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Study Of SSC Experimental Hall Concepts Using Model Detectors

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STUDY OF SSC EXPERIMENTAL HALL CONCEPTS
USING MODEL DETECTORS

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PREFACE

This document reports on the progress of a team of CDG and RTK personnel in exploring possible experimental facilities for the SSC. As such, the report considers detector models, their assembly, the required underground space, and the associated aboveground facilities. It also includes construction sequences and an example schedule. This material is intended to support the generation of a cost estimate adequate to the technical complexity of the facilities.

There is no attempt to define the scope and details of the future research program for the SSC. This report, in conjunction with other technical and physics studies, will be used later in the site-specific conceptual design for the accelerator and experimental facilities.

The technical work was initiated in the middle of 1988 by a series of informational meetings. Detector concepts were extracted from the literature of high energy physics summer studies and workshops, and visitors to the Central Design Group contributed to the ongoing work. The personnel who participated routinely in the studies and assisted in the preparation of this document are Alex Autin, Per Dahl, Lor Gehret, Gil Gilchriese, Dave Goss, Chris Laughton, Liria Lorano, Barbara McHugh, Alan Nunez, Bill Terry, Tim Toohig, and Don Scapuzzi. All participants are to be thanked for drawing together the diverse ideas, concepts, drawings, tables, and schedules into a coherent and informative report.

It is expected that this report will serve as a valuable resource document as conceptual design work is initiated for the SSC site in Texas.

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CHAPTER 1 INTRODUCTION

The purpose of this report is to describe examples of experimental facilities for the SSC, based on three model detectors. To create these examples, experimental designs for various types of detectors described in a number of summer studies and reports from the last few years were examined. The primary reference material for these detector designs includes a preliminary cost estimate of SSC experimental equipment[1], the 1987 Berkeley workshop on experiments, detectors, and experimental areas[2], and the 1984[3], 1986[4], and 1988[5] Snowmass SSC summer studies.

Although these references contain a large number of experimental ideas and concepts, this study is limited to facilities for three model detectors. These detectors are extrapolations of detectors presently in use for the type of large experiments expected at the SSC.

Because the site of the SSC was not known during the course of this study, each of the experimental facilities for the three detector models is discussed as it would exist at two different depths below the ground surface: 23 m and 150 m to beam centerline. These depths were chosen because 23 m is approximately the minimum depth to beam centerline expected for the experimental halls at any of the potential SSC sites, whereas 150 m is typical of the depth anticipated at those sites with the collider ring situated deep underground.

This report also examines different types of hall configurations that might arise from considering geotechnical factors or collider operations. For example, collider operation and experiment scheduling will influence the decision of whether or not to build a below-ground assembly area in addition to a collider hall for an experiment, while geotechnical issues will influence the number and nature of shafts or ramps to the experimental halls. Rather than make premature choices based on these considerations, this study explores various types of halls that span, to some extent, the range of possible choices. It should be emphasized that this report does not present all of the possibilities for experimental facilities at the SSC, nor does it represent an endorsement of any particular type of detector or experiment.

CHAPTER 2 DETECTOR MODELS

The three detector models discussed are:

- a Large Solenoid Detector[1]
- a Beauty Spectrometer[2]
- a Bottom Collider Detector[3].

At this time, not even the most rudimentary engineering design of any of these three model detectors exists. What does exist are descriptions of the approximate sizes and weights of the detector elements and of the purposes of the major detector components. This information was used to set the dimensions of the experimental halls and accesses to the halls (shafts and ramps). The dimensions of the various halls and accesses are determined, not only by the dimensions of the detector in its operational configuration, but also by the detector's spatial assembly and maintenance requirements. For the Large Solenoid Detector and the Bottom Collider Detector models a multistage assembly sequence is described (in Sections 3.1.7 and 3.3.6) as an example of how spatial requirements for assembly determine hall dimensions. For the Large Solenoid Detector model, the report briefly addresses the issue of movement of detector components for maintenance (Section 2.1.3).

2.1 LARGE SOLENOID DETECTOR MODEL (LSD)

2.1.1 General Description

The Large Solenoid Detector is an example of the largest and heaviest detectors expected at the SSC. As such, the associated collision hall will likely be the one with the greatest span (transverse to the beamline) and height, although it will not necessarily have the greatest length along the beamline.

Dimensions of the major components were established using sketches from Reference 4 as a starting point, followed by discussions of how to move outer detector components to obtain access to inner detector components and electronics for maintenance. In addition, some aspects of mechanical support were taken into consideration, where they might affect the basic dimensions. It should be emphasized that the viability of the various mechanical supports for large components of the detector (e.g., the iron yoke) has not been established; these components await a true engineering design.

The Large Solenoid Detector weighs about 38,000 tons. Influenced, in part, by this very large weight, the authors assumed that the detector will be assembled in place on the beamline. In this way, this model differs from most large colliding beam detectors, which are not constructed on beamline (although there are exceptions, such as the L3 detector at the Large Electron-Positron Collider at CERN and the CLEO detector at Cornell). Accordingly, this model lacks a below-ground assembly area or any other area to which the detector or large pieces of the detector may be removed for servicing or repair.

This study, however, does not explore the impact of this design feature on the startup or operation of the SSC, nor does it examine the possibilities for construction of a below-ground assembly area for this detector. This choice in no way demonstrates the impossibility of building such an assembly area or of constructing the detector so as to take advantage of it.

2.1.2 Dimensional Basis

The major components of the Large Solenoid Detector are shown in Figure 2-1. (See Chapter 7 for all drawings.) They are as follows:

- vertex detector
- central tracking detectors, including both central and plug chambers
- barrel calorimeter
- superconducting coil
- iron flux return and muon tracking support
- end caps (2)
- half-toroids (2 sets of 2 each)
- forward tracking system, calorimeter, and muon toroids enclosing the low β quadruples

The detector is shown in an elevation view in Figure 2-2. Figures 2-3 through 2-6 depict various details of its components.

The dimensions of the very large superconducting coil were obtained from existing literature[4] and from private communications.[5] The dimensions of the iron yoke were obtained from Reference 4 with modifications suggested by the Stanford Linear Collider Detector Design Report[6] and private communications.[7] As indicated previously, engineering studies have yet to demonstrate that the iron yoke can be built as shown. However, it is believed that the dimensions shown would closely approximate those obtained from such a detailed study, although the support structure for the yoke may, in fact, be quite different in detail.

The dimensions of the remainder of the components were obtained from Reference 4 and CDG drawing No. B2M256 (24 Jul 87), modified slightly to make them consistent with the dimensions of the iron yoke and coil, and to accommodate the operational considerations described in this document.

The floor level beneath the iron yoke is about 1 m below the muon-tracking apparatus attached to the yoke; consequently, the floor is 9.5 m below beam centerline.

Also, the forward end of the low β quadruple is 21.8 m from the interaction point, as a result of the various spatial requirements for retracting the end cap.

2.1.3 Assumptions

In order to model the collision hall, shafts, and other facilities associated with the Large Solenoid Detector, this study makes a number of assumptions regarding the detector's basic dimensions, its maintenance and minor repair needs, assembly sequence, and the interface of its operation with that of the SSC. These assumptions are as follows:

The detector will be built in place on the beamline. The iron support yoke, except for the end caps, remains permanently anchored in place. The intermediate toroids are split vertically so that they may be moved sideways and then away from the interaction point to allow the end cap to be retracted. The end cap may be retracted for personnel access to the central tracking chambers, the vertex detector, and the ends of the barrel calorimeter. The forward/backward tracking system, calorimetry system, and muon systems remain fixed.

2.2 BEAUTY SPECTROMETER MODEL (B SPECTROMETER)

2.2.1 General Description

The Beauty Spectrometer is one of a class of possible SSC detectors with relatively moderate dimensions transverse to the beamline but much longer dimensions along the beamline than the Large Solenoid Detector. Unlike the other two detectors discussed in this report, the Beauty Spectrometer has no central component surrounding the interaction point.

It is assumed that this model will have a moderate-size below-ground assembly area; however, as a result of the final size of some of the major detector sections, substantial assembly activity will also have to occur in the collision hall. The design of this model detector has a substantial amount of empty space along the beamline allowing lay-down and assembly space in the collision hall with no increase in hall size beyond that needed to accommodate the finished detector. However, this model will be assembled in both the collision and assembly halls because it will aid the construction process to assemble major sections of the detector before moving them into the collision hall.

2.2.2 Dimensional Basis

The dimensions for the Beauty Spectrometer were derived from sketches in Reference 4 and from a CDG sketch labeled "SSC Downstream Beauty Spectrometer" from a workshop held in Berkeley, July 7-17, 1987. Some components of the detector will have individual supports to the floor level; some of the smaller ones will be grouped onto common supports. A rail system will allow movement along the beam and, transverse to the beamline for some groups of components, to allow removal to the assembly area. An exploded isometric view of this detector is shown in Figure 2-7. Although a number of the components shown as rectangular may ultimately have a different shape, these variations do not change the requirements for hall dimensions.

2.2.3 Assumptions

The most important assumption about the Beauty Spectrometer is that it has a below-ground assembly area shielded from the collision hall. This assembly area has been deliberately made too small to assemble all of the detector components in the hall and roll them into the collision hall, in a reasonable period of time. For an optimal schedule, considerable assembly must take place in both the collision hall and assembly hall. Furthermore, it is assumed that only the vertex detector region may be retracted from the collision hall in the time span of a few days; the remainder of the detector requires a longer access period. In this sense, this model is a mix of the Large Solenoid Detector model, in which all assembly occurs in the collision hall, and the Bottom Collider Detector model, in which almost all of the assembly occurs in the below-ground assembly area. No construction sequence for this model has been devised.

2.3 BOTTOM COLLIDER DETECTOR MODEL (BCD)

2.3.1 General Description

The Bottom Collider Detector is an example of one of the moderate-sized SSC detectors. A basic description of this detector is given in Chapter 1, Reference 5 (also see Chapter 2, Reference 3). The BCD consists of a central dipole magnet, forward and backward intermediate angle spectrometers, and a forward spectrometer. It is designed with tracking chambers and particle identification devices. An exploded isometric view of this detector is shown in Figure 2-8.

The size and weight of the major pieces of the BCD are comparable to those of existing colliding beam detectors. Thus, it is assumed that the major components of this detector will be assembled in a below-ground area shielded from the collision hall and then moved into the collision hall itself. It is also assumed that a major section of the detector, such as the central dipole magnet and its associated apparatus, may be rolled out of the collision hall into the assembly area in a few days time, as is the current practice with colliding beam detectors. The removal of other major sections would take longer. The presence of a shielded below-ground assembly area would allow continued SSC operation while major sections of this detector were being assembled or repaired.

2.3.2 Dimensional Basis

The dimensions of the BCD are given in Chapter 1, Reference 5 and Chapter 2, Reference 3. Various component supports, extending to floor level, have been added. Some components will have individual supports, and some will be grouped together onto a common base. The floor will be below beam centerline.

2.3.3 Assumptions

The most important assumption made for the BCD model is that major sections of the detector may be constructed, repaired, or upgraded in a shielded below-ground assembly area while the SSC is operational. The most intricate major section of the detector will be the center dipole magnet and the associated detector elements. The modest weight of this section, approximately 2,500 tons, allows it to be rolled directly out of the collision hall with no disassembly. Other parts of the detector could be removed through one of two access ways into the assembly area. It is assumed that some parts of the detector, such as the muon toroids, would not ordinarily be removed from the collision hall.

CHAPTER 3 UNDERGROUND FACILITIES - DEEP LOCATION

3.1 LARGE SOLENOID DETECTOR MODEL

3.1.1 General Description

The basic features of the underground facilities of this model are shown in Figures 3-1 and 3-2. The associated surface facilities are shown in Figures 3-3 and 3-4.

As discussed in Chapter 2, the primary assumption for this model is that the detector will be assembled in place on the beamline; because of the size and weight of its major components, there is only a collision hall, and no separate assembly hall.

3.1.2 Collision Hall

The shape of the collision hall cross section for the 150-m depth is shown in Figure 3-1 as the 'bread loaf' design, with the dome arch configuration similar to those shown in the Central Design Group SSC-SR-1028 publication. This study does not include quantitative designs for the arch dimensions or for the thickness of walls or floors of tunnels, shafts, or halls.

The overall length of the hall was initially set at 80 m, as specified in CDG sketches. This length was then determined to be the minimum required during installation, as shown in Figure 3-5.

The interaction point is 43 m from one end of the hall. This leaves approximately 8 m between the detector (low β quadruples) and the right end wall and approximately 14 m free at the left end of the hall. Figure 3-5 shows how these locations and dimensions relate to the required lay-down and access areas during the installation phases of the detector.

The centerline of the collision hall is offset by 1 m from the centerline of the detector. The inside width of the hall is 28 m. This width is determined by the clearances required to move the half muon toroids and the end caps for maintenance of the core components. When the toroids are retracted, there is approximately 1 m clearance between the forward components and the two half-toroids; approximately 1 m clearance between one sidewall and a toroid; and approximately 3 m clearance between the other sidewall and the other half-toroid. These dimensions allow passage of people and small equipment and include space for mounting electric cables and equipment on the walls and detector components.

The hall crane hook height is 25 m above the floor, reaching the base of the dome arch. The dome adds approximately 12.4 m to the overall height of the hall at its peak, making the maximum overall height of the hall approximately 37.4 m above the floor. The crane hook is 7 m above the magnet yoke structure and the muon tracking apparatus, leaving a 2.5-m clearance above the roof of a 4.5-m electronics house.

