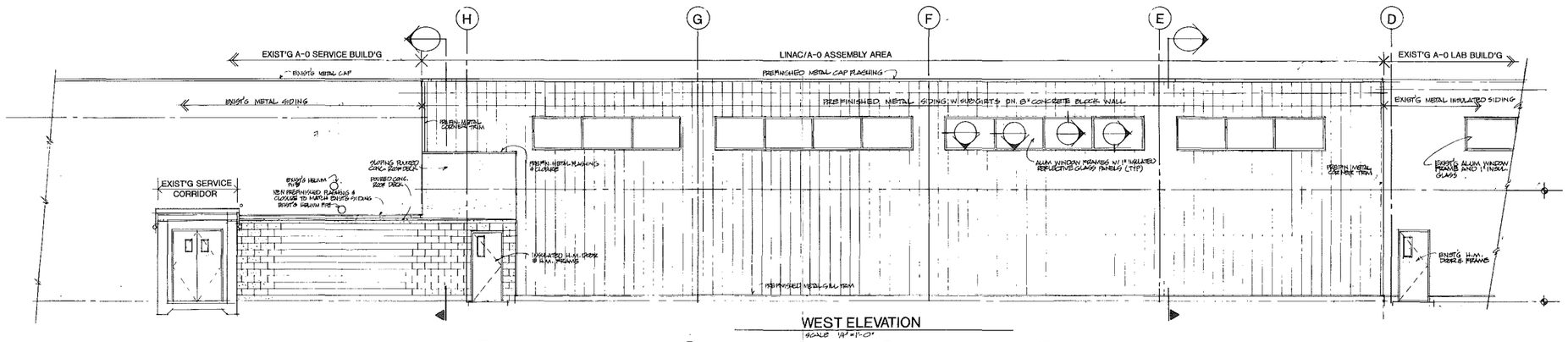
DRAWING NO. 4-1-2B TITLE I A-2 REV.

16 FEB. 2000



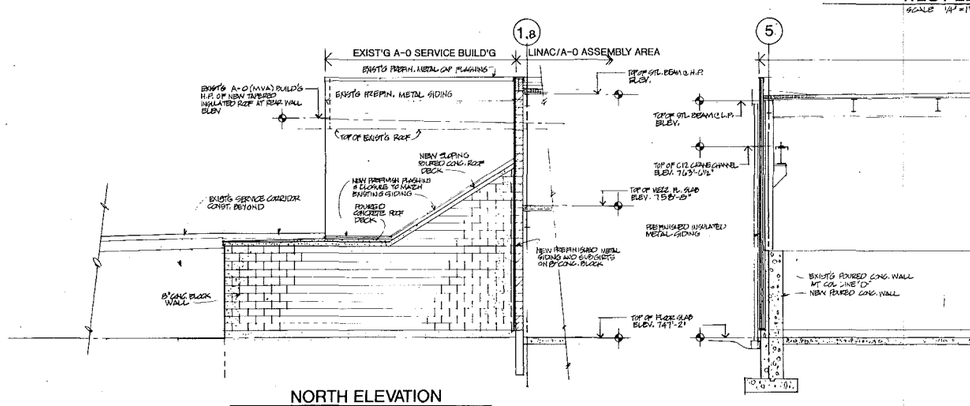
EAST ELEVATION

SCALE 1/4" = 1'-0"



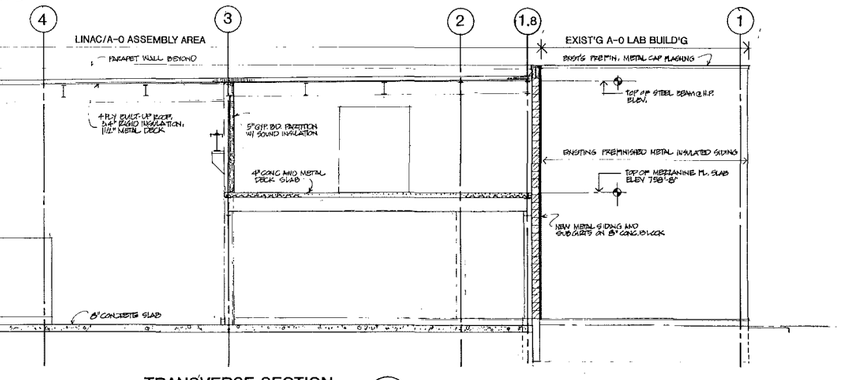
WEST ELEVATION

SCALE 1/4" = 1'-0"



NORTH ELEVATION

SCALE 1/8" = 1'-0"



TRANSVERSE SECTION

SCALE 1/4" = 1'-0"

REV.	DATE	DESCRIPTIONS
		REVISIONS
DESIGNED		
DRAWN		
CHECKED		
APPROVED		
SUBMITTED		

1/4" = 1'-0" Scale 0 4 8 Feet

FERMI NATIONAL ACCELERATOR LABORATORY

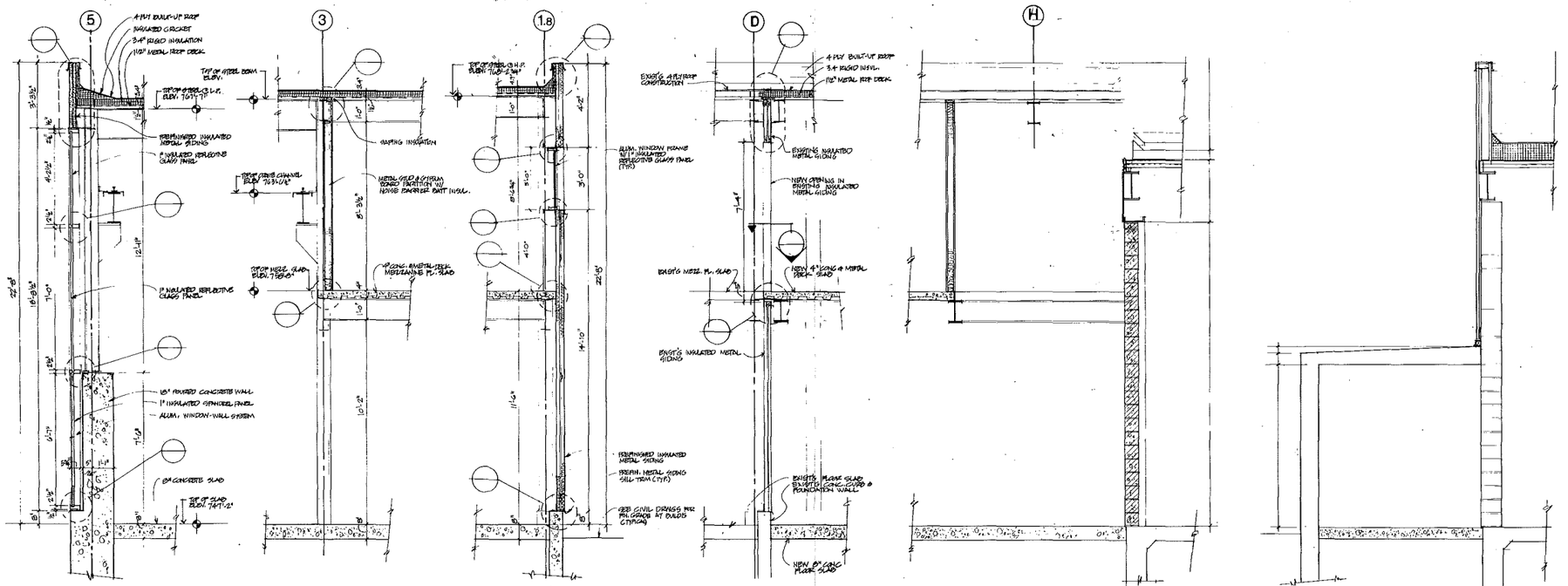
UNITED STATES DEPARTMENT OF ENERGY

FERMILAB LINAC UPGRADE

LINAC/A-0 ASSEMBLY AREA ELEVATIONS AND SECTION

DRAWING NO. 4-1-2B TITLE I A-3 REV.

16 FEB. 1990



SECTION A

SECTION B

SECTION C

SECTION D

SECTION E

SECTION F

1/2"=1'-0" Scale 0 1 2 3 4 5 Feet

1 1/2"=1'-0" Scale 0 1 Feet

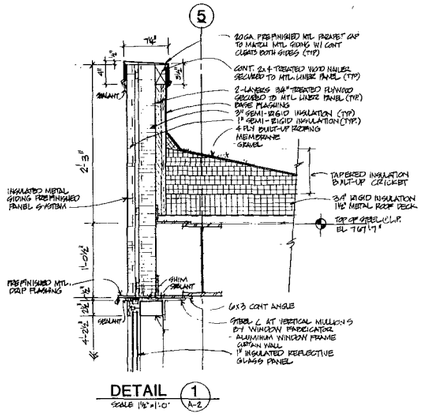
REV.	DATE	DESCRIPTIONS
		REVISIONS
DESIGNED		
DRAWN		
CHECKED		
APPROVED		
SUBMITTED		

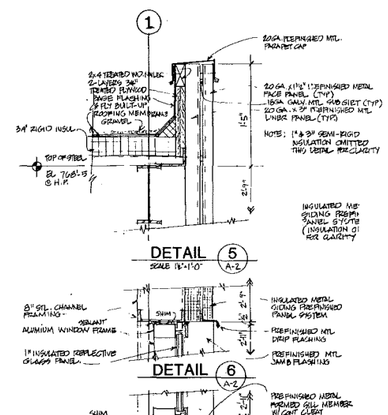
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

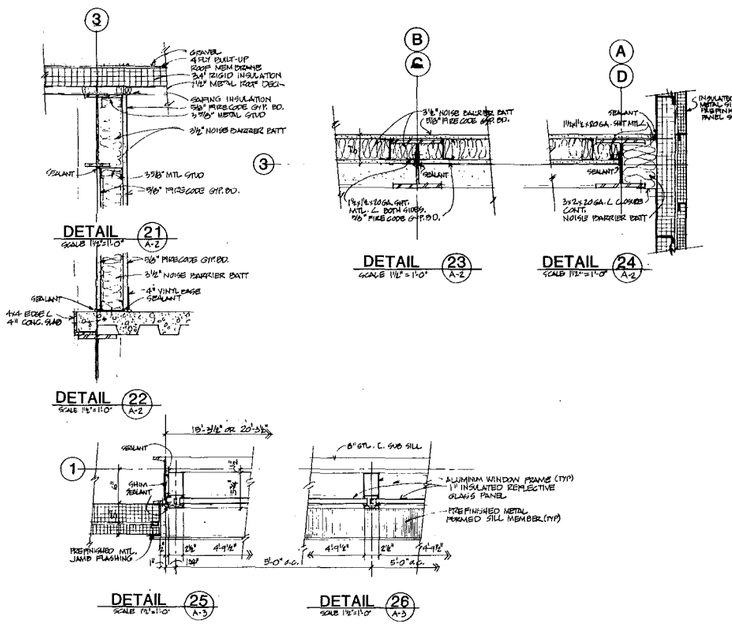
FERMILAB LINAC UPGRADE
LINAC/A-0 ASSEMBLY AREA
WALL SECTIONS AND DETAILS

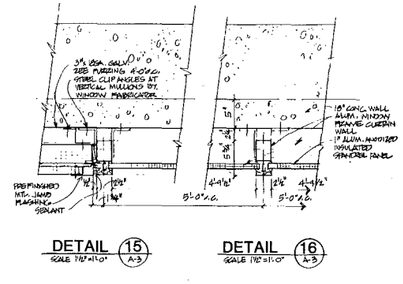
DRAWING NO. 4-1-2B TITLE I A-4 REV.

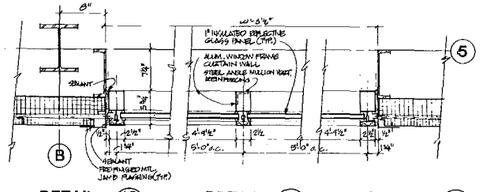
16 FEB. 1990











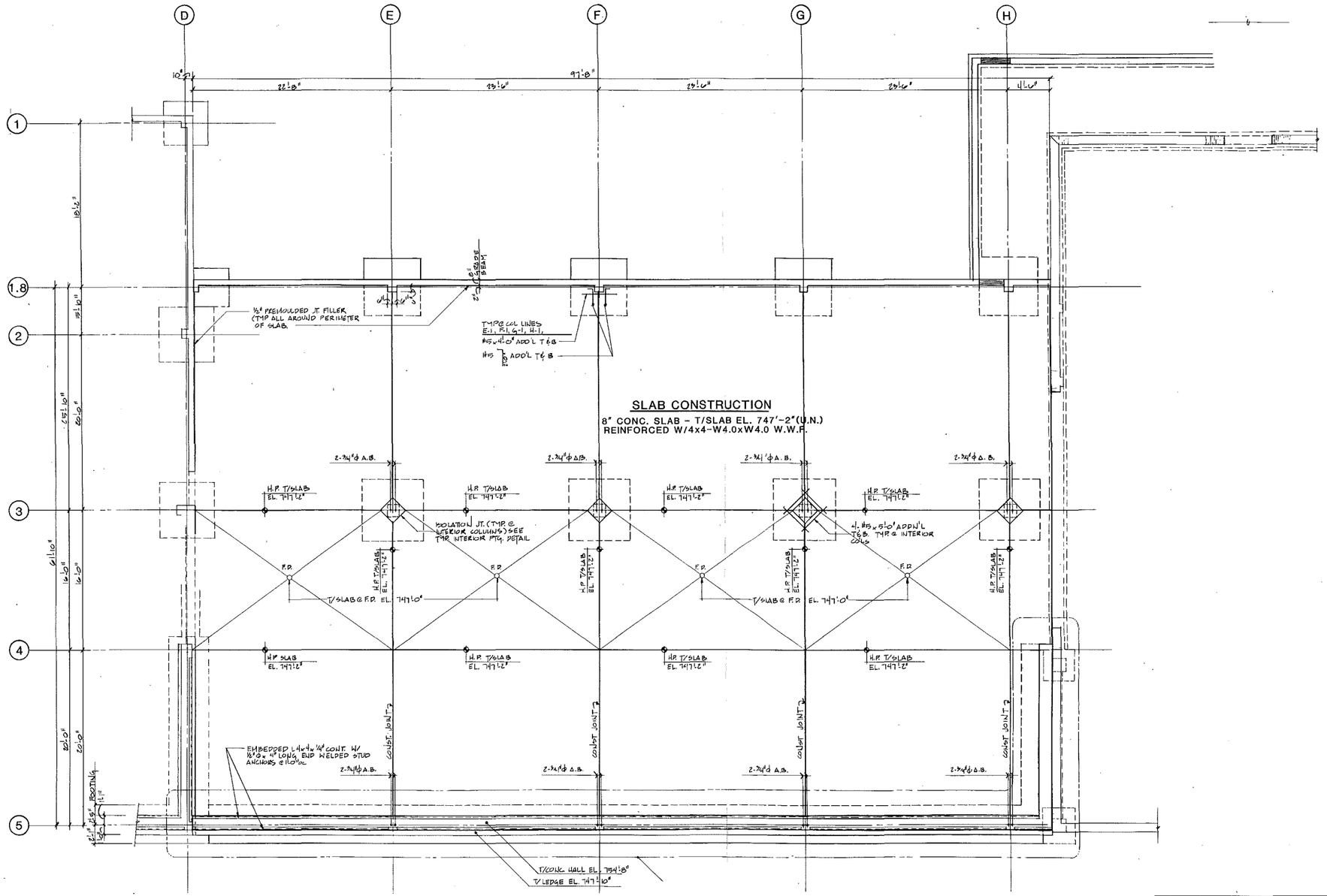
REV.	DATE	DESCRIPTIONS
		REVISIONS
DESIGNED		
DRAWN		
CHECKED		
APPROVED		
SUBMITTED		

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

FERMILAB LINAC UPGRADE
LINAC/A-0 ASSEMBLY AREA
DETAILS

DRAWING NO. 4-1-2B TITLE I A-5 REV.

16 FEB. 1990



SLAB CONSTRUCTION

8" CONC. SLAB – T/SLAB EL. 747'-2" (U.N.)
REINFORCED W/4x4-W4.0xW4.0 W.W.F.