3.1.3 Shafts and Tunnels

One rectangular construction shaft, two circular personnel shafts, one circular equipment shaft, three hall access tunnels, and a utilities bypass tunnel were modeled. They are shown in Figure 3-2, along with the ring tunnel. The dimensions and requirements of each is as follows:

- The 12-m by 9-m construction shaft is sized to allow the lowering of large preassembled pieces from the surface during construction. (An example is a half-coil weighing approximately 400 tons, and measuring 10.5 m in diameter by 8 m long.) This shaft, directly over one end of the hall, will be used for excavation during construction of the facility. Afterwards, the shaft will be plugged with shielding blocks during collider operation.

- The two 7-m-internal-diameter personnel shafts are sized to include an elevator and a stairwell. In addition, one of these shafts includes a 2.2-m-diameter vent duct. One shaft is on the side of the hall facing the ring center and extends up into the office area of the surface facilities. Access tunnels to the ring bypass tunnel and to the main tunnel into the hall are provided. The other personnel shaft is on the opposite side of the hall, close to its end. It also includes an elevator and stairwell but no vent duct. This shaft, which extends up to the surface facilities adjacent to the construction shaft and crane, allows personnel and equipment to enter the hall during construction and operation without going through the surface building.

- The 9-m-internal-diameter equipment shaft includes a stairwell and vent duct. It is sized to allow a 5-m by 5-m preassembled component to be lowered into the hall. This shaft is approximately 17 m away from the side of the hall opposite ring center, near the end opposite the construction shaft. The equipment shaft extends to the surface and terminates at one end of the external detector building. A dual 100/100-ton bridge crane in this building provides the lifting capacity for this shaft.

- The bypass tunnel is 3 m in diameter to match the circular dimensions of the ring beam tunnel. It includes a concrete floor for personnel and vehicle passage. The straight section of the tunnel is 13 m from the hall wall; this distance provides sufficient shielding from the collision hall. The tunnel horizontal curvature radius is set at 40 m to allow magnet transporter passage.

3.1.4 Cranes

Two top-running bridge cranes are provided in the collision hall. Both cranes have a hook height of 25 m and a span of approximately 27 m, and they run on a common set of rails.

The crane at the construction shaft end of the hall will be a 100/100-ton crane, i.e., it will have two 100-ton hooks, each on a separate trolley. This crane will be used for handling the large quantities of steel required for the magnet yoke assembly, most of which will be lowered down the construction shaft by the 200-ton gantry crane on the surface.

The second crane will be a 100/20-ton crane with both hooks on the same trolley. This crane will be primarily used for component assembly work.

3.1.5 Carriers

Carriers, or transfer carts supported by multirollers, will transfer equipment from the bottom of the equipment shaft into the collision hall for installation. In the collision hall, the overhead crane may be used to position component parts for assembly.

Special carriers will be provided for massive components, such as half of a coil or a calorimeter, that cannot be handled by crane. The components designed to be moveable, such as half-toroids and end caps, will be assembled on permanent carriers and rolled into position.

3.1.6 Air Conditioning, Cooling, and Ventilation Systems

Air Conditioning and Cooling - The hall cooling system is sized to provide cooling for 1 MW of heat transmitted to the air by the equipment and not cooled by other systems. The system will be designed to maintain a hall temperature of 70°F with a maximum temperature rise of 15°F from the floor to the top of the detector, using 40-45°F chilled water for cooling. The temperature at any elevation will be controlled to within $\pm$ 1°F.

The refrigerator load is calculated to be 285 tons, and the system is split into ten separate units with five units along each side wall of the hall. The inlet and outlet grills are at an elevation suitable for efficient cooling of the detector. Each unit will have a fan coil with a capacity of 21,600 ft^3/min. Valves in the chilled water supply lines will provide temperature control.

Ventilation - The hall ventilation system is designed for a normal operation of one air change per hour, with an emergency ventilation capability of three air changes per hour. This system uses a two-speed fan with sufficient horsepower to overcome the additional pressure loss during an emergency.

A central unit at the surface will provide 45,000 ft^3/min of conditioned air during normal operations and 135,000 ft^3/min of minimally conditioned air during an emergency, based on a normal velocity of 1,000 ft/min.

3.1.7 Assembly Sequence

The length of the collision hall for the detector is determined by assembly requirements, and not just by the actual length of the detector. The width of the hall is determined by the space required to move the intermediate half-toroids sideways to allow retraction of the end cap. To estimate assembly area dimensions, the four-stage assembly sequence shown in Figure 3-5 was devised. This sequence applies to a deep location, although a similar sequence may be devised for a near surface location. Each of these four phases represents a substantial time period. This crude assembly sequence adequately illustrates the additional space needed in the collision hall for the assembly process.

Phase 1 - Phase 1 comprises the initial assembly of the iron yoke and barrel calorimeter. Iron pieces for the yoke are brought through the rectangular construction shaft and calorimeter modules are brought in through the equipment shaft. It is assumed that construction of the 5,000-ton barrel calorimeter consists of both assembly and testing. To separate calorimeter activities from the iron assembly, a clean room with an internal crane is established for this construction.

Phase 2 - During phase 2, the yoke is completed and the superconducting coil is installed. With special rigging, the coil modules are brought in through the construction shaft. Also during phase 2, construction begins on the iron yoke for the intermediate toroids and end cap doors, and assembly and testing of the barrel calorimeter continue. Simultaneously, other parts of the detector are constructed in the surface facilities.

Phase 3 - During phase 3, the barrel calorimeter is installed and construction continues on the toroids and end cap doors.

Phase 4 - During phase 4, the calorimeter parts of the end caps are installed, and the forward tracking apparatus, calorimeters, and toroids are brought down to the hall and assembled. Access is through both the construction shaft and the equipment shaft. By the end of phase 4, the detector is assembled and ready for continued testing.

3.1.8 Parameter Tables

The following parameter tables list physical dimensions for the large solenoid detector (150-m depth) collision hall and tunnels, as well as utility specifications for the collision hall air conditioning, cooling, and ventilation systems.

Table 3-1

LARGE SOLENOID DETECTOR PARAMETER TABLES

a.) Physical Parameters Table - Underground Halls and Tunnels

Model: Large Solenoid Detector
Location: Deep Location (150M)
Ref. Dwgs: 01-M-03

AREA	Dimensions (meters) W	L	H (max)	Volume (M3 x 1000) TOTAL	CROWN	TO ARCH	Crane Hook Ht (M)	Cap (t)	Remarks
Collision Hall	28	80	37.4	79.4	23.4	56	25 25	100/100 100/20	Dual Trolleys
No. 1 Personnel Shaft Tunnel	3.5	29	5	0.45	0.14	0.31			
No. 2 Personnel Shaft Tunnel	3.5	25	5	0.39	0.12	0.27			
Equip. Shaft Tunnel	9	25.5	7	1.44	0.41	1.03			
TOTAL				81.68	24.07	57.61			

b.) Utilities Parameters Table - Underground Halls

Model: Large Solenoid Detector
Location: Deep Location (150M)
Ref. Dwgs: 01-M-03

AREA	MECHANICAL Cooling Water M3/MIN	Plant Air M3/MIN	HVAC Air Heat Load (kw)	Air Cooling (TONS)	Ventil. (M3/hr x 1000)	POWER Volts	Demand kw	COMMUNICATIONS
Collision Hall			1000	285	76.5			

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3.2 BEAUTY SPECTROMETER MODEL

3.2.1 General Description

The major features of the underground facilities for the Beauty Spectrometer model are shown in Figure 3-6. The associated surface facilities are shown in Figures 3-7 and 3-8.

The basic concept governing the arrangement of the underground facilities for this model is that two halls, a collision hall and an assembly hall, will be constructed parallel to the beam and joined by two shielded access tunnels. The separate assembly hall allows assembly and/or maintenance work during collider operation.

It is also assumed that this detector model may be preassembled and disassembled in pieces small and light enough to be handled by transfer carts. Installation in the collision hall is by cart and overhead crane. A system of imbedded rails will allow multiroller-supported detector components to be moved along the beam centerline to create openings for access into the detector assembly.

Access to the below-ground assembly hall is provided by an equipment shaft and a personnel shaft. In this scheme, access to the collision hall is by way of one of these two shafts and then through the assembly hall.

3.2.2 Halls

Collision Hall - The inside dimensions of the collision hall are 104 m long by 16 m wide, with a 14-m hook height. The long dimension of this hall model is parallel to the collider beam. These dimensions provide minimum clearances around the detector, and a 10-m space from the interaction point to the left end of the detector, as shown in Figure 3-6.

The detector dimensions are based on the Central Design Group (CDG) sketch labeled "SSC Downstream Beauty Spectrometer" from a Workshop held in Berkeley, July 7-17, 1987. The interaction point is 10 m from one end of the wall, and 2-m clearance is provided at the other end of the hall between the wall and the end of the detector. The 10-m distance provides space to roll out intermediate spectrometer components for access to the core detectors.

The width of the hall (transverse to the beam) is established by providing 1.75-m clearance on the side opposite the assembly hall and 3.75-m clearance on the assembly side. Thus, the centerline of the hall is offset from the centerline of the beam by 1 m (see Figure 3-6). These clearances allow for personnel access, air conditioning, cooling, and ventilation system components mounted on the walls, some maintenance access on one side, and miscellaneous electrical cables and other equipment around the detector.

Based on the same CDG sketch, a vertical distance of 5.75 m is established as the vertical distance from beam centerline to floor level. This allows room for a 0.5-m support frame between the bottom of the muon toroid and the floor. As in the Large Solenoid Detector model, a level hall floor is assumed, with supports to position the smaller components on the beam centerline.

A hook clearance of 3 m is provided above the detector's tallest component, and another 5 m for crane depth and arch height. Thus, the height of the hall is 19 m from floor to peak of arch.

Two rail systems are incorporated in the collision hall floor. These rails will be used to roll multiroller-supported component frames along the beam centerline. This will allow access to and/or removal of some of the detector components or subcomponents. Additionally, groups of some of the smaller components will be supported by a common base, while incorporating a secondary rail system to allow extraction of individual components on a single base.

Assembly Hall - The assembly hall is 68 m long by 15 m wide, with a hook height of 9 m. The length of this hall is based on the component assembly requirements and the need to locate the two transfer tunnels strategically with respect to the collision hall and detector assembly.

One end of the assembly hall is located directly opposite the interaction point to allow transfer of assembled intermediate spectrometer components in and out of the collision hall. The other end of the assembly hall is opposite the long RICH section of the forward spectrometer. This provides access to these lighter components of the detector as well as to the muon toroids and calorimeter section, when the lighter components are rolled back toward the interaction point.

The width of this hall is 15 m, the minimum width required for preassembly of the larger components.

The hook height of 9 m is required for complete preassembly of selected components such as the dipole magnets, or preassembly of a quadrant of a component such as the muon toroid. An additional 5 m is allowed as the peak distance from hook to roof, making the assembly hall height 14 m from floor to peak.

The size and weight of items that are transferred from the assembly hall to the collision hall will be determined by sequence of installation, use of permanent transfer carts, and crane capacity.

3.2.3 Shafts and Tunnels

In this scheme, three shafts are provided: one excavation shaft, one personnel and services shaft, and one equipment shaft.

Two shielded tunnels used for access or transfer of equipment run between the assembly and collision halls (see Figure 3-6). A personnel and utilities labyrinth provides access to the collision hall from the assembly hall. There is access to the utilities bypass tunnel from the personnel shaft.

The dimensions and features of the shafts and tunnels are as follows:

- The excavation shaft is 7 m in diameter and extends from the surface to the roof of the collision hall at the end opposite the interaction point. This shaft will be used only for excavation of the hall(s); it will be plugged with shielding blocks during collider operation.

- The 7-m-diameter personnel and utilities shaft is approximately 11 m away from one end of the assembly hall. It extends from the office building at the surface to the floor of the assembly hall and includes an elevator, utility chase, stairwell, and vent duct. Access from this shaft to the assembly hall is via a 3.5-m by 5-m-high tunnel. A short additional tunnel from this shaft at beam elevation provides access to the utility bypass tunnel.

- The equipment shaft is 9 m in diameter and is approximately 15 m away from the end of the assembly hall opposite the personnel shaft. It includes a stairwell and vent duct, and extends from the floor of the assembly hall to the floor of the surface assembly facility. A 50/10-ton bridge crane provides lifting capacity for this shaft. Preassembled component parts and materials up to 5 m^2 may be lowered to the assembly hall in this shaft.

- The equipment transfer tunnels are 7 m wide by 7 m high and approximately 19 m long. The cross-sectional size is determined by the largest size of a piece of equipment that a transfer cart can handle. The length provides shielding and takes into account the geotechnical considerations of constructing side-by-side caverns in rock. These tunnels have shield doors that roll back into excavated 'pockets' during assembly and maintenance operations.

- The 3-m-wide by 5-m-high labyrinth passageway from the assembly hall to the collision hall provides for cabling, ventilation, and routine access during nonoperating periods.

- A 3-m-diameter utility bypass tunnel is provided on the ring side of the assembly hall. It is approximately 9 m from the wall of the assembly hall and connected to the beam tunnel by S-shaped curved sections of 40-m radius. This tunnel has a level concrete floor for personnel and vehicle passage.