FOUNDATION PLAN

1/4" = 1'-0"

REV.	DATE	DESCRIPTIONS
		REVISIONS
DESIGNED		
DRAWN		
CHECKED		
APPROVED		
SUBMITTED		

PROJECT NORTH

1/4"=1'-0" SCALE 0' 4' 8' FEET

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

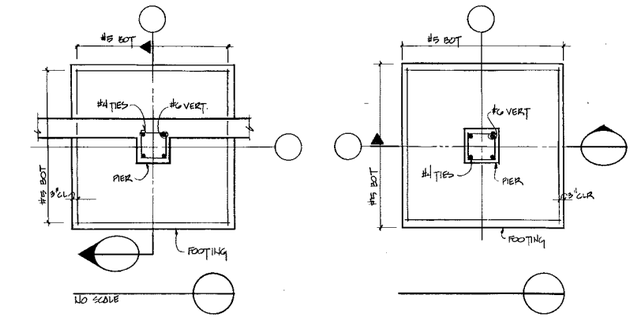
FERMILAB LINAC UPGRADE
LINAC/A-0 ASSEMBLY AREA
FOUNDATION PLAN

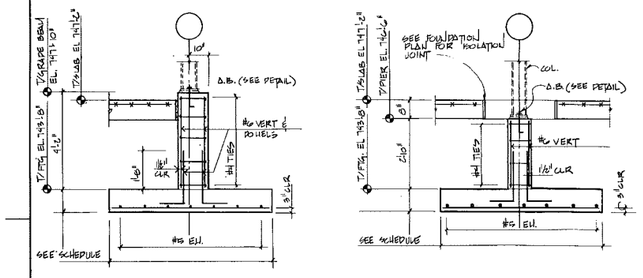
DRAWING NO. 4-1-2B TITLE 1 S-1 REV.

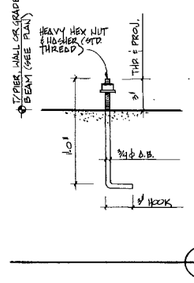
16 FEB. 1990

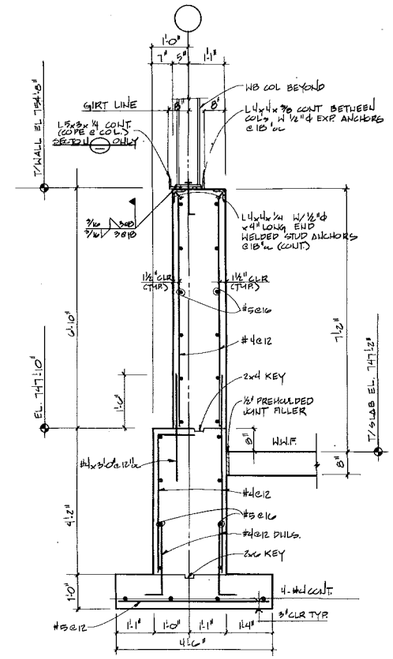
FOOTING SCHEDULE

MARK	FOOTING		PIER			
	SIZE	BOTTOM REINFORCEMENT	DETAIL	SIZE	VERTICAL REINFORCEMENT	TIES









REV.	DATE	DESCRIPTIONS
		REVISIONS
DESIGNED		
DRAWN		
CHECKED		
APPROVED		
SUBMITTED		

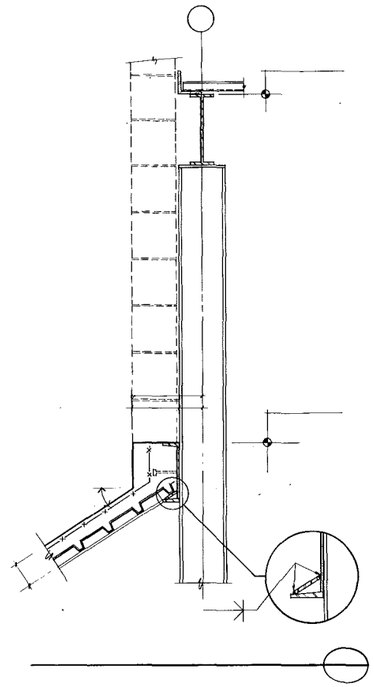
1½"=1'-0" Scale 0 1 Feet

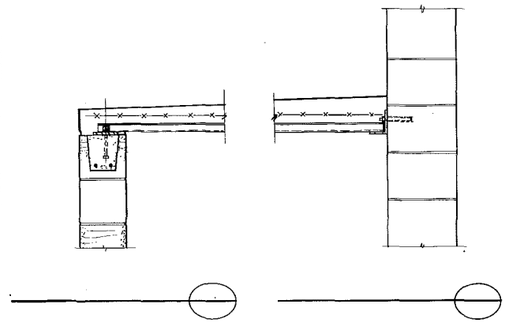
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

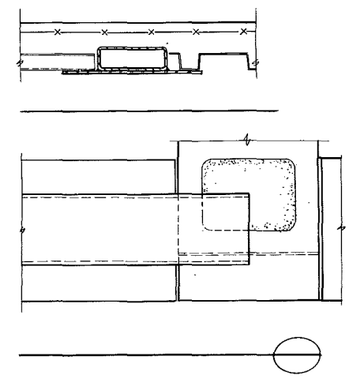
FERMILAB LINAC UPGRADE
LINAC/A-0 ASSEMBLY AREA
CONCRETE SECTIONS AND DETAILS

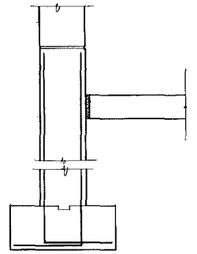
DRAWING NO. 4-1-2B TITLE I S-2 REV.

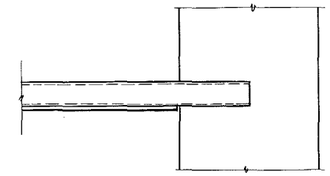
16 FEB. 1990

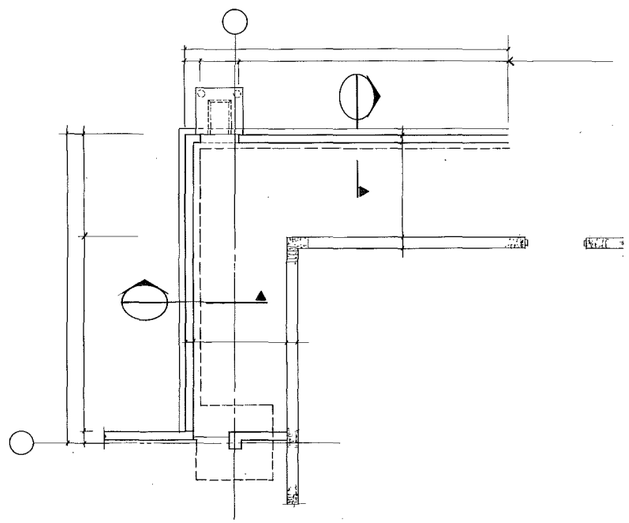


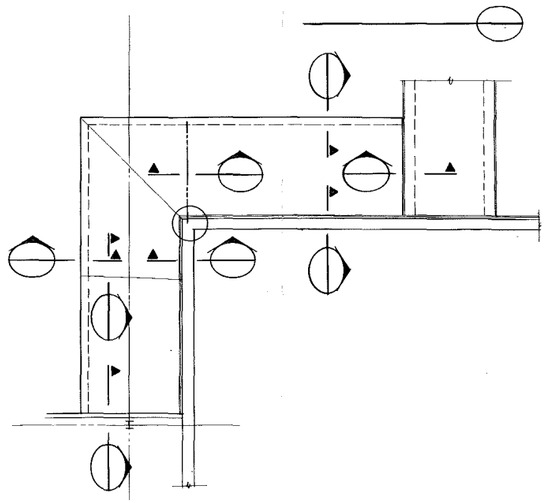












REV.	DATE	DESCRIPTIONS
		REVISIONS

DESIGNED		
DRAWN		
CHECKED		
APPROVED		
SUBMITTED		

PROJECT NORTH

1/4"=1'-0" SCALE FEET

1 1/2"=1'-0" Scale Feet

FERMI NATIONAL ACCELERATOR LABORATORY

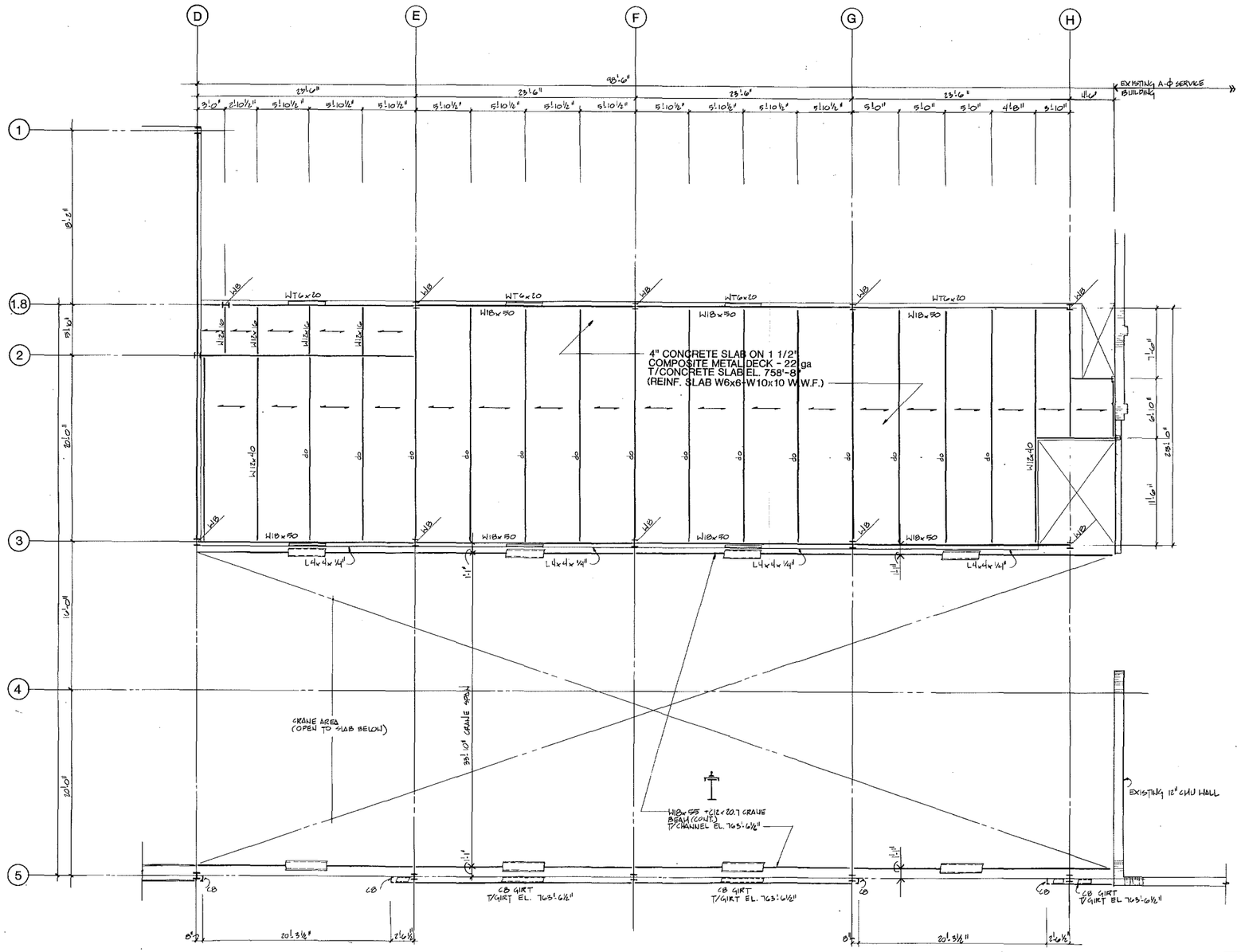
UNITED STATES DEPARTMENT OF ENERGY

FERMILAB LINAC UPGRADE

LINAC/A-0 ASSEMBLY AREA
PASSAGEWAY PLANS AND SECTIONS

DRAWING NO. 4-1-2B TITLE I S-3 REV.

16 FEB. 1990



MEZANINE LEVEL FRAMING PLAN

REV.	DATE	DESCRIPTIONS
		REVISIONS
DESIGNED		
DRAWN		
CHECKED		
APPROVED		
SUBMITTED		

PROJECT NORTH

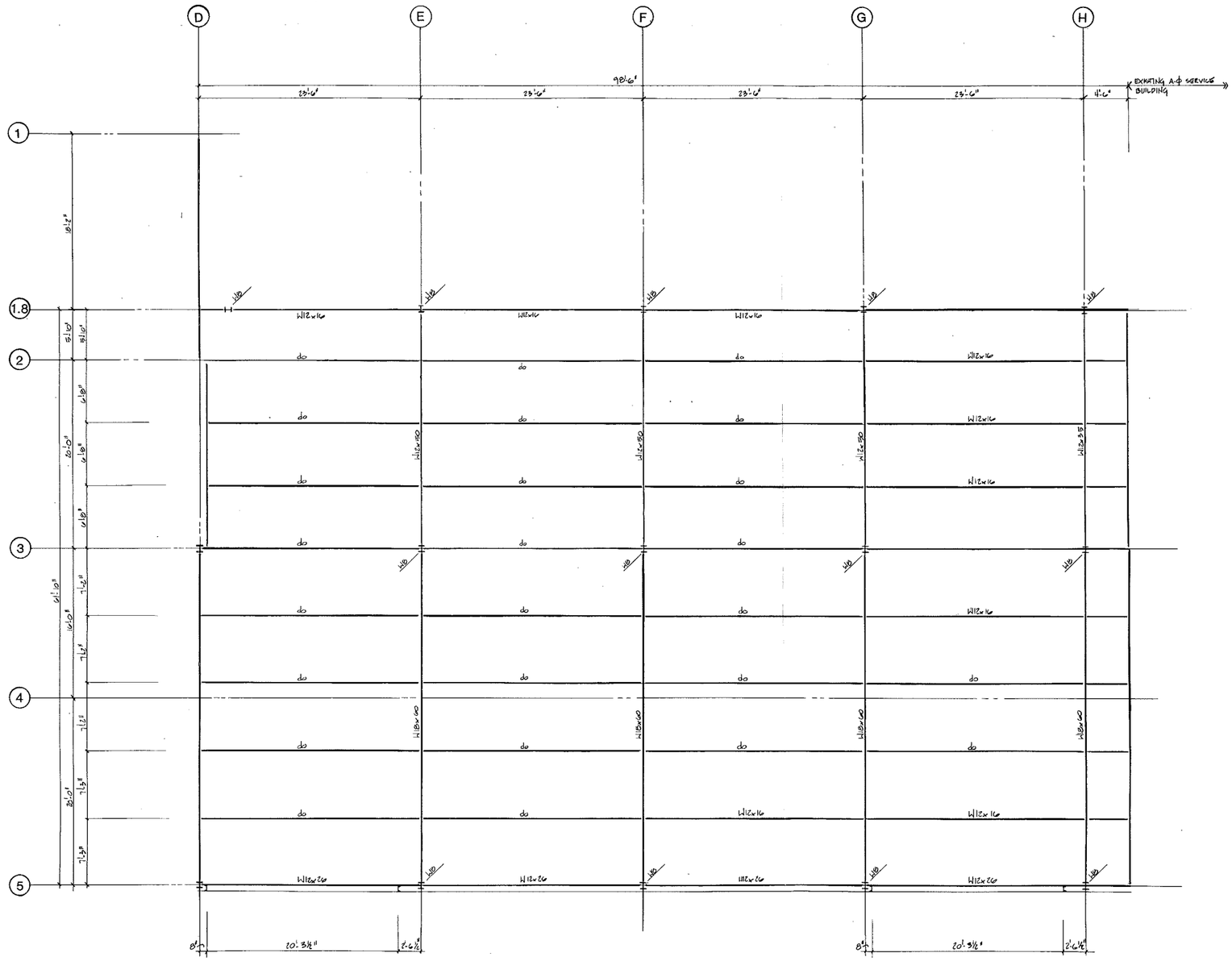
1/4"=1'-0" SCALE

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

FERMILAB LINAC UPGRADE
LINAC/A-0 ASSEMBLY AREA
MEZZANINE FRAMING PLAN

DRAWING NO. 4-1-2B TITLE I S-4 REV.

16 FEB. 1990



ROOF FRAMING PLAN

PROJECT NORTH

1/4"=1'-0" SCALE 0 4 8 FEET

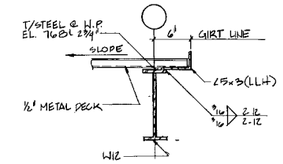
REV.	DATE	DESCRIPTIONS
		REVISIONS
DESIGNED		
DRAWN		
CHECKED		
APPROVED		
SUBMITTED		

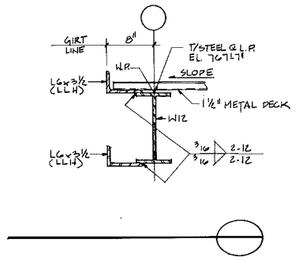
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

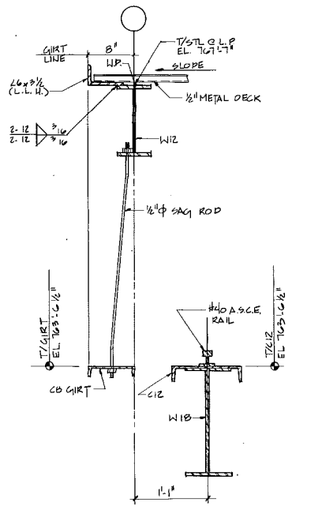
FERMILAB LINAC UPGRADE
LINAC/A-0 ASSEMBLY AREA
ROOF FRAMING PLAN

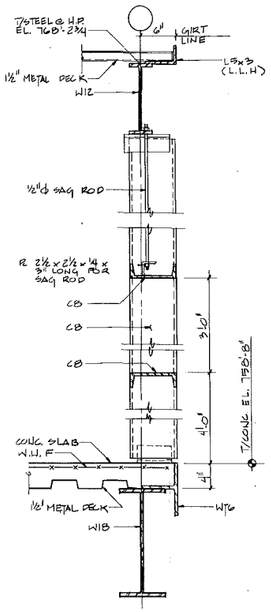
DRAWING NO. 4-1-2B TITLE I S-5 REV.