3.2.4 Cranes

Two top-running bridge cranes are provided for the underground facilities; one for the collision hall and one for the assembly hall. Each crane will have dual hook trolleys of 20- and 5-ton capacity each. Thus, the maximum weight of a subassembly requiring installation by crane is assumed not to exceed 20 tons.

3.2.5 Air Conditioning, Cooling, and Ventilation Systems

Air Conditioning and Cooling - The collision hall cooling requirements for equipment heat load are assumed to be 0.4 x 1MW = 400 kW, or 40 percent of that for the large solenoid detector model. On this basis, four 28-ton cooling units similar to those designed for the Large Solenoid Detector model are mounted on the hall walls.

Ventilation - The equipment and personnel shafts are assumed to have ventilation ducts, but there has been no quantitative analysis to size this equipment or to design duct routing to provide ventilation to the collision hall.

3.2.6 Parameter Tables

The following parameter tables list physical dimensions for the Beauty Spectrometer (150-m depth) halls, shield door cavities, labyrinth, and tunnels, as well as specifications for the collision hall HVAC system.

BEAUTY SPECTROMETER PARAMETER TABLES

a.) Physical Parameters Table - Underground Halls and Tunnels

Model: Beauty Spectrometer
Location: Deep Location (150M)
Ref. Dwgs: 03-M-03

AREA	Dimensions (meters) W	L	H (max)	Volume (M3 x 1000) TOTAL	CROWN	TO ARCH	Crane Hook Ht (M)	Cap (t)	Remarks
Collision Hall	16	104	19	31.6	8.3	23.3	14	20/5	
Assembly Hall	15	68	14	14.1	4.9	9.2	9	20/5	
Transfer Tunnel No. 1	7	19	7.5	0.89	0.36	0.53			
Transfer Tunnel No. 2	7	19	7.5	0.89	0.36	0.53			
Personnel Shaft Tunnel	3.5	11.3	4.75	0.17	0.05	0.12			
Equip. Shaft Tunnel	9	14.5	7.5	0.83	0.31	0.52			
Shield Door Cavity No. 1	8	9	8	0.58					
Shield Door Cavity No. 2	8	9	8	0.58					
Labyrinth	3	29.6	5	0.44					
TOTAL				50.08	14.28	34.2			

b.) Utilities Parameters Table - Underground Halls

Model: Beauty Spectrometer
Location: Deep Location (150M)
Ref. Dwgs: 03-M-03

AREA	MECHANICAL Cooling Water M3/MIN	Plant Air M3/MIN	HVAC Air Heat Load (kw)	Air Cooling (TONS)	Ventil. (M3/hr x 1000)	POWER Volts	Demand kw	COMMUNICATIONS
Collision Hall			400	114				

3.3 BOTTOM COLLIDER DETECTOR

3.3.1 General Description

The major features of the underground facilities for this model are shown in Figures 3-9 and 3-10. The associated surface facilities are shown in Figures 3-11 and 3-12. Key elements of the design of these facilities include the following:

- This model, like the Beauty Spectrometer model, has two underground halls parallel to the beam centerline: a collision hall and an assembly hall, separated by large shielded transfer tunnels. Thus, the beam may be operated while the detector components are undergoing construction or maintenance in the adjacent assembly hall.

- The assembly hall is large enough to accommodate nearly all of the detector preassembly. Completed assemblies may be rolled into the collision hall via the transfer tunnels.

- No excavation shaft is provided directly above the collision hall. A horizontal tunnel at roof height, connected to the equipment shaft, would be used to start the excavation of the collision hall.

3.3.2 Halls

Collision Hall - The inside dimensions of the collision hall are 60 m long by 18 m wide, with a hook height of 16 m. The detector model dimensions are based on a CDG sketch labeled "SSC Beauty Spectrometer", Proceedings of 1988 Snowmass Summer Study, First Draft. From this sketch, the distance from the beam to the floor was determined to be 7 m.

As in other models, minimal clearances between the detector and the collision hall are provided on one side (opposite the assembly hall). The 18-m width provides 1 m clearance on one side of the large dipole magnet and 3 m clearance on the other side.

The 60-m length provides approximately 5 m clearance at each end of the detector in the beam centerline direction. The 16-m hook height provides 4-m clearance above the large dipole magnet. Another 5 m is allowed for the crane plus the crown of the dome, so that the floor-to-peak height of this hall is 21 m.

Assembly Hall - The inside dimensions of the assembly hall are 50 m long by 18 m wide, with a hook height of 16 m. As stated in Section 3.3.1, this hall is sized to allow preassembly of all of the detector components before transfer to and installation in the collision hall.

One end of the assembly hall is dedicated to the construction of the large dipole magnet and its related components. The remaining space is required for assembly of the other components, as described in Section 3.3.6, and shown in Figures 3-13 and 3-14.

3.3.3 Shafts and Tunnels

Only two shafts were modeled for the Bottom Collider Detector: an equipment shaft and a personnel and services shaft. These shafts are on either end of the assembly hall and connected to this hall by short tunnels at floor level. Two large equipment-transfer tunnels are also provided between the assembly and collision halls at strategic positions with respect to the interaction point and detector assembly. A labyrinth is included for personnel and utility access between the two halls.

One excavation tunnel is provided between the equipment shaft and the crown of the collision hall. Two more excavation tunnels are provided at each end of the assembly hall at crown level, one from the equipment shaft and one from the personnel shaft. This scheme is an alternative to the large independent excavation shaft described in Section 3.2 for the Beauty Spectrometer model.

Dimensions and features of these shafts and tunnels are as follows:

- The 9-m-diameter equipment shaft is approximately 15 m away from one end of the assembly hall (the end farthest from the interaction point). This shaft is placed so that the excavation tunnel leading from it to the hall is on the hall centerline. The shaft extends 157 m from floor level to the surface facilities, and it includes a stairwell and vent duct.

- The 7-m-diameter personnel and services shaft is approximately 11 m away from the other end of the assembly hall (the end closest to the interaction point). It is also located so that the excavation tunnel enters at the crown height of the collision hall on the hall centerline.

- Two transfer tunnels connect the collision hall and assembly hall. Each is approximately 7 m wide by approximately 14 m high by 19 m long. One of these tunnels is situated directly opposite the interaction point, to allow transfer in and out of the large dipole and its attached components. The second tunnel is situated close to the end of the assembly hall. These tunnels will both be filled with three shielding blocks, each 4 m thick, with a width and height to match the tunnel dimensions. This creates a total shielding thickness of 12 m. During installation or major maintenance, these blocks must be moved and stored in the collision and assembly halls. A scheme for storing these blocks is shown in Figure 3.9.

- The excavation tunnels consist of 4-m by 4-m sections to allow for equipment. The tunnel from the collision hall to the equipment shaft is approximately 30 to 35 m long, and includes some curved sections. The other two excavation tunnels are short and straight.

3.3.4 Cranes

As in the Beauty Spectrometer model, two top-running bridge cranes are provided for the underground facilities, one for each hall. These cranes are shown as 25/5-ton, dual hook, single trolley cranes. The assumption is that all components not designed for roll-in, roll-out operation may be assembled in subassemblies weighing less than 25 tons.

3.3.5 Air Conditioning, Cooling, and Ventilation Systems

The cooling and vent ducts for the halls shown in this model were copied from the Beauty Spectrometer model. No other information was available regarding required cooling loads.

3.3.6 Assembly Sequence

The basic outline of the detector was used to establish the dimensions of the collision hall; this study does not allow for additional lay-down or assembly space in the collision hall. The dimensions of the below-ground assembly area were estimated by devising a crude construction sequence for the detector. The construction sequence is illustrated in Figure 3-13 and Figure 3-14 and described as follows:

Phase 1 - During phase 1, the steel for the large and small dipole magnets is assembled, as are the muon toroids. This assembly could occur with or without shielding in place between the collision and assembly halls.

Phase 2 - During phase 2, the muon toroids (instrumented steel) and the small magnet are moved into the collision hall from the assembly hall. Work continues on the large superconducting dipole magnet and begins on the assembly of tracking chamber packages, RICH devices, and the electromagnetic calorimeter.

Phase 3 - In phase 3, the tracking apparatus, RICH devices, and electromagnetic calorimeters may be installed in the collision hall. The large dipole magnet is moved so that it is ready to be rolled into the collision hall. Installation of detector components in the dipole aperture and on the magnet begins.

Phase 4 - During phase 4, the instrumentation of the large dipole is completed, and it is ready to be rolled into the collision hall.

This particular construction sequence is obviously not unique and may also not be optimal; however, it does show that the assembly area space provided will be adequate for the work required.

3.3.7 Parameter Tables

The following parameter tables list physical dimensions for the Bottom Collider Detector (150 m depth) halls, labyrinth, and tunnels, as well as specifications for the collision hall HVAC system.

BOTTOM COLLIDER DETECTOR PARAMETER TABLES

a.) Physical Parameters Table - Underground Halls and Tunnels

Model: Bottom Collider Detector
Location: Deep Location (150M)
Ref. Dwgs: 05-M-03

AREA	Dimensions (meters) W	L	H (max)	Volume (M3 x 1000) TOTAL	CROWN	TO ARCH	Crane Hook Ht (M)	Cap (t)	Remarks
Collision Hall	18	60	21	22.5	5.2	17.3	16	25/5	
Assembly Hall	18	50	21	18.8	4.4	14.4	16	25/5	
Transfer Tunnel No. 1	7	19	14	1.84	0.11	1.73			
Transfer Tunnel No. 2	7	19	14	1.84	0.11	1.73			
Personnel Shaft Tunnel	3.5	11.3	3.75	0.13	0.04	0.09			
Equip. Shaft Tunnel	9	14.5	7	0.84	0.25	0.59			
Labyrinth	3	25.8	5	0.39					
Excavation Tunnel No. 1	4	47.3	4	0.76					
Excavation Tunnel No. 2	4	11	4	0.18					
Excavation Tunnel No. 3	4	14	4	0.22					
TOTAL				47.5	10.11	35.84			

b.) Utilities Parameters Table - Underground Halls

Model: Bottom Collider Detector
Location: Deep Location (150M)
Ref. Dwgs: 05-M-03

AREA	MECHANICAL Cooling Water M3/MIN	Plant Air M3/MIN	HVAC Air Heat Load (kw)	Air Cooling (TONS)	Ventil. (M3/hr x 1000)	POWER Volts	Demand kw	COMMUNICATIONS
Collision Hall			400	114				
Assembly Hall								

CHAPTER 4 UNDERGROUND FACILITIES - NEAR SURFACE LOCATION

4.1 LARGE SOLENOID DETECTOR MODEL

4.1.1 General Description

The design of the near surface facilities for the Large Solenoid Detector model is based on the same assumption as the deep location (150-m) design, namely, that the detector will be built in place on the beamline. The facilities will include an underground collision hall and above-ground assembly areas, with equipment, supplies, and utilities entering the hall via shafts and tunnels. An additional feature of the near surface model is a large above-ground shielding mound, required because the roof of the collision hall is essentially at grade level. Views of these facilities, including the surface facilities, are shown in Figures 4-1 through 4-4.

4.1.2 Collision Hall

The basic dimensions of the collision hall are the same as for the deep location: 80 m long by 28 m wide with a hook height of 25 m.

The roof of the hall will be a thick, reinforced, pretensioned or post-tensioned concrete structure designed to support the weight of the shielding mound. For access during construction, two 9-m by 12-m cutouts are provided in the roof, over which a 200-ton gantry crane runs on rails. These access holes will be covered by shielding blocks and the shielding mound during collider operation.

4.1.3 Shafts and Tunnels

In addition to the rectangular access holes in the collision hall roof, two circular shafts provide permanent access to the collision hall.

A 9-m-diameter equipment shaft with a stairwell and vent duct is provided on the side of the collision hall closest to ring center. This shaft is approximately 25 m from the collision hall wall, with the bypass tunnel running between the hall and the shaft. This distance allows for shielding of the bypass tunnel and construction of the shaft/tunnel intersection. An access tunnel to the bypass tunnel is provided at bypass level.

The shaft extends from the collision hall floor level up to the surface and emerges inside the surface assembly building. A 100/100-ton crane in this building has direct access to the shaft.

A 7-m-diameter personnel and services shaft is on the side of the collision hall away from ring center. This shaft extends from hall floor level to the office building and includes an elevator, stairwell, vent duct, and utilities chase. Because of the requirement for a shielding mound above the surface, the shaft is approximately 20 m away from the collision hall wall.

A 3-m-diameter utility bypass is provided on the ring side of the hall, similar to the deep location model. For shielding purposes, it is 13 m away from the collision hall wall.

4.1.4 Shielding

The required shielding mound above the collision hall roof is assumed to be approximately 12.5 m thick. The assumption is that the hall may be constructed without internal shielding around the beam line. With internal shielding or with a detector in place, a much smaller external shielding mound would be sufficient.

4.1.5 Cranes

Two overhead bridge cranes with 100/100-ton and 100/20-ton capacities are provided in the collision hall just as in the deep location model.

4.1.6 Air Conditioning, Cooling, and Ventilation Systems

The hall cooling system for this model is identical to that designed for the deep location model.

4.1.7 Parameter Tables

The following parameter tables list physical dimensions for the Large Solenoid Detector (near surface location) collision hall and tunnels as well as utility specifications for the collision hall air conditioning, cooling, and ventilation systems.

LARGE SOLENOID DETECTOR PARAMETER TABLES

a.) Physical Parameters Table - Underground Halls and Tunnels

Model: Large Solenoid Detector
Location: Near Surface Location (23M)
Ref. Dwgs: 02-M-03,04

AREA	Dimensions (meters) W	L	H (max)	Volume (M3 x 1000) TOTAL	CROWN	TO ARCH	Crane Hook Ht (M)	Cap (t)	Remarks
Collision Hall	28	80	29.5	66.1	10.1	56	25 25	100/100 100/20	Dual Trolleys
Personnel Shaft Tunnel	3.5	27	5	0.42	0.13	0.29			
Equip. Shaft Tunnel	9	31	7	1.75	0.5	1.25			
TOTAL				68.27	10.73	57.54			

b.) Utilities Parameters Table - Underground Halls

Model: Large Solenoid Detector
Location: Near Surface Location (23M)
Ref. Dwgs: 02-M-03,04

AREA	MECHANICAL Cooling Water M3/MIN	Plant Air M3/MIN	HVAC Air Heat Load (kw)	Air Cooling (TONS)	Ventil. (M3/hr x 1000)	POWER Volts	Demand kw	COMMUNICATIONS
Collision Hall			1000	285	76.5			

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4.2 BEAUTY SPECTROMETER MODEL

4.2.1 General Description

The major features of the near surface facilities for the Beauty Spectrometer model are shown in Figures 4-5 through 4-7, with the below-ground arrangement depicted primarily in Figure 4-7. Key concepts of this arrangement are:

- The below-ground assembly hall is considerably smaller than in the deep location model, because most of the preassembly of the detector will take place in the surface assembly building.
- There is a single transfer tunnel opposite the interaction point leading from the assembly hall to the collision hall. Thus, the detector must be assembled in sequence, starting with the forward spectrometer components located farthest from the interaction point. Also, some of the preassembly will take place in the collision hall itself.
- There is sufficient earth cover above the collision hall at this depth that an additional shielding mound is not required.
- An independent personnel shaft and labyrinth tunnel provide secondary access to the collision hall.

4.2.2 Halls

Collision Hall - All of the features and dimensions for this case are identical to the deep location model, except for the design of the roof. For this model, the roof will be a solid concrete structure, designed to withstand the earth pressures above it. No cutouts have been provided in this roof, as all assembly and installation will take place through the assembly hall.

Assembly Hall - The assembly hall is 25 m long by 15 m wide by approximately 29 m deep, extending from the surface assembly building to the collision hall floor level. It is separated from the collision hall by a 21-m-long transfer tunnel; the shielding requirements of the offices at the surface determine this tunnel length.

There are two mezzanine floors between the surface and the hall floor: one directly above the assembly hall crane, and a second midway between the first mezzanine and the surface. These floors may be used for material storage and/or assembly of components. The surface assembly building floor and each of these two mezzanine floors has a 6-m by 6-m cutout to lower or raise material from the assembly hall floor.

4.2.3 Shafts and Tunnels

This model has only one shaft, designed for the independent personnel elevator that provides access to the collision hall. Tunnels include one transfer tunnel, two labyrinth tunnels, and the utility bypass tunnel.

- o The personnel shaft is approximately 3.5 m in diameter and contains only an elevator. It is near the end of the collision hall, away from the interaction point and far enough from the hall wall for adequate shielding. Access to the collision hall is via a 3-m by 5-m labyrinth tunnel.

- o A second labyrinth tunnel is located between the assembly hall and the collision hall.

- o A transfer tunnel, 7 m wide by 7 m high by 21 m long, connects the assembly hall to the collision hall. It is located directly opposite the interaction point to allow roll-in and roll-out of intermediate-sized spectrometer components. This tunnel incorporates a moveable shielding block with a built-in pocket for shield storage during installation and maintenance.

- o The 3-m-diameter utility bypass tunnel is on the ring center side of the assembly hall.

4.2.4 Shielding

As discussed in Section 4.2.1, the depth of the beam and the height of the collision hall roof are designed so that the 12.8-m earth cover provides adequate shielding for this model.

Shielding between the collision hall and the assembly hall is effectively provided by shielding blocks, labyrinth tunnel design, and the separation of the two halls.

4.2.5 Cranes

Cranes for the underground facilities for this model are identical to those for the deep location case: one 25/5-ton crane in each of the collision and assembly halls.

4.2.6 Air Conditioning, Cooling, and Ventilation Systems

The hall cooling system for this model is identical to that designed for the deep location model.

4.2.7 Parameter Tables

The following parameter tables list physical dimensions for the Beauty Spectrometer (near surface location) halls, shield door cavity, labyrinth, and tunnels, as well as specifications for the collision hall air conditioning, cooling, and ventilation systems.

BEAUTY SPECTROMETER PARAMETER TABLES

a.) Physical Parameters Table - Underground Halls and Tunnels

Model: Beauty Spectrometer
Location: Near Surface Location (23M)
Ref. Dwgs: 04-M-02,03

AREA	Dimensions (meters) W	L	H (max)	Volume (M3 x 1000) TOTAL	CROWN	TO ARCH	Crane Hook Ht (M)	Cap (t)	Remarks
Collision Hall	16	104	17	28.3	5	23.3	14	20/5	
Assembly Hall	15	25	29.75	11.2	7.8	3.4	9	20/5	
Transfer Tunnel	7	21	7.5	0.98	0.4	0.58			
Shield Door Cavity	8	9	8	0.58					
Labyrinth No.1 (Ass'y Hall)	3	29.2	5	0.44					
Labyrinth No.2 (Personnel Shaft)	3	28.2	5	0.42					
TOTAL				41.92	13.2	27.28			

b.) Utilities Parameters Table - Underground Halls

Model: Beauty Spectrometer
Location: Near Surface Location (23M)
Ref. Dwgs: 04-M-02,03

AREA	MECHANICAL Cooling Water M3/MIN	Plant Air M3/MIN	HVAC Air Heat Load (kw)	Air Cooling (TONS)	Ventil. (M3/hr x 1000)	POWER Volts	Demand kw	COMMUNICATIONS
Collision Hall			400	114				
Assembly Hall								

4.3 BOTTOM COLLIDER DETECTOR

4.3.1 General Description

The major features of the Bottom Collider Detector model at near surface are shown in Figures 4-8 through 4-10. Many concepts are similar to previous models, but some are new, including the following:

- o A permanent access ramp extends from the floor of the assembly hall to the surface at a grade of 10 percent.
- o A secondary access tunnel is provided between the ramp and the beam tunnel.
- o The collision hall and assembly hall floor plan dimensions are identical to the deep location Bottom Collider Detector model. However, the assembly hall in this model is called an assembly pit, as it is without ceiling and open to the surface. The same crane services both the assembly pit and the surface assembly facilities.
- o The size of the above ground shielding mound is determined by the depth of the beam and the height of the roof: the near-surface version of the Large Solenoid Detector requires a large mound; the Beauty Spectrometer requires no mound; and the Bottom Collider Detector requires a small mound.

4.3.2 Halls

Collision Hall - The dimensions of the collision hall are identical to those of the Bottom Collider Detector's deep location model, except that a large concrete roof will be constructed in lieu of the arch. This roof does not require cutouts, because all equipment is first assembled in the assembly hall and then transferred to the collision hall through the transfer tunnels.

Assembly Pit - The plan dimensions of this pit are identical to those of the assembly hall in the Bottom Collider Detector deep location model, except that this pit is open to the surface. The walls extend vertically to the surface without a ceiling, and this open pit forms a portion of an enclosed surface assembly building. There are work areas at the surface level on either end of the pit, and a single overhead crane services both the pit and the surface work areas.

An elevator and a stairwell are provided in one corner of the assembly pit for personnel access to the pit floor and collision hall via the transfer tunnels or labyrinth.

4.3.3 Shafts and Tunnels

No shafts are required for this model. Two transfer tunnels and one labyrinth provide a route between the assembly pit and the collision hall.

A key design concept of this model is a permanent access between the surface and the assembly pit floor. This ramp will also be used during excavation and construction of the halls. The ramp dimensions are 6 m wide by 6 m high for the 120 m of tunnel section of the ramp. The exposed section of the ramp is 6 m wide with a wall height that diminishes from 18 m to zero, as the ramp ascends to the surface.

The access tunnel from the access ramp and the beam tunnel is 5 m wide by 5 m high and runs horizontally between the tunnels at an included angle of approximately 30 degrees.

4.3.4 Shielding

Approximately 1.5 m of additional shielding mound is required above the collision hall at the surface. Shielding blocks identical to those for the deep location model are required for the transfer tunnels. The placement scheme for these blocks is also identical to that of the deep location model.

4.3.5 Cranes

A 24/5-ton bridge crane with a hook height of 16 m, similar to those of the previous model, is provided for the collision hall.

A second 50/10-ton bridge crane with a hook height of 38 m serves both the surface assembly building and the pit.

4.3.6 Air Conditioning, Cooling, and Ventilation Systems

Cooling and ventilation requirements are assumed to be similar to the deep location Bottom Collider Detector model.

4.3.7 Parameter Tables

The following parameter tables list physical dimensions for the Bottom Collider Detector (near surface location) halls, labyrinth, tunnels, and ramp, as well as specifications for the collision hall air conditioning, cooling, and ventilation systems.

Table 4-3

BOTTOM COLLIDER DETECTOR PARAMETER TABLES

a.) Physical Parameters Table - Underground Halls and Tunnels

Model: Bottom Collider Detector
Location: Near Surface Location (23M)
Ref. Dwgs: 06-M-02,03

AREA	Dimensions (meters) W	L	H (max)	Volume (M3 x 1000) TOTAL	CROWN	TO ARCH	Crane Hook Ht (M)	Cap (t)	Remarks
Collision Hall	18	60	19	20.5	3.2	17.3	16	25/5	
Assembly Hall	18	50	30	27	(Open)		39	50/10	
Transfer Tunnel No. 1	7	26.5	14	2.6					
Transfer Tunnel No. 2	7	26.5	14	2.6					
Excavation Ramp (Tunnel)	6	120	6	4.3					
Excavation Ramp (Exposed)	6	180	0-18	9.7					
Labyrinth	3	33.3	5	0.5					
TOTAL				67.2	3.2	17.3			

b.) Utilities Parameters Table - Underground Halls

Model: Bottom Collider Detector
Location: Near Surface Location (23M)
Ref. Dwgs: 06-M-02,03

AREA	MECHANICAL Cooling Water M3/MIN	Plant Air M3/MIN	HVAC Air Heat Load (kw)	Air Cooling (TONS)	Ventil. (M3/hr x 1000)	POWER Volts	Demand kw	COMMUNICATIONS
Collision Hall			400	114				
Assembly Hall								

CHAPTER 5 SURFACE FACILITY EXAMPLE

This chapter describes an example surface facility for the Large Solenoid Detector in a deep site location, which can be used as a guide for designing the surface facilities for the SSC. The first of the chapter's four sections presents the general organization of the surface area, and the subsequent sections discuss the three main groups of surface facilities: the detector preassembly unit, the utilities plant, and the office area. At the end of the chapter is a parameter table, which lists specifications for site circulation, detector preassembly, utilities, and office needs for this model.

This example facility is limited, because no details of the specific experiments to be conducted at the SSC are outlined at present. Also, the example does not include parameters such as location, topography, or other site-specific conditions.

5.1 SITE ORGANIZATION

Figure 5-1 depicts the relationships between the various site areas. Each box contains one specific set of facilities, grouped and titled according to its function. The groups, which will be studied separately in the following sections, are linked to one another by a network of roads, shafts, and tunnels, all called the site circulation system.

Figure 5-1 shows how the surface facilities may be divided into three main areas:

- Detector preassembly area
- Utilities plant
- Office building

The detector preassembly area is, in turn, divided into three units: the external detector components, the coil, and the central detector components. The utilities plant consists of two units: the utilities needs and utilities storage area. The office building has three distinct parts: the administration section, the experiment control section, and the living area.

5.1.1 Underground Facilities

In order to build and operate this experimental area quickly, safely, economically, and efficiently, the surface facilities are organized to correspond closely to the underground facilities.

The main underground facility is the collision hall, which contains a detector centered on the interaction point of the particle beams (Figures 5-2 and 5-3). The collision hall is connected to the surface facilities by four main shafts: one construction shaft (C1), two personnel and utilities shafts (P1 and P2, a close-up view of which is shown in Figure 5-4) and one equipment shaft (E1, not visible in Figure 5-2).

The detector occupies most of the underground hall; it is a massive assembly of iron, cables, and pipes 18 m high, 18 m wide, and 50 m long, with a total weight of approximately 38,000 tons.[1] The main electrical and gas supplies for the detector are located on the surface in the utilities plant area (see Section 5.3).

This model detector, which will be assembled in place in the collision hall, is designed in a modular fashion to speed up construction. Many of the modules will be built in the surface facility, (see Section 5.2) and then lowered to the collision hall by either the construction shaft or the equipment shaft. These shafts together provide access to both ends of the collision hall.

During operation, the particle collision data are stored and studied in the surface office building (see Section 5.4, Office Needs).

5.1.2 Surface Plan

Surface Plan During Underground Construction - During the 27-month underground construction period, the surface site will be organized into six areas (see Figure 5-5), which will eventually become the various surface facilities. The shafts will be excavated simultaneously, starting with C1, followed by P1, E1, and finally P2.

C1 will be equipped with a 30- by 30-ton gantry crane and mucking gear; P1 will be equipped with a personnel elevator (Alimak type), a concrete gear, and mucking gear.