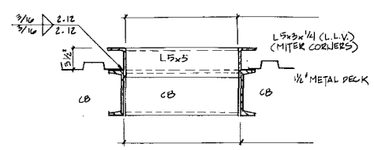
16 FEB. 1990

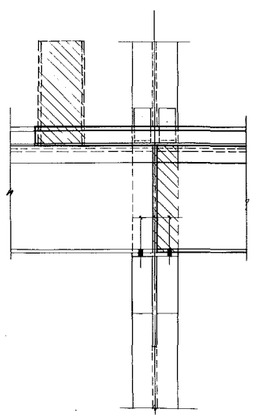


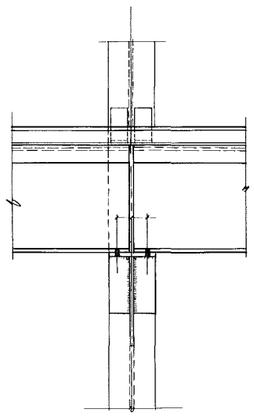


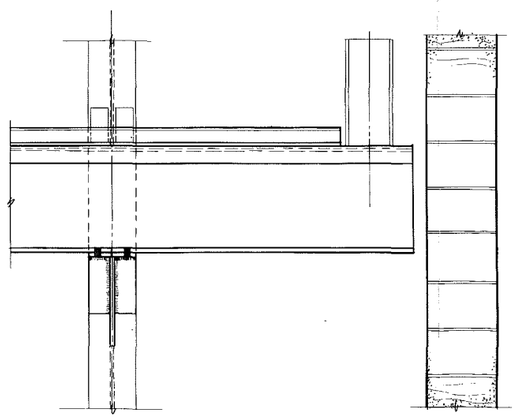


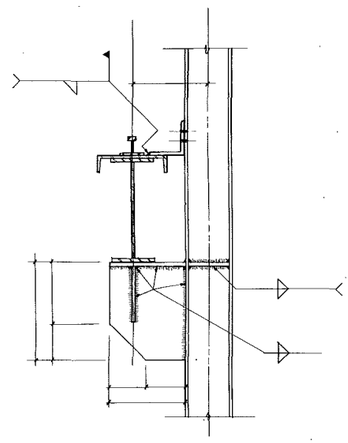












REV.	DATE	DESCRIPTIONS
		REVISIONS
DESIGNED		
DRAWN		
CHECKED		
APPROVED		
SUBMITTED		

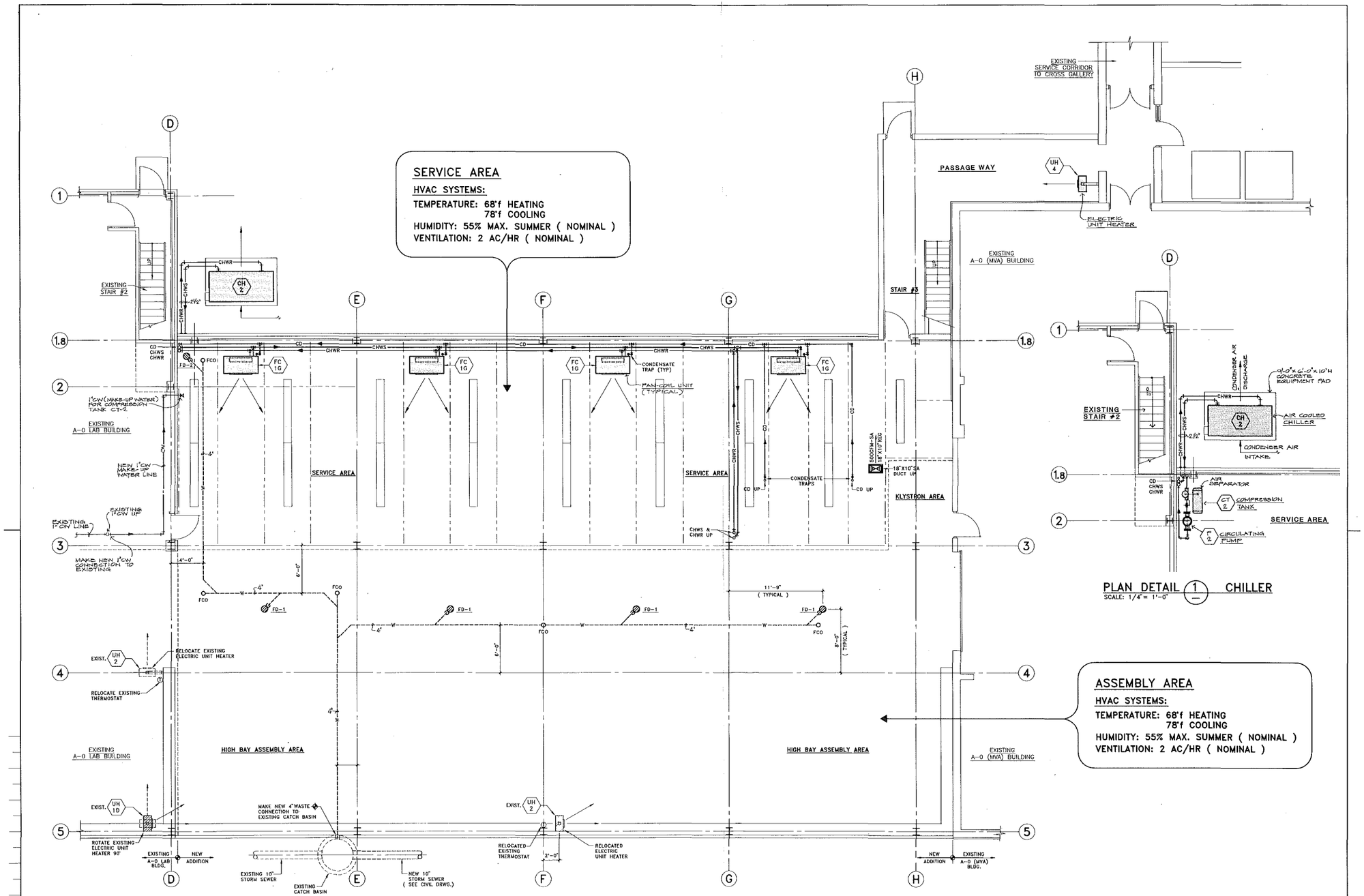
1½"=1'-0" Scale 0 1 Feet

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

FERMILAB LINAC UPGRADE
LINAC/A-0 ASSEMBLY AREA
STEEL SECTIONS AND DETAILS

DRAWING NO. 4-1-2B TITLE I S-6 REV.

16 FEB. 1990



HVAC GROUND FLOOR PLAN
SCALE: 1/4" = 1'-0"

PLAN DETAIL 1 CHILLER
SCALE: 1/4" = 1'-0"

ASSEMBLY AREA
HVAC SYSTEMS:
TEMPERATURE: 68'f HEATING
78'f COOLING
HUMIDITY: 55% MAX. SUMMER (NOMINAL)
VENTILATION: 2 AC/HR (NOMINAL)

REV.	DATE	DESCRIPTIONS
		REVISIONS
DESIGNED		S.KRSTULOVICH 2/16/90
DRAWN		M.OLSON 2/16/90
CHECKED		2/16/90
APPROVED		2/16/90
SUBMITTED		2/16/90

PROJECT NORTH

SCALE: 1/4"=1'-0" (0 4 8 FEET)

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

FERMILAB LINAC UPGRADE
LINAC/A-0 ASSEMBLY AREA
HVAC GROUND FLOOR PLAN & CRITERIA

DRAWING NO. 4-1-2B TITLE I M-1 REV.