As shown in Figure 5-5, the first area ready for surface facilities will be area 1, then area 2, and so on through area 6. Area 6 contains the utilities (electrical transformers, diesel generator, and air compressors), the 60-vehicle parking lot, and the personnel facilities (including canteen, changing room, and 20 offices).

Surface Plan During Operation - During operation, the surface facilities remain closely connected to the underground facilities: the shafts between them are situated along a central axis, except for the equipment shaft, which is in one of the detector preassembly buildings. (See Figure 5-6, Surface Organization, and Figure 5-7, Surface Plan.) Other key elements, such as the office building and the access to the site, are along that same central axis, with the remaining facilities arranged symmetrically on either side. The circulation system is very simple and effective, as it consists of one main loop circling the central facilities, providing easy access to every area. This system is also designed so that it can be easily and efficiently extended.

5.1.3 Site Circulation System

The site circulation system is a network of roads, shafts, and tunnels connecting the different functional areas of the site. The component parts of this system are:

Site Access Control - The security-and-control equipment building at the site entrance controls access to the site. There is direct communication from this control point to the experiment management group and to the central laboratory fire and security department.

Roads and Unloading Areas - The roads and unloading areas are designed to provide a safe and efficient circulation system that will not delay the construction schedule.

Parking Lots and Storage Area - The main outside storage area is in parking lot 2. Other areas at several locations on the site can also be used for outdoor storage of equipment and materials. The parking lots are sized to accommodate 200 cars and 26 trucks, distributed as follows:

Parking 1:	94 cars	
Parking 2:	49 cars	6 trucks
DPA buildings:	20 cars	12 trucks
P2 shaft:	15 cars	4 trucks
Utilities plant:	20 cars	4 trucks
Site access:	3 cars	

Shafts - The underground and surface facilities are connected to one another by four shafts: the construction shaft, the equipment shaft, and two personnel and utilities shafts.

- The construction shaft (C1) is connected to one end of the collision hall, and provides an access for the large pre-assembled detector pieces, such as the two parts of the coil (weighing 400 tons each) and some of the magnetized iron pieces for the muon detector. It will also be used as an access and excavation shaft during the construction of the underground infrastructures. This shaft will be equipped with a 2-ton by 30-ton gantry crane during underground construction and with a 200-ton gantry crane during the assembly of the detector. Because this shaft is located directly over the collision hall (see Figures 5-2 and 5-5), a five-m-thick concrete radiation shield is provided on top of the shaft.

- The equipment shaft (E1) provides access to the collision hall for the smaller or lighter detector pieces, such as the calorimeter modules (weighing up to 100 tons each), the central tracking chamber, the muon tracking chamber, the planar chamber, and the vertex detector. The equipment shaft is located at the opposite end of the collision hall for efficient detector assembly.

- For safety, two personnel and utilities shafts (P1 and P2) are provided, one at each end of the collision hall. These shafts are equipped with overpressurized rooms at their top and bottom, and provide a buffer for evacuation of personnel. Each shaft includes a 2-ton elevator (25-person capacity), a stairwell, and separate sections for the ventilation, electrical, communication, gas, cooling, and cryogenics systems (see Figure 5-4). This safety system has been successfully tested at similar projects[2].

5.2 DETECTOR PREASSEMBLY BUILDING

The detector preassembly building (Figure 5-8) consists of three units: the external detector components (EDC), the coil assembly area, and the central detector components (CDC).

5.2.1 External Detector Components (EDC)

The external detector has two distinct components: the iron flux return yoke and the muon-tracking chamber. The iron flux return yoke is the heaviest part of the detector (16,000 tons).

The EDC area includes the following:

Receiving - The receiving area provides efficient material movement from the outside to each EDC facility. The main door is 12 m wide and 10 m high.

Storage - The storage area provides some storage for the thousands of tons of equipment that will transit the EDC area.

Technical Room - The technical room contains the EDC area's command board for electrical, lighting, heating, and ventilation systems. It also includes a cleaning and maintenance room, rest rooms, and a changing room.

Muon-Tracking Chamber - The muon-tracking chamber provides space for some assembly or repair of muon chamber modules up to 8 m long. Space is also provided for module testing.

Iron Yoke Assembly Area - Although the iron yoke is designed to be assembled directly in the collision hall, the iron yoke assembly area provides space for preassembly of the 100-ton modules to minimize work in the underground areas.

5.2.2 Coil

The coil is the detector element that creates the 2-Tesla magnetic field surrounding all the central detector components. It is made of two solenoids, 9.5 m in diameter and 8 m long, and each 8-m unit will contain four identical 2-m-long liquid helium/coil modules. The modules are mechanically connected and share a common vacuum vessel. These two half-coils will be lowered into the collision hall after testing[3].

The coil area is divided into six units: the receiving area, the technical room, and the winding, welding, testing, and storage areas. These last four areas are designed specifically for the construction of this particular coil.

Receiving - The receiving area provides efficient material and personnel movement from the outside to each coil facility. The main door is 12 m wide and 10 m high.

Storage Area - The modules and other elements are stored in this location when not in use. Each module is 1.7 m long, with an inner diameter of 8.2 m and an outer diameter of 9.2 m, and weighs 56 tons. The modules are made of copper, aluminium, and stainless steel and use liquid helium as a cryogenic fluid. Also, after testing, the half-coil is rotated 90 degrees to its final orientation in the storage area before being lowered to the collision hall. The horizontal section of the half coil measures 7.82 by 9.20 m^2.

Technical Room - The technical room contains the coil area command board for electrical, lighting, heating, and ventilation systems. It also includes a cleaning and maintenance room, rest rooms, and a changing room.

Winding Area - Each module is assembled and wound in the winding area. Winding will be done with the coil axis vertical. After winding, the inner shell of the helium vessel will be welded to the coil form.

Welding Area - After it is wound, the module is placed in the welding area, where the half coil is assembled. The modules are placed horizontally on top of each other and welded.

Testing Area - Once the half coil is completely assembled, it is tested before being lowered to the collision hall, where it will be placed in its final position.

5.2.3 Central Detector Components (CDC)

The central detector components are grouped together because they are parts of the same detector unit, all located inside the coil. They are also grouped together by loading requirements, since the various components will be handled by the same 20-ton crane.

The CDC area is composed of the following:

Receiving Area - The receiving area provides efficient material movement from the outside to each area of the CDC facility. The main door is 12 m wide and 6 m high.

Storage Area - The storage area is large enough to hold the arriving modules as well as the tested equipment awaiting removal from the building.

Technical Room - The technical room contains the CDC building's command board for electrical, lighting, heating, and ventilation systems. It also includes a cleaning and maintenance room, rest rooms, and a changing room.

Central Calorimeter Preassembly Area - Although the central calorimeter barrel and calorimeter caps are assembled in the collision hall, the calorimeter is preassembled in modules in this 250-m^2 area to speed up the construction. The total weight of the central calorimeter will be 5,700 tons, but each module (which will be made of lead, iron, or uranium) may weigh as much as 20 tons.

Forward Calorimeters Preassembly Area - There are two forward calorimeters (one at each end of the main detector), and their total weight is only 700 tons (350 tons each). The modules for the forward calorimeters will be assembled in an area next to the central calorimeter preassembly area.

Calorimeter Modules Test Area - Next to the assembly area for the calorimeter modules is an area where they are subsequently tested. Testing the modules is the last step before they are lowered to the collision hall for final assembly.

Planar Chamber Assembly and Test Area - The planar chambers are assumed to be disks 3.2 m in diameter and 0.15 m thick. Thirty of these chambers will be made and tested in this area. The chambers are assembled horizontally on two large tables. In the testing area, the chambers are assembled in groups and tested vertically.

Central Chamber Assembly Area - The central chamber is a 4-m-long cylinder, measuring 3.2 m in diameter, which must be assembled and tested in a clean room.

5.3 UTILITIES PLANT

The utilities plant supplies the power required for the experiment. In addition to the usual facilities, this area has five specific units: the electrical, cooling, ventilation, and cryogenic units and the unit that supplies gas as needed.

This group of facilities consists of two main subareas: the utilities building and the utilities storage area, which contains equipment located outside the building for functional or safety reasons.

5.3.1 Utilities Building

The utilities building (shown in the top half of Figure 5-9), consists of facilities that have been developed in similar projects[4]. These facilities are described below:

Receiving Area - The receiving area provides efficient material movement from the outside to each facility. The main door is 8 m wide and 6 m high.

Storage Area - The storage area is large enough to hold equipment awaiting installation.

Technical Room - The technical room contains the building command board for electrical, lighting, heating, and ventilation systems. It also includes a cleaning and maintenance room, rest rooms, and a changing room.

Cooling Unit - The cooling unit has several demineralized water pumps available for the conventional cooling of the major part of the experiment.

Electrical Control Area - The electrical control area houses the electricity distribution equipment. It has a double floor to allow for the assorted pipes and cables passing to a personnel and utilities shaft.

Ventilation Plant - The ventilation plant houses the main air conditioning installations and generates the ventilation required in the underground experimental area. Two different modes of operation are possible: a normal mode and a smoke extraction mode for fast evacuation of smoke or explosive gases from the collision hall. The required ventilation during routine operation is two air changes per hour, which would increase to four air changes per hour during emergency operation.

Several refrigerators in the ventilation plant produce cold water. Each of these refrigerators consists of two independent freon compressors associated with an evaporator, two water condensers, and three large air condensers.

Water Supply - In addition to the distribution systems for the demineralized cooling water and the water for air conditioning, two other systems are provided for the experimental area: the distribution network for untreated water (air conditioning, toilets, etc.) and an independent water distribution network pressurized at 5 bars. This independent network supplies hydrants at surface level and water hoses in the underground compartments for fire protection; it also supplies sprinklers located inside the cable compartments of the two personnel and utilities shafts.

Helium Compressors - The helium compressors are used to make the cryogenic fluid that cools the superconducting coil. A refrigerator supplies helium to two 5,000-l storage dewars located on top of the flux return yoke of the detector.

5.3.2 Utilities Storage

Utilities storage is close to the utilities building to minimize the number of links (cables and pipes) needed between these two facilities. However, for adequate fire and explosion protection, 20 m should separate the two areas.

Electrical Transformers - This is the distribution point for electricity to the various facilities.

Helium Storage Tanks - Helium is the cryogenic fluid used to cool the superconducting coil. Some 20 m^3 of helium gas are stored at a pressure of 20 bars. High-pressured helium (200 bars) and nitrogen are also available.

Detector Gas Mixing Building - This small building houses storage for the detector gases. Here, the different available gases are mixed, purified, and pressurized. Some storage tanks are adjacent to this building.

Cooling Tower - A cooling tower is the most efficient available cooling system. Since it generates a certain amount of noise and steam, it is located away at one end of the site.

5.4 OFFICE NEEDS

Located on the experimental area site, this three-story facility is divided into five main units: the office area on floor 3; conference rooms and CAD stations on one half of floor 2; the control area on the remainder of floor 2; the experiment administration section on floor 1; and the living area, also on floor 1 (see Figures 5-10 through 5-13). Approximately 250 people would work here. This building is next to the personnel shaft P1 to provide convenient access to the underground facilities and to simplify the connections linking the control rooms to the detector and the various underground facilities.

5.5 PARAMETER TABLES

The following parameter tables list specifications for site circulation, detector preassembly, utilities, and office needs for the Large Solenoid Detector model in a deep site location. The total land surface occupied by the facilities is also shown. This total closely approximates plans for similar projects[5].

Table 5-1

EXAMPLE SURFACE FACILITIES

PARAMETER TABLES

1. SITE CIRCULATION

Equipment	: Surface (m^2)	Height(m)	Crane(tons)
Site access control	: 50		
Outside storage	: 1,800		
Roads and unloading areas	: 5,000		
Parking	: 6,280		
Construction shaft (9 by 12 m)	: 1,600	15	200
Personnel shaft (7-m dia)	200	6	
Personnel shaft (7-m dia)	: 200	6	
Total 1	**: 15,130**		

2. DETECTOR PREASSEMBLY

Equipment	: Surface (m^2)	Height(m)	Crane(tons)
Central detector components			
Receiving	: 192	6	20
Storage	: 210	6	20
Technical room	: 30		
Circulations	: 196		
Forward detector assembly clean room	: 117	6	20
Calorimeter modules assembly	: 247	6	20
Calorimeter test	: 78	6	20
Planar chamber assembly	: 247	6	20
Planar chamber test	: 78	6	20
Central chamber assembly and test	: 117	6	20
External detector components			
Receiving	: 234	12	100
Storage	: 387	12	100
Technical room	: 54		
Circulations	: 200		
Equipment shaft (9-m dia)	: 195	12	100
Muon chamber assembly and test	: 585	12	100
Iron assembly	: 585	12	100
Coil			
Receiving	: 264	15	100
Storage	: 252	15	100
Technical room	: 60		
Circulations	: 412		
Winding	: 696	15	100
Welding	: 432	15	100
Testing	:		
Total 2	**: 6,300**		

Table 5-1 (Cont)

3. UTILITIES PLANT

Equipment	: Surface (m^2)	Height(m)	Crane(tons)
Receiving	: 240	6	20
Storage	: 128	6	20
Technical	: 40		
Circulation	: 400		
Cooling system	: 312	6	20
Electrical control	: 336	6	20
Ventilation plant	: 560	6	20
Helium compressors	: 560	6	20
1,500 kVA transformers	: 260		
5,000 gal. liquid and gas tanks	: 260		
Detector gas mixing	: 540		
Cooling tower	: 300		
Total 3	**: 3,936**		

4. OFFICE NEEDS

Equipment	: Surface (m^2)	Height(m)	Crane(tons)
Experiment control	: 300		
Cryogenics	: 200		
Electronics	: 200		
Facilities	: 200		
Experiment administration	: 300		
Scientific staff	: 1,200		
Data storage	: 150		
Facilities management	: 50		
Conference rooms	: 300		
Cafeteria	: 240		
Visitors information	: 200		
Sleeping area	: 50		
Changing room	: 40		
First aid and rescue	: 40		
Maintenance room	: 40		
Technical services	:		
Total 4	**: 3,600**		
Total 4 (land occupation)	**: 840**		
Total 1+2+3+4 (land occupation)	**: 26,206**		
Unoccupied land + extension	**: 40,322**		
Total site	**: 68,200**		

CHAPTER 6 CONSTRUCTION APPROACH AND SCHEDULE EXAMPLE

6.1 GENERAL ASSUMPTIONS

A construction schedule was generated using the Large Solenoid Detector hall model sited at a depth of 150 m. A dry, shallow overburden is assumed to overlie the site, it is assumed that the host rock(s) can withstand excavation of a rectangular shaft and also give long-term cavern sidewall support, when combined with shotcrete and rock-bolt support mechanisms.

6.2 PROPOSED EXCAVATION PROCEDURE

The excavation is sequenced to limit parallel excavation and lining activities. Priority is given to the establishment of the cavern roof and the installation of the site mucking and access facilities. The individual operations are outlined below.

6.2.1 Sinking of the Construction Shaft

The construction shaft will be sunk from the surface with the aid of conventional drill and blast techniques (Step 1, Figure 6-1). As the excavation advances, temporary supports will be installed, using a combination of occasional rock bolting, chain link, and a layer of shotcrete.

6.2.2 Opening the Cavern Roof

Once the shaft excavation has entered the roof of the cavern, the intersection zone will be reinforced by rock bolts. Crown drifts will then be driven along the roof, using perimeter blasting techniques (Step 2, Figure 6-1). Temporary support, consisting of a combination of systematic rock bolting, chain link, and shotcrete will be installed as excavation advances.

Roof supports will be placed, as the work advances, to ensure structural stability of the rock mass around the opening and give continuous cover for the underground personnel. The initial support, placed at crown drift level, will be installed in two passes. For all other levels, the support will be completed, as work advances, in one pass. The crown (levels 1, 2, and 3) will be developed in horizontal passes of approximately 5 m, down to the gantry-crane beam level (Step 3, Figure 6-1).

6.2.3 Permanent Support of the Cavern Roof

At gantry beam level, excavation of the cavern will be interrupted to allow placement of the crane beams and permanent roof arch (Step 4, Figure 6-1, and Step 5, Figure 6-2). This suspension of activities will allow easier access for construction of the permanent structures;

otherwise, given the height of the final excavation, access during the final stages of the excavation would present difficulties and interfere with other tasks.

A set of permanent rock anchors will support the gantry beam and roof arch. The cast-in-situ concrete of the roof arch will provide long-term support for the cavern roof and incorporate a waterproof lining to ensure umbrella-type protection above the detector zone.

6.2.4 Excavation to the Base of the Personnel Shaft (P1)

During the placement of the cavern's permanent roof support, a part of the construction shaft will be dropped down to floor level and a tunnel driven to the base of the personnel shaft (Step 4, Figure 6-1). Access to the gantry beam and roof arch operations at level 3 will be maintained throughout the excavation to the base of P1 by splitting the construction shaft floor area in two. A bank level will be established at both the roof arch and cavern floor levels.

6.2.5 Excavation of the Personnel Shaft (P1)

Once access to the shaft base is established, conventional raise-boring operations will be performed. The raise will serve as a mucking drop, once the shaft is enlarged to its final diameter by drilling and blasting (Step 5, Figure 6-2). Temporary support mechanisms will be the same as those used in the support of the construction shaft.

6.2.6 Installation of Site Access, Underground Services, and Mucking System

After breakthrough, the P1 shaft will be equipped to provide personnel access, services, and mucking for the duration of the underground construction. The construction shaft will continue to be the preferred shaft for heavy equipment access.

6.2.7 Benching the Cavern

On completion of the roof support, excavation of the main body of the cavern will begin, using conventional drill and blast benching techniques. Perimeter blasting should be practiced to minimize disturbance of the rock structure outside the excavation profile. Long-term sidewall support will be provided by systematic rock bolting, chain link, and shotcrete, installed upon excavation (Steps 6, 7, and 8, Figure 6-2).

Development of the Equipment Shaft - During excavation of bench level 5 (Step 6, Figure 6-2), a side ramp will be driven to the base of the equipment shaft. Once access is obtained, raise-boring and enlargement operations will begin, in the same manner as with the excavation of the P1 shaft. The connecting tunnel excavation will be completed as part of the normal cavern benching activities (Steps 7 and 8, Figure 6-2).

Intersecting the Beam Tunnels with the Tunnel Boring Machine (TBM) During excavation of bench level 6, beam tunnel side headings will be driven to intersect with the previously completed TBM excavation (Step 7, Figure 6-2).

Development of the Personnel Shaft P2 - During excavation of bench level 6 (Step 7, Figure 6-2), a side ramp will be driven to the base of the second personnel shaft (P2). Once access is obtained, raise-boring and enlargement operations will begin, in the same manner as with the excavation of the P1 and E1 shafts. The connecting tunnel excavation will be completed as part of the normal cavern benching activities (Step 8, Figure 6-2).

6.2.8 Final Lining of the Shafts

All the shafts will be permanently lined, using slipform techniques. One set of slipform equipment will be used, in the following sequence:

Construction Shaft - The construction shaft will be lined during the cavern and equipment shaft excavation periods (Steps 6 and/or 7, Figure 6-2). This concrete lining will incorporate structural reinforcement and a shielding frame, so that it can be sealed off during operation of the machine. A waterproof complex will be placed behind the slipform lining.

Equipment Shaft - The equipment shaft will be lined on the completion of the associated excavation activities (Step 9, Figure 6-3). A cylindrical concrete lining, incorporating a drainage complex, will be installed for long-term support.

Personnel Shafts P1 and P2 - A cylindrical concrete lining, incorporating a drainage complex, will be installed in both personnel shafts for long-term support (Step 10, Figure 6-3).

6.2.9 Foundation Works

When shaft mucking and cavern ground treatment are completed, a mass concrete floor slab will be placed. The slab will be placed in stages, progressing from the equipment toward the construction and personnel shafts (Steps 9 and 10, Figure 6-3). The shafts will be slipformed at the same time as the concrete is laid.

6.2.10 Completion Works

The site will be evacuated by using the P1 and construction shafts; this will allow for early access to the cavern for installation of mechanical, electrical, and other equipment via the equipment shaft. (Step 10, Figure 6-3).

6.3 SCHEDULE

The bar charts on the following pages present a temporal breakdown of the tasks discussed in this chapter. They are based on a 5-day work week, a work day consisting of three 8-hour shifts, and eight holidays per year. The overall time period is from January 1989 to May 1991.

The summary schedule gives an overview of the excavation tasks; the general detail schedule breaks down the summary schedule's tasks into subtasks (detail tasks); and the specific cavern detail schedule isolates the subtasks of a single major task, the cavern excavation. The activities in the summary schedule broken down into subtasks in the general and specific detail schedules are indicated by crosses. The dashed bars represent the duration of each summary task, and the solid bars represent the duration of each subtask. All tasks are listed in order of their beginning dates, the subtasks appearing directly beneath their corresponding summary tasks.

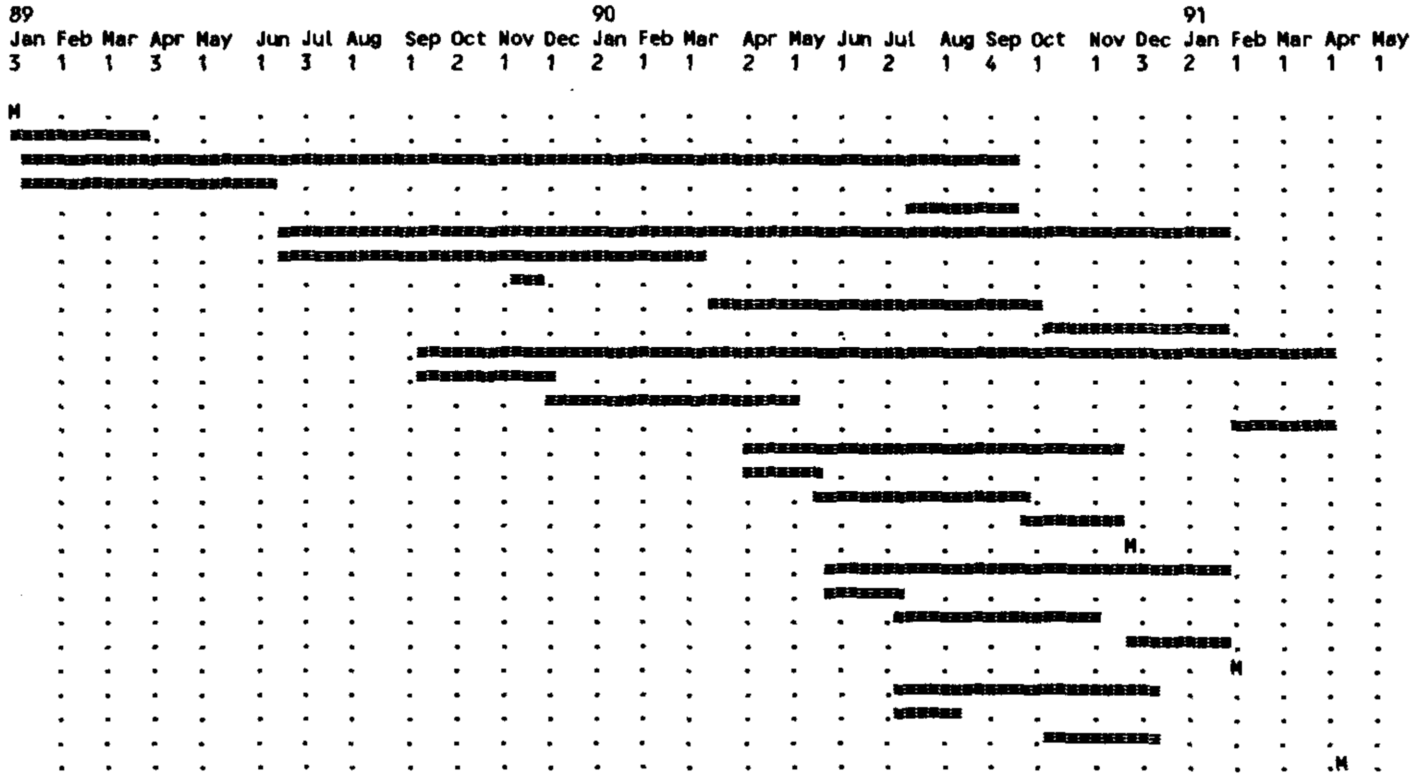
These schedules can also be used when construction is underway. As the legend indicates, the bar charts will eventually record actual starting times, slack times, schedule conflicts, and resource delays.

Table 6-1

SSC EXPERIMENTAL HALL SCHEDULE SUMMARY

Schedule Name : SSC - EXPERIMENTAL HALL
Responsible : Liria C. Larano
As-of Date : 7-Dec-88 Schedule File : C:\TL3\DATA\EXPHALL

Task Name	Duratn (Days)
AWARD CONTRACT	0
+ SITE PREPARATIONS	60
CONSTRUCTION SHAFT (C)	430
+ SHAFT SINK	110
+ CONCRETE LINING	50
CAVERN	410
+ CAVERN ROOF EXCAVATION/SUPPORT	185
+ DEVELOPMENT TO P1 ACCESS	15
+ HALL EXCAVATION & SUPPORT	145
+ FINAL WALL/FOUNDATION WORK	80
PERSONNEL ACC. SHAFT/TUNN.(P1)	395
+ SHAFT SINK (SURFACE OPS.)	60
+ SHAFT SINK (UNDERGROUND OPS.)	110
+ CONCRETE LINING	45
EQUIP. ACCESS SHAFT/TUNNEL (E)	165
+ SHAFT SINK (SURFACE OPS.)	35
+ SHAFT SINK (UNDERGROUND OPS.)	95
+ CONCRETE LINING	45
BENEFICIAL OCCUPANCY	0
PERSONNEL ACC. SHAFT/TUNN.(P2)	175
+ SHAFT SINK (SURFACE OPS.)	35
+ SHAFT SINK (UNDERGROUND OPS.)	90
+ CONCRETE LINING	45
BENEFICIAL OCCUPANCY	0
BEAM TUNNELS	115
+ EXCAVATION	30
+ LINING	50
EXPERIMENTAL HALL EXCAV. COMPL	0



Detail Task ===== Summary Task M Milestone
(Started) ==≡≡≡ (Started) >>> Conflict
(Slack) ≡≡≡— (Slack) .. Resource delay
Scale: 1 week per character