16 FEB. 1990

OFFICE – TECH SPACE

HVAC SYSTEMS:

TEMPERATURE: 70'f HEATING
75'f COOLING
HUMIDITY: 55% MAX. SUMMER (NOMINAL)
VENTILATION: 2 AC/HR (NOMINAL)

ASSEMBLY AREA

HVAC SYSTEMS:

TEMPERATURE: 68'f HEATING
78'f COOLING
HUMIDITY: 55% MAX. SUMMER (NOMINAL)
VENTILATION: 2 AC/HR (NOMINAL)

HVAC MEZZANINE FLOOR PLAN

SCALE: 1/4" = 1'-0"

HVAC MECH. EQUIPMT. RM. FLOOR PLAN

SCALE: 1/4" = 1'-0" (AT FLOOR LEVEL)

HVAC MECH. EQUIPMT. RM. FLOOR PLAN

SCALE: 1/4" = 1'-0" (AT ROOF LEVEL)

REV.	DATE	DESCRIPTIONS
		REVISIONS
DESIGNED	S.KRSTULOVICH	2-16-90
DRAWN	M.OLSON	2-16-90
CHECKED		2-16-90
APPROVED		2-16-90
SUBMITTED		2-16-90

SCALE: 1/4"=1'-0" (4 0 4 8 SCALE FEET)

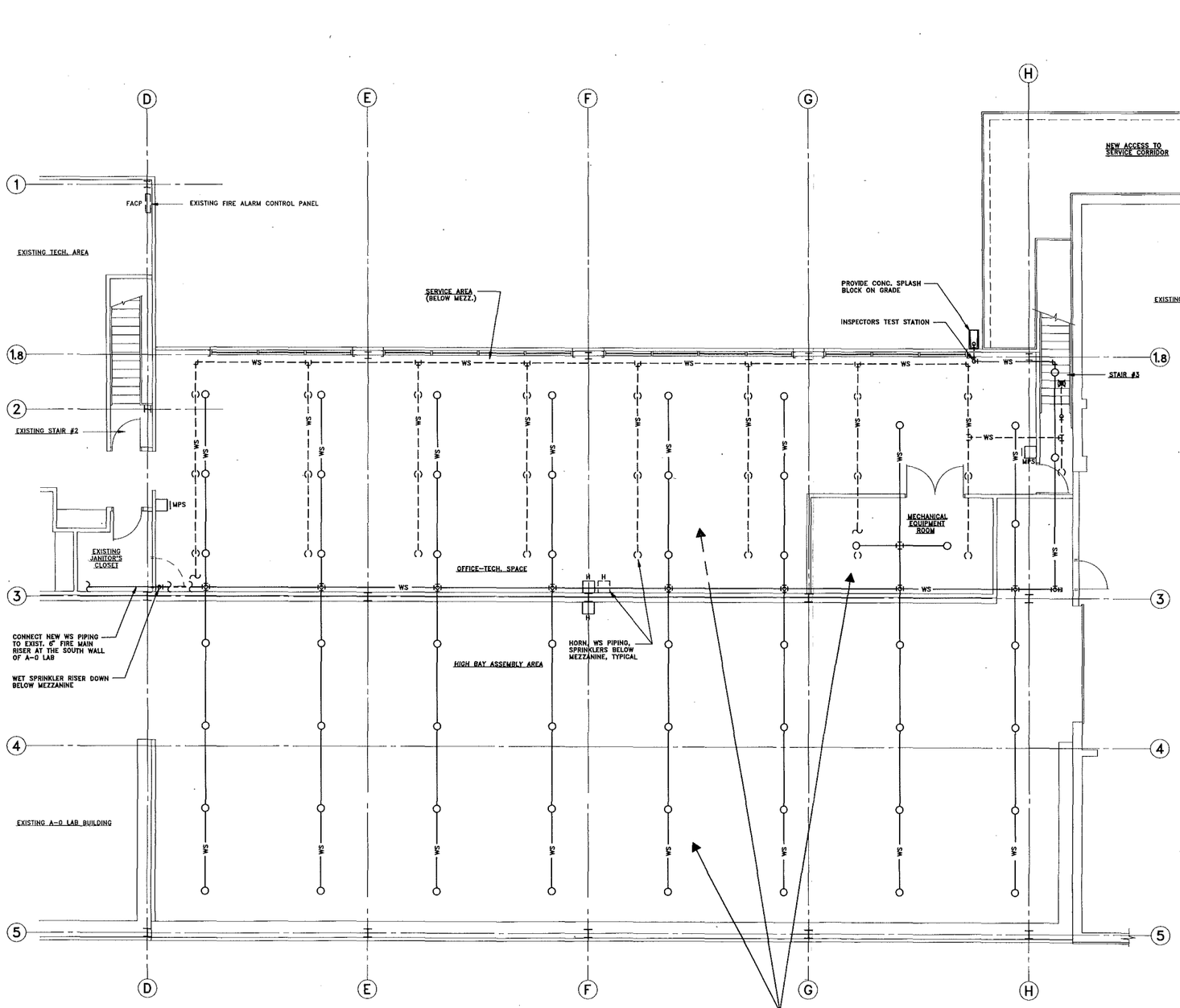
PROJECT NORTH

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

FERMILAB LINAC UPGRADE
LINAC/A-0 ASSEMBLY AREA
HVAC MEZZANINE PLAN & CRITERIA

DRAWING NO. 4-1-2B TITLE I M-2 REV.

16 FEB. 1990



SYMBOL LIST

- UPRIGHT SPRINKLER HEAD
- PENDENT SPRINKLER HEAD IN WIRE CAGE
- WS — WET SPRINKLER PIPING
- ELBOW TO NEAR SIDE
- ELBOW TO FAR SIDE
- BRANCH FROM NEAR SIDE OF TEE
- BRANCH FROM FAR SIDE OF TEE
- BRANCH FROM SIDE OF TEE
- MPS — MANUAL PULL FIRE ALARM STATION
- H — FIRE ALARM HORN ON WALL
- FACP — FIRE PROTECTION PROCESSING UNIT

FIRE PROTECTION PLAN

SCALE: 1/4" = 1'-0"

ASSEMBLY, SERVICE, OFFICE AND TECH. AREAS

FIRE PROTECTION:

DETECTION: PULL STATIONS AND FLOW SWITCH

SUPPRESSION: OVERHEAD WET SPRINKLER SYSTEM DESIGNED FOR NFPA STANDARD 13, ORDINARY HAZARD OCCUPANCY GROUP 2, 0.19 GPM PER SQ. FT. DENSITY OVER THE MOST REMOTE 1500 SQ. FT.

PROJECT NORTH

SCALE: 1/4"=1'-0" (0, 4, 8 FEET)

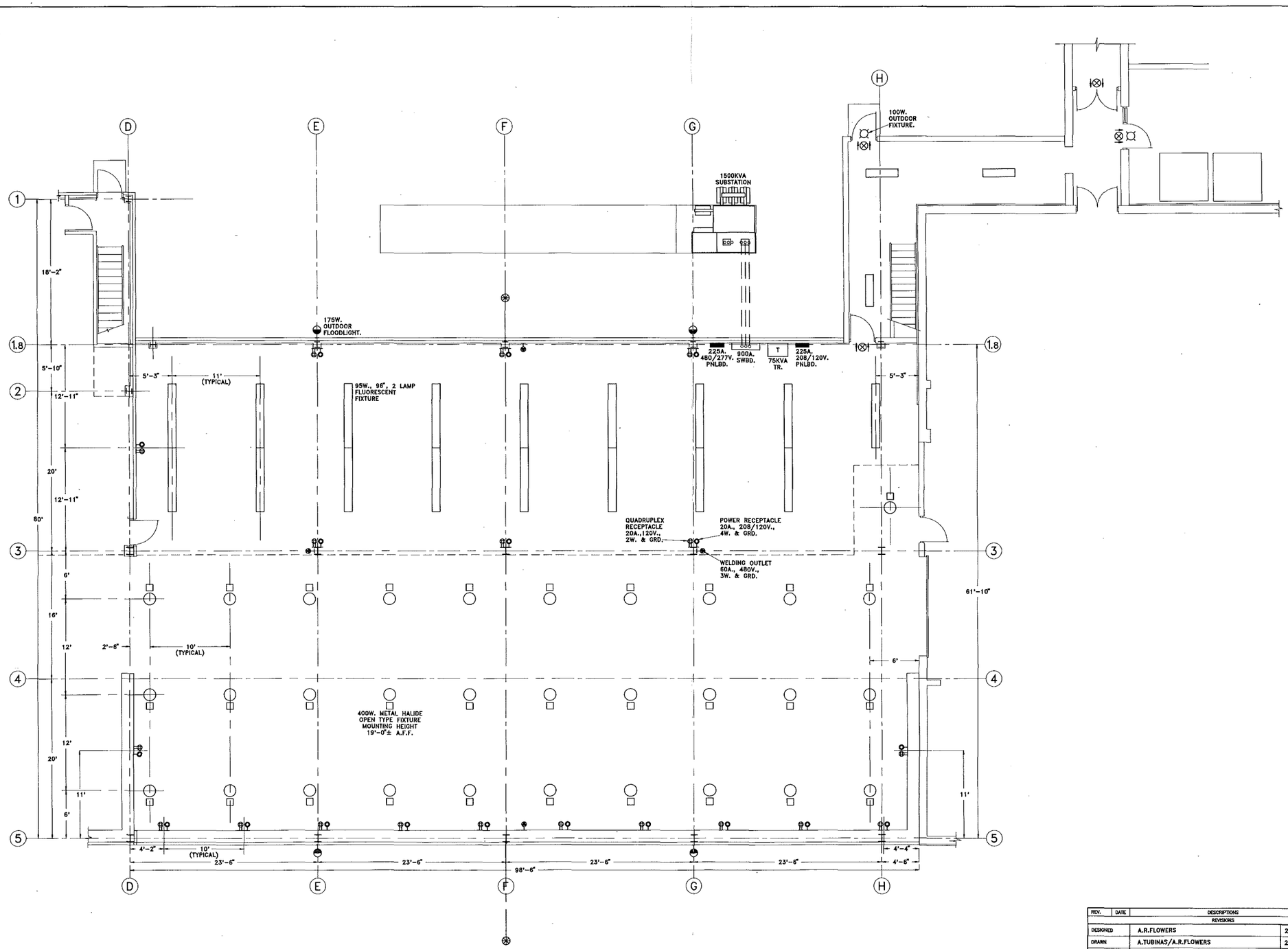
REV.	DATE	DESCRIPTIONS
		REVISIONS
DESIGNED		S. KRSTULOVICH / R. R. WELDON — 2-16-90
DRAWN		C. HOLMGREN — 2-16-90
CHECKED		2-16-90
APPROVED		2-16-90
SUBMITTED		2-16-90