TIME LINE Gantt Chart Report, Strip 1, Page 1

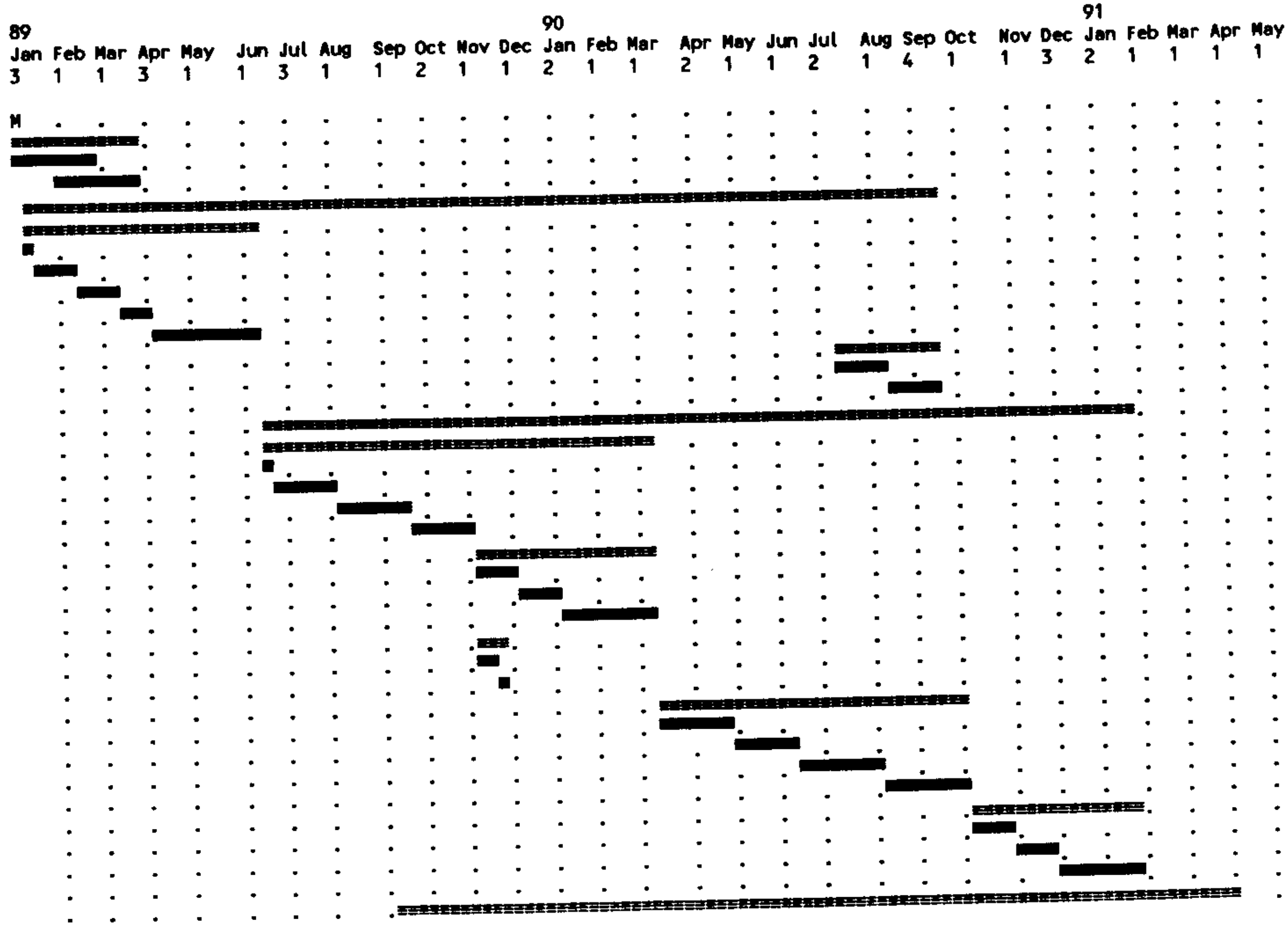
Table 6-2

SSC EXPERIMENTAL HALL SCHEDULE

GENERAL DETAIL

Schedule Name : SSC - EXPERIMENTAL HALL
Responsible : Liria C. Larano
As-of Date : 7-Dec-88 Schedule File : C:\TL3\DATA\EXPHALL

Task Name	Duratn (Days)
AWARD CONTRACT	0
SITE PREPARATIONS	60
STRIP/GRADE	40
SURFACE INSTALLATIONS	40
CONSTRUCTION SHAFT (C)	430
SHAFT SINK	110
EXCAVATE IN OVERBURDEN	5
COLLAR FOUNDATION	20
EXCAVATE IN SHALLOW ROCK	20
OVER-SHAFT INSTALLATIONS	15
EXCAVATION TO FULL DEPTH	50
CONCRETE LINING	50
SLIPFORM INSTALLATIONS	25
SLIPFORM CONCRETING	25
CAVERN	410
CAVERN ROOF EXCAVATION/SUPPORT	185
REINFORCEMENT OF INTERSECTION	5
BENCH LEVEL 1	30
BENCH LEVEL 2	35
BENCH LEVEL 3	30
GANTRY BEAM & ROOF CONST.	85
BEAM ANCHORS	20
CONCRETING OF THE BEAM	20
ROOF ARCH CONSTRUCTION	45
DEVELOPMENT TO P1 ACCESS	15
EXCAVATE 1/2 C SHAFT	10
EXCAVATE TUNNEL TO P1	5
HALL EXCAVATION & SUPPORT	145
BENCH LEVEL 4	35
BENCH LEVEL 5 (INCL. E1 RAMP)	30
BENCH LEVEL 6 (INCL. BT RAMP)	40
BENCH LEVEL 7	40
FINAL WALL/FOUNDATION WORK	80
SIDEWALL TREATMENT	20
FOUNDATION	20
SLAB	40
PERSONNEL ACC. SHAFT/TUNN.(P1)	395



Detail Task   Summary Task   M Milestone
(Started)   (Started)   >>> Conflict
(Slack)   (Slack)   Resource delay

Scale: 1 week per character

TIME LINE Gantt Chart Report, Strip 1, Page 1

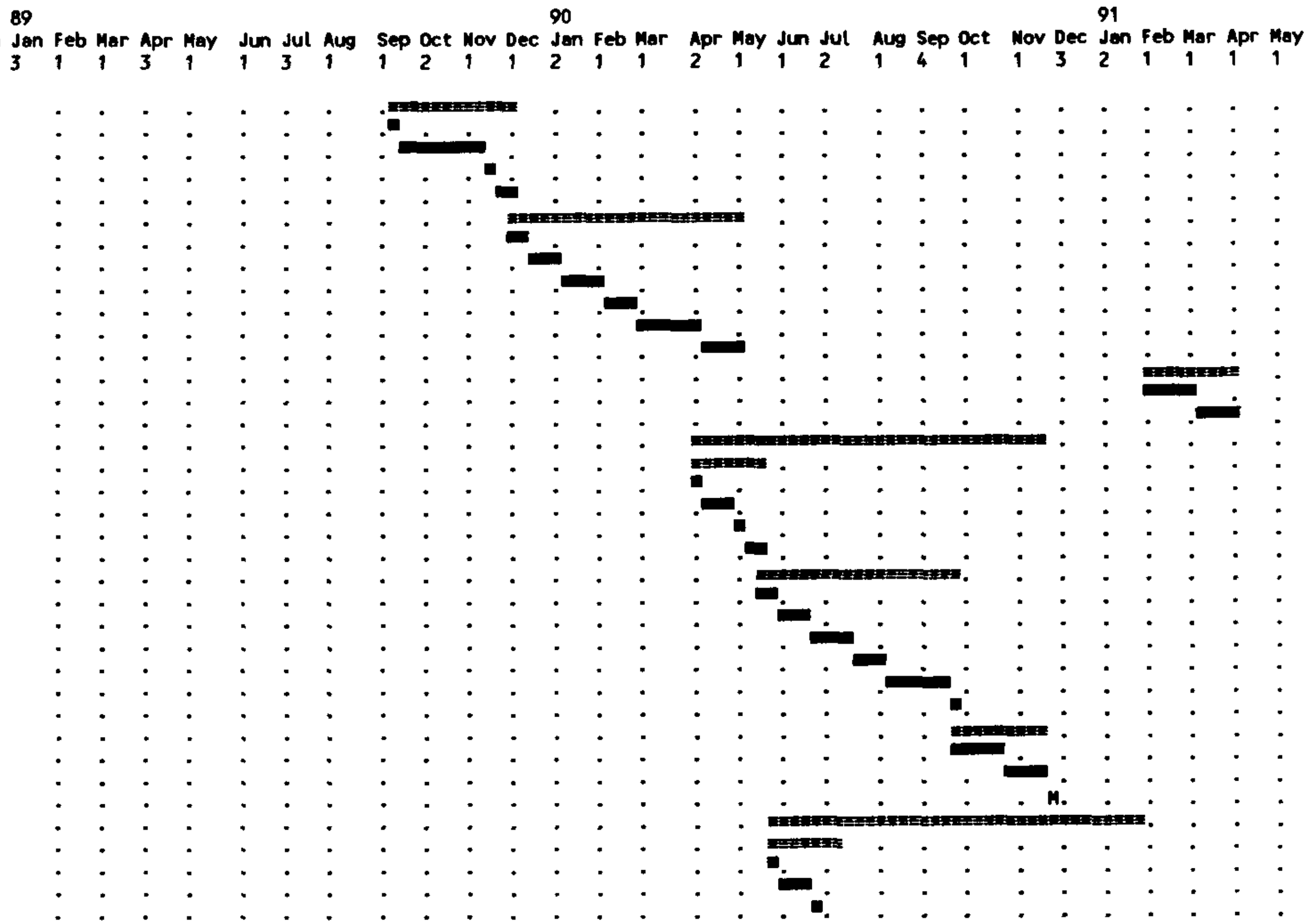
Table 6-2 (Cont)

SSC EXPERIMENTAL HALL SCHEDULE

GENERAL DETAIL

Schedule Name : SSC - EXPERIMENTAL HALL
Responsible : Liria C. Larano
As-of Date : 7-Dec-88 Schedule File : C:\TL3\DATA\EXPHALL

Task Name	Duratn (Days)
SHAFT SINK (SURFACE OPS.)	60
EXCAVATION IN OVERBURDEN	5
COLLAR FOUNDATION	40
INSTALL RAISE BORE	5
DRILL PILOT HOLE	10
SHAFT SINK (UNDERGROUND OPS.)	110
TUNNEL DRIVE	10
REAMING	15
EXCAVATE IN SHALLOW ROCK	20
STAGE INSTALLATION	15
EXCAVATION TO FULL DEPTH	30
INSTALL. OF SITE MUCKING FAC.	20
CONCRETE LINING	45
SLIPFORM INSTALLATION	25
SLIPFORM	20
EQUIP. ACCESS SHAFT/TUNNEL (E)	165
SHAFT SINK (SURFACE OPS.)	35
EXCAVATION IN OVERBURDEN	5
COLLAR FOUNDATION	15
INSTALL RAISE BORE	5
DRILL PILOT HOLE	10
SHAFT SINK (UNDERGROUND OPS.)	95
TUNNEL DRIVE (TOP HALF)	10
REAMING	15
EXCAVATION IN SHALLOW ROCK	20
STAGE INSTALLATION	15
EXCAVATION TO FULL DEPTH	30
TUNNEL DRIVE (BOTTOM HALF)	5
CONCRETE LINING	45
SLIPFORM INSTALLATIONS	25
SLIPFORM CONCRETING	20
BENEFICIAL OCCUPANCY	0
PERSONNEL ACC. SHAFT/TUNN.(P2)	175
SHAFT SINK (SURFACE OPS.)	35
EXCAVATION IN OVERBURDEN	5
COLLAR FOUNDATION	15
INSTALL RAISE BORE	5



Detail Task ===== Summary Task M Milestone
(Started) ===== (Started) >>> Conflict
(Slack) ===— (Slack) .. Resource delay

Scale: 1 week per character

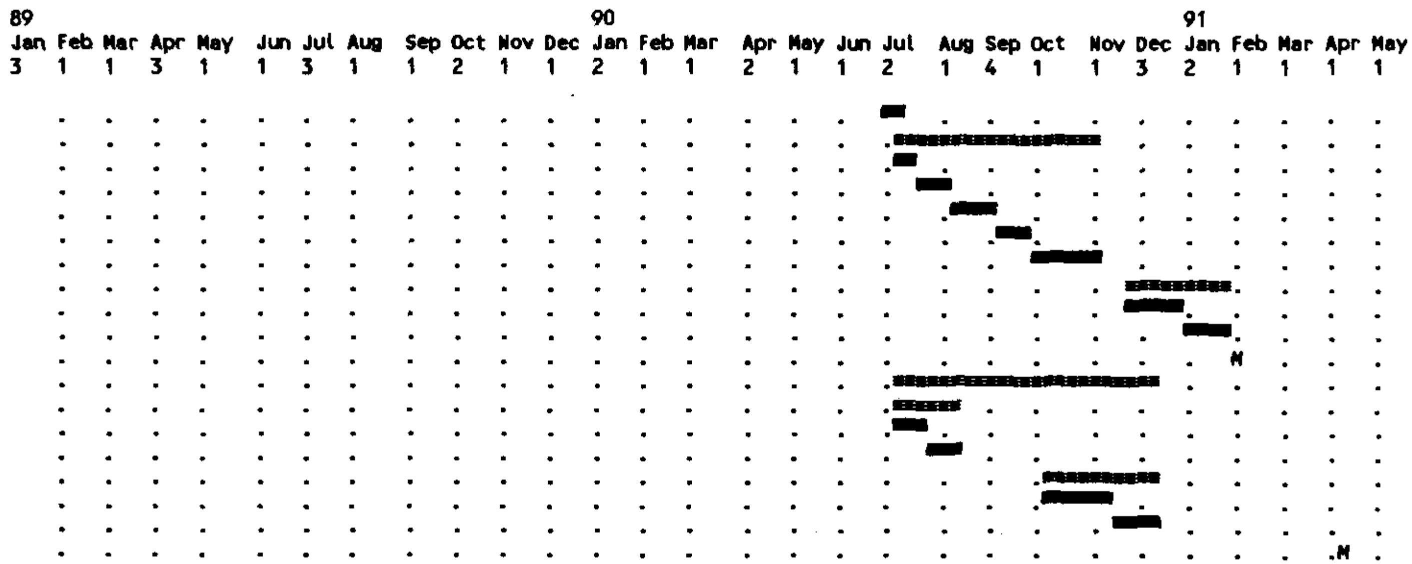
Table 6-2 (Cont)