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

FERMILAB LINAC UPGRADE
LINAC/A-0 ASSEMBLY AREA
FIRE PROTECTION PLAN AND CRITERIA

DRAWING NO. 4-1-2B TITLE I FP-1 REV.

16 FEB. 1990



ELECTRICAL GROUND FLOOR PLAN
SCALE: 1/4"= 1'-0"

REV.	DATE	DESCRIPTIONS
		REVISIONS

DESIGNED	A.R.FLOWERS	2-16-90
DRAWN	A.TUBINAS/A.R.FLOWERS	2-16-90
CHECKED		2-16-90
APPROVED		2-16-90
SUBMITTED		2-16-90

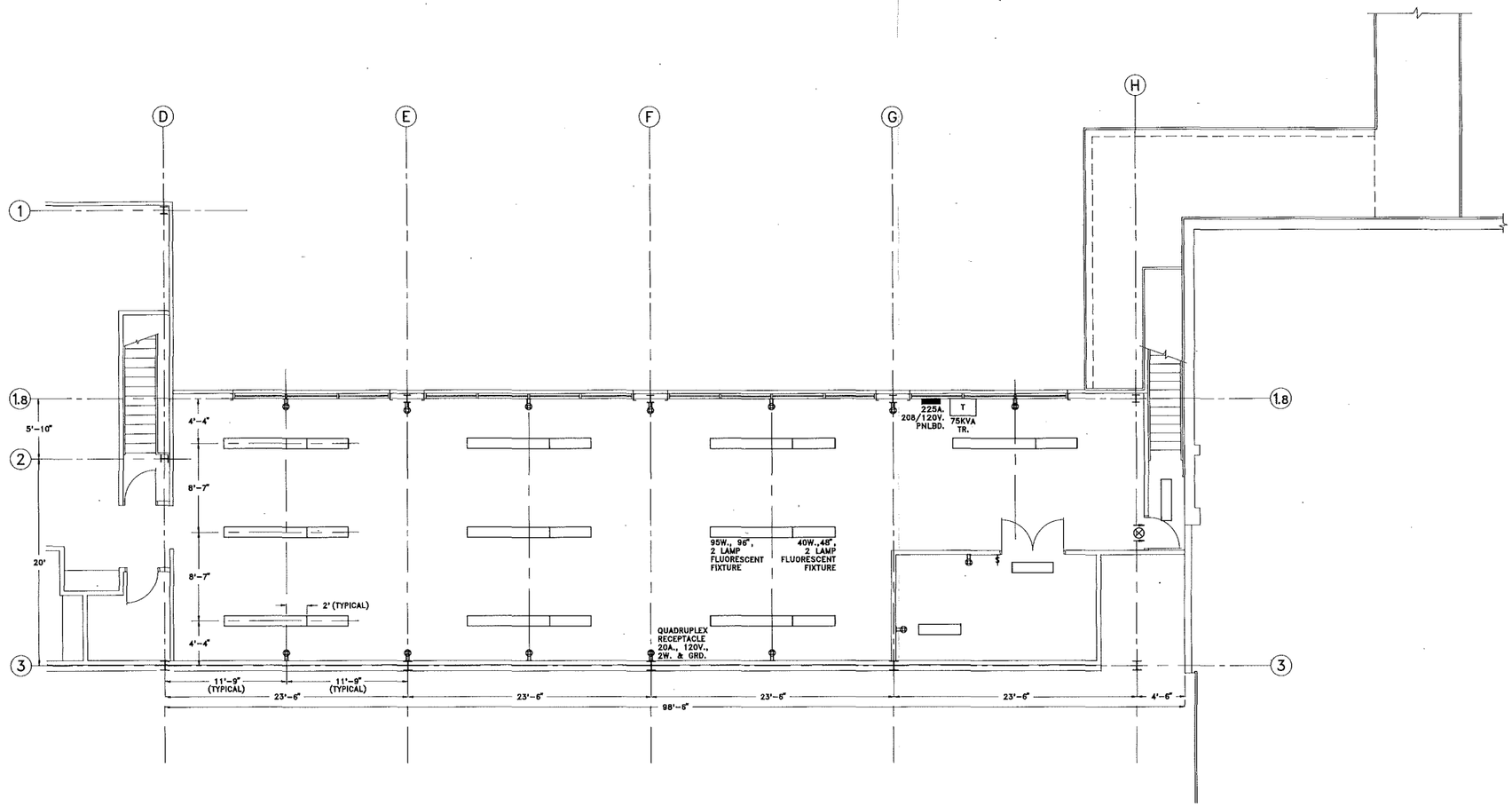
PROJECT NORTH

SCALE: 1/4"=1'-0" (4 0 4 8 SCALE FEET)

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

FERMILAB LINAC UPGRADE
LINAC/A-0 ASSEMBLY AREA
ELECTRICAL GROUND FLOOR PLAN

DRAWING NO. 4-1-2B TITLE 1 E-1 REV. 15 FEB. 1990



ELECTRICAL MEZZANINE FLOOR PLAN
SCALE: 1/4" = 1'-0"

REV.	DATE	DESCRIPTIONS
		REVISIONS
DESIGNED	A.R.FLOWERS	2-16-90
DRAWN	J.BANKS/A.R.FLOWERS	2-16-90
CHECKED		2-16-90
APPROVED		2-16-90
SUBMITTED		2-16-90

PROJECT NORTH

SCALE: 1/4"=1'-0" (0, 4, 8 FEET)

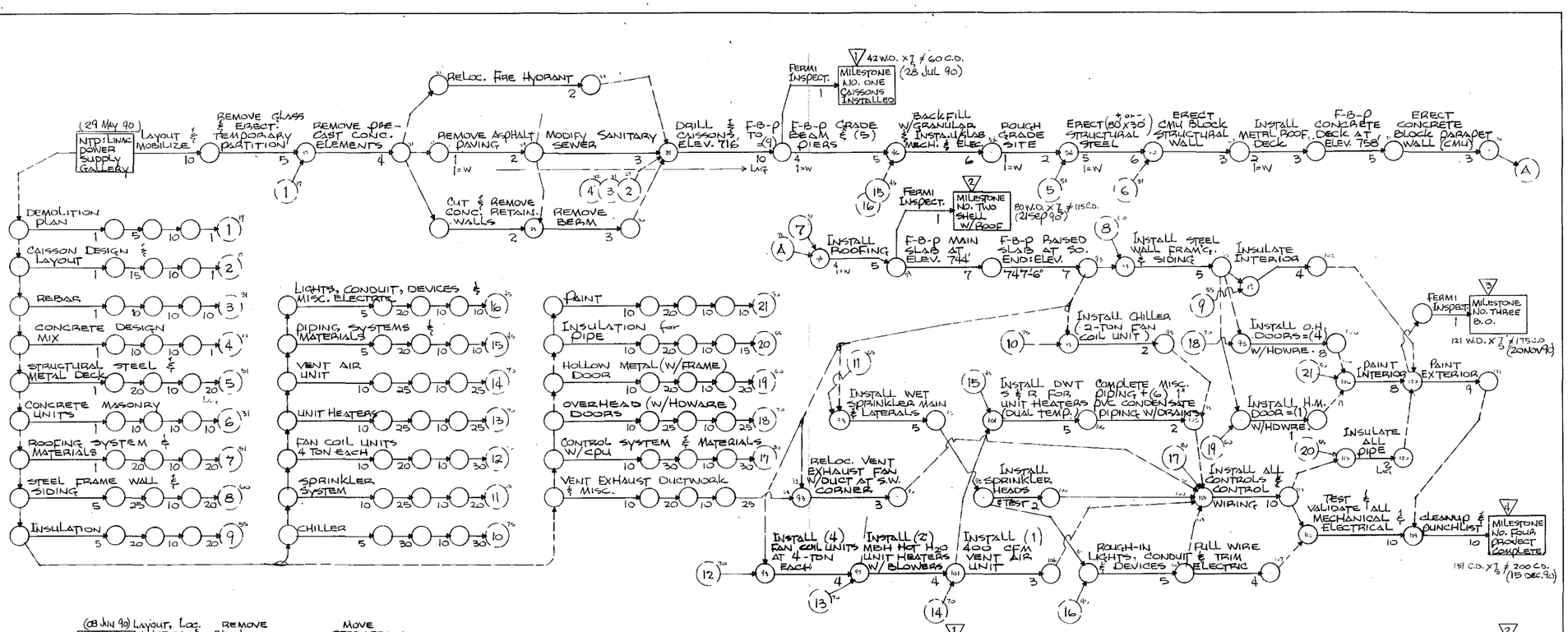
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

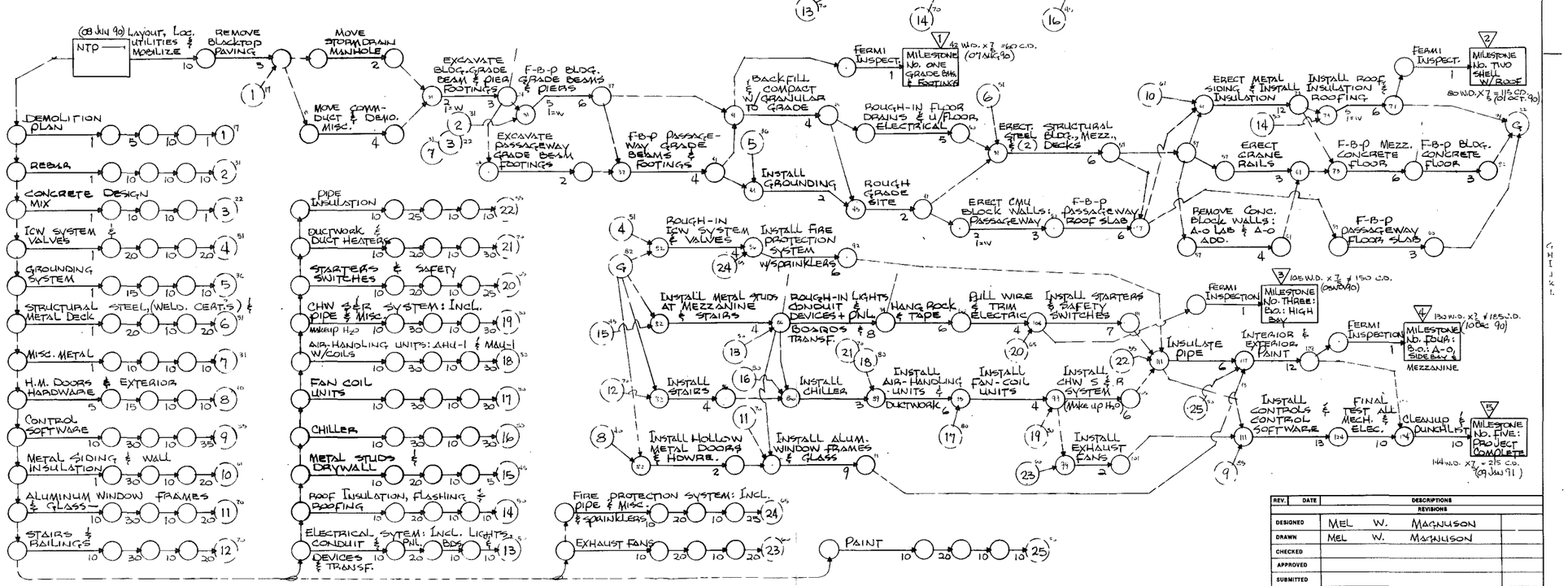
FERMILAB LINAC UPGRADE
LINAC/A-0 ASSEMBLY AREA
ELECTRICAL MEZZANINE FLOOR PLAN

DRAWING NO. 4-1-2B TITLE 1 E-2 REV.

16 FEB. 1990

WBS 1.2.1 LINAC POWER SUPPLY GALLERY





1. ACTIVITY DATA: 8 SCHED. START WK. DAY; 8 SCHED. FIN. WK. DAY OF PRECEED. ACTIVITY; 13 ACTIVITY DESCRIPTION; 5 = SCHED. START DATE OF SUCCEED. ACTIVITY; START NODE; END NODE; DURATION IN WORK DAYS

2. ACTIVITY STATUS: DUMMY ACTIVITY FOR LOGIC RELATIONSHIP HAS ZERO DURATION; NON-CRITICAL ACTIVITY; CRITICAL PATH

3. NETWORK LOGIC RULES:
1. 'B' CANNOT BEGIN UNTIL 'A' IS COMPLETED
2. 'D' CANNOT BEGIN UNTIL BOTH 'A' & 'C' ARE COMPLETED
3. 'B' DOES NOT DEPEND ON 'C'

4. INTERFACE ACTIVITIES: INTERFACE CONVENTION IS USED TO AVOID DRAWING UNUSUALLY LONG ACTIVITY ARROWS
SHEET #1 W/NODE #21 ON SHEET #2
SHEET #2 W/NODE #13 ON SHEET #1

5. MILESTONE EVENTS: A SIGNIFICANT EVENT IN THE PROJECT FOR WHICH A SCHED. DATE HAS BEEN SPECIFIED
CALENDAR DAYS CONVERTED FROM WORK DAY TOTALS BY C.D. = 176
EVENT TITLE & NUMBER
DATE:

6. ABBREVIATIONS:
F-B-P = FORM PLACE REINF. STL. & PLACE CONCRETE
I.P.O. = ISSUE PURCHASE ORDER
P.S.D. = PREPARE SHOP DRWGS.
A.S.D. = APPROVE SHOP DRWGS.
F. &D. = FABRICATE & DELIVER
W = TOTAL WEATHER ALLOW. IN WORK DAYS TO NODE

REV.	DATE	DESCRIPTIONS
		REVISIONS
DESIGNED	MEL W. MAGNUSON	
DRAWN	MEL W. MAGNUSON	
CHECKED		
APPROVED		
SUBMITTED		

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

FERMILAB LINAC UPGRADE
WBS 1.2.1 AND WBS 1.2.2
CONSTRUCTION NETWORK DIAGRAM

DRAWING NO. 4-1-2 TITLE I CPM-1 REV. 16 FEB. 1990

Appendix F

CPM NETWORK - CONSTRUCTION SCHEDULE

Appendix F

CPM NETWORK - CONSTRUCTION SCHEDULE

4-1-2	CPM-1	WBS 1.2.1 and WBS 1.2.2 Construction Network Diagram
	CPM-2	WBS 1.2.3 and WBS 1.2.4 Construction Network Diagram

WBS 1.2.3 LINAC UTILITIES & SERVICES

WBS 1.2.4 LINAC ENCLOSURE ACCESS & PENETRATIONS

REV.	DATE	DESCRIPTIONS
		REVISIONS

DESIGNED	MEL W. MAGNUSON	
DRAWN	MEL W. MAGNUSON	
CHECKED		
APPROVED		
SUBMITTED		

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

FERMILAB LINAC UPGRADE
WBS 1.2.3 AND WBS 1.2.4
CONSTRUCTION NETWORK DIAGRAM

DRAWING NO. 4-1-2 TITLE I CPM-2 REV.

16 FEB. 1990