SSC EXPERIMENTAL HALL SCHEDULE

GENERAL DETAIL

Schedule Name : SSC - EXPERIMENTAL HALL
Responsible : Liria C. Larano
As-of Date : 7-Dec-88 Schedule File : C:\TL3\DATA\EXPHALL

Task Name	Duratn (Days)
DRILL PILOT HOLE	10
SHAFT SINK (UNDERGROUND OPS.)	90
TUNNEL DRIVE	10
REAMING	15
EXCAVATION IN SHALLOW ROCK	20
STAGE INSTALLATION	15
EXCAVATION TO FULL DEPTH	30
CONCRETE LINING	45
SLIPFORM INSTALLATION	25
SLIPFORM	20
BENEFICIAL OCCUPANCY	0
BEAM TUNNELS	115
EXCAVATION	30
LEFT HEADING	15
RIGHT HEADING	15
LINING	50
FLOOR	30
ROOF	20
EXPERIMENTAL HALL EXCAV. COMPL	0



Detail Task | Summary Task | M Milestone
(Started) | (Started) | >>> Conflict
(Slack) | (Slack) | .. Resource delay

Scale: 1 week per character

TIME LINE Gantt Chart Report, Strip 1, Page 3

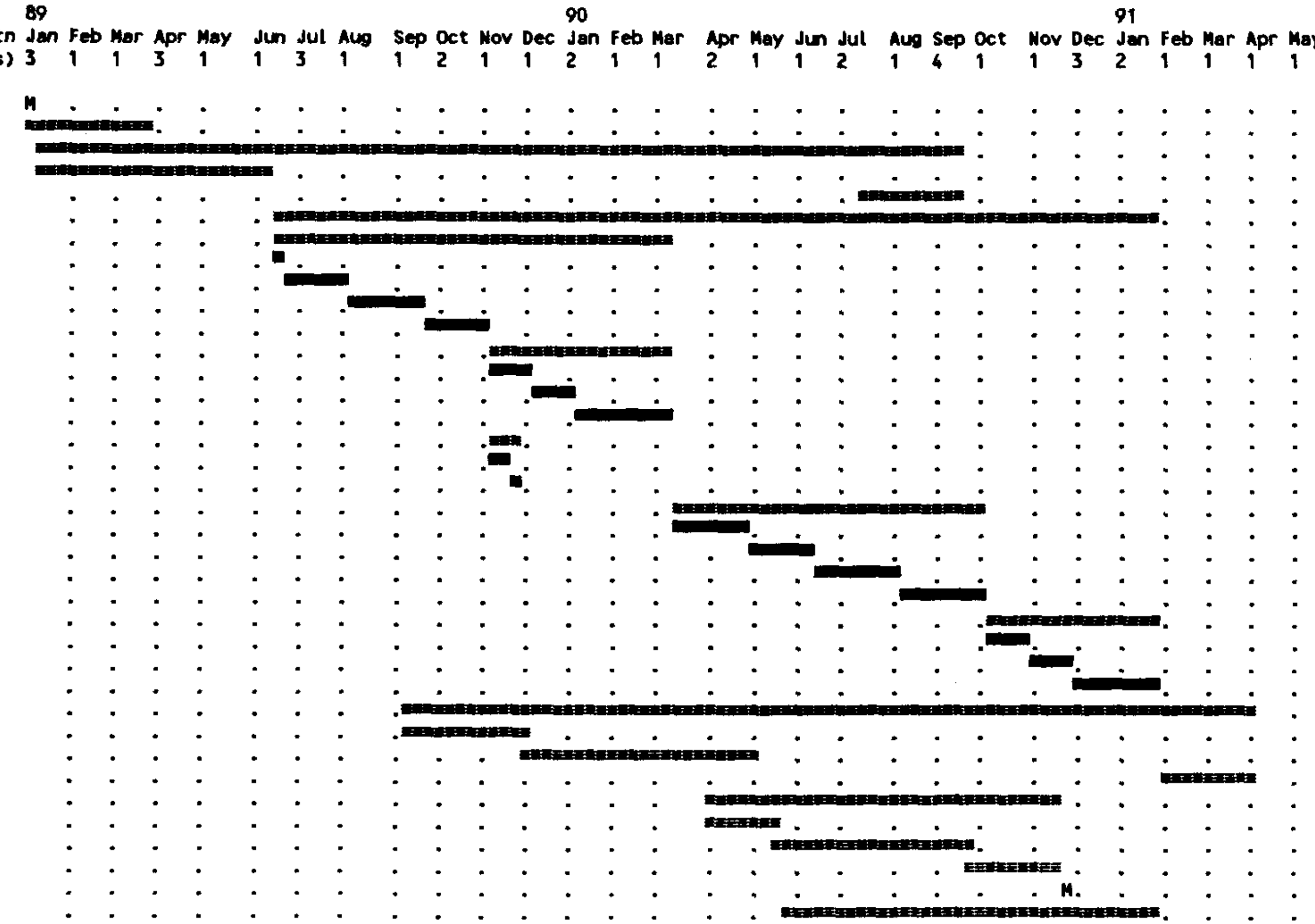
Table 6-3

SSC EXPERIMENTAL HALL SCHEDULE

SPECIFIC CAVERN DETAIL

Schedule Name : SSC - EXPERIMENTAL HALL
Responsible : Liria C. Larano
As-of Date : 7-Dec-88 Schedule File : C:\TL3\DATA\EXPHALL

Task Name	Duratn (Days)
AWARD CONTRACT	0
+ SITE PREPARATIONS	60
CONSTRUCTION SHAFT (C)	430
+ SHAFT SINK	110
+ CONCRETE LINING	50
CAVERN	410
CAVERN ROOF EXCAVATION/SUPPORT	185
REINFORCEMENT OF INTERSECTION	5
BENCH LEVEL 1	30
BENCH LEVEL 2	35
BENCH LEVEL 3	30
GANTRY BEAM & ROOF CONST.	85
BEAM ANCHORS	20
CONCRETING OF THE BEAM	20
ROOF ARCH CONSTRUCTION	45
DEVELOPMENT TO P1 ACCESS	15
EXCAVATE 1/2 C SHAFT	10
EXCAVATE TUNNEL TO P1	5
HALL EXCAVATION & SUPPORT	145
BENCH LEVEL 4	35
BENCH LEVEL 5 (INCL. E1 RAMP)	30
BENCH LEVEL 6 (INCL. BT RAMP)	40
BENCH LEVEL 7	40
FINAL WALL/FOUNDATION WORK	80
SIDEWALL TREATMENT	20
FOUNDATION	20
SLAB	40
PERSONNEL ACC. SHAFT/TUNN.(P1)	395
+ SHAFT SINK (SURFACE OPS.)	60
+ SHAFT SINK (UNDERGROUND OPS.)	110
+ CONCRETE LINING	45
EQUIP. ACCESS SHAFT/TUNNEL (E)	165
+ SHAFT SINK (SURFACE OPS.)	35
+ SHAFT SINK (UNDERGROUND OPS.)	95
+ CONCRETE LINING	45
BENEFICIAL OCCUPANCY	0
PERSONNEL ACC. SHAFT/TUNN.(P2)	175



Detail Task · (Started) · (Slack) · Summary Task · (Started) · (Slack) · M Milestone · >>> Conflict · Resource delay

Scale: 1 week per character

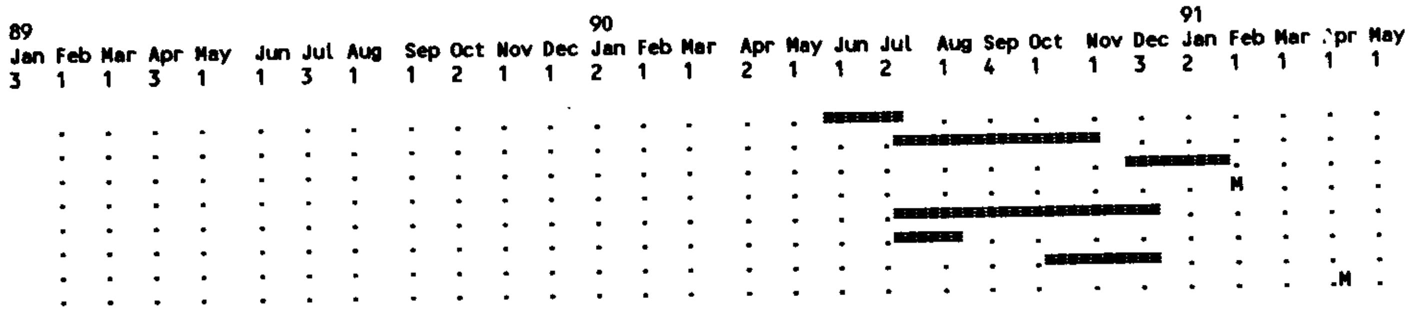
Table 6-3 (Cont)

SSC EXPERIMENTAL HALL SCHEDULE

SPECIFIC CAVERN DETAIL

Schedule Name : SSC - EXPERIMENTAL HALL
Responsible : Liria C. Larano
As-of Date : 7-Dec-88 Schedule File : C:\TL3\DATA\EXPHALL

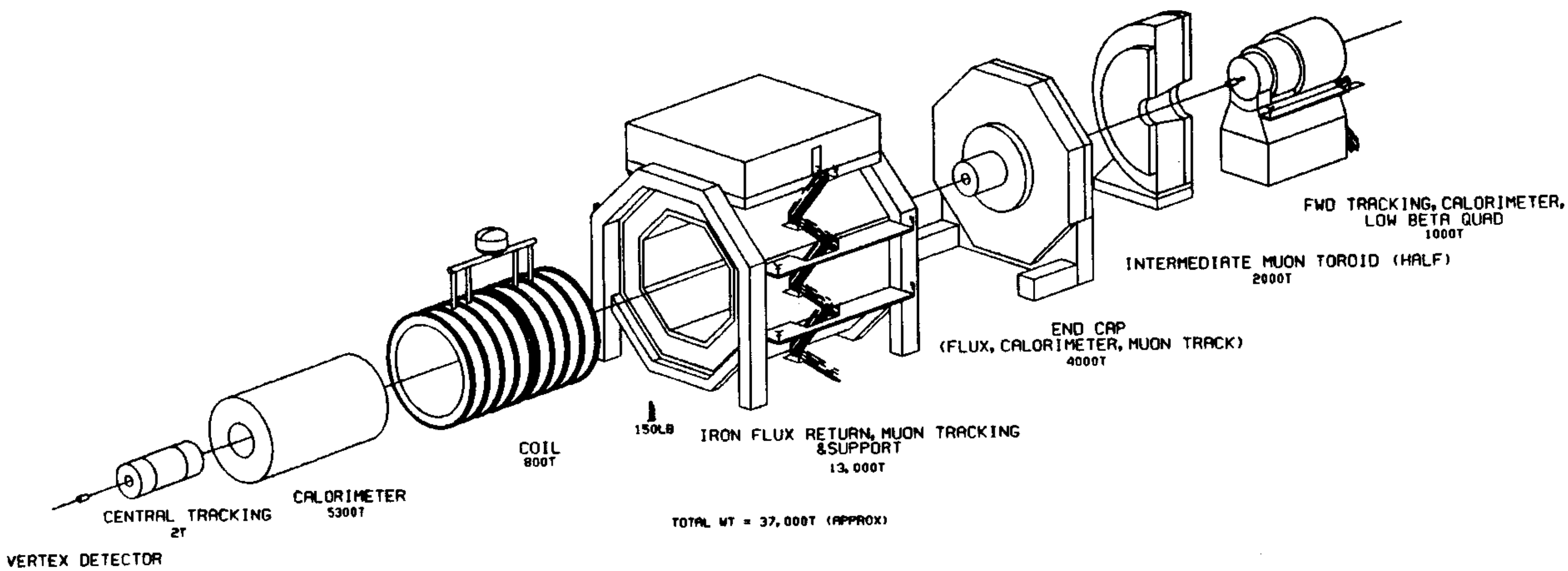
Task Name	Duratn (Days)
+ SHAFT SINK (SURFACE OPS.)	35
+ SHAFT SINK (UNDERGROUND OPS.)	90
+ CONCRETE LINING	45
BENEFICIAL OCCUPANCY	0
BEAM TUNNELS	115
+ EXCAVATION	30
+ LINING	50
EXPERIMENTAL HALL EXCAV. COMPL	0



Detail Task | Summary Task | M Milestone
(Started) | (Started) | >>> Conflict
(Slack) | (Slack) | Resource delay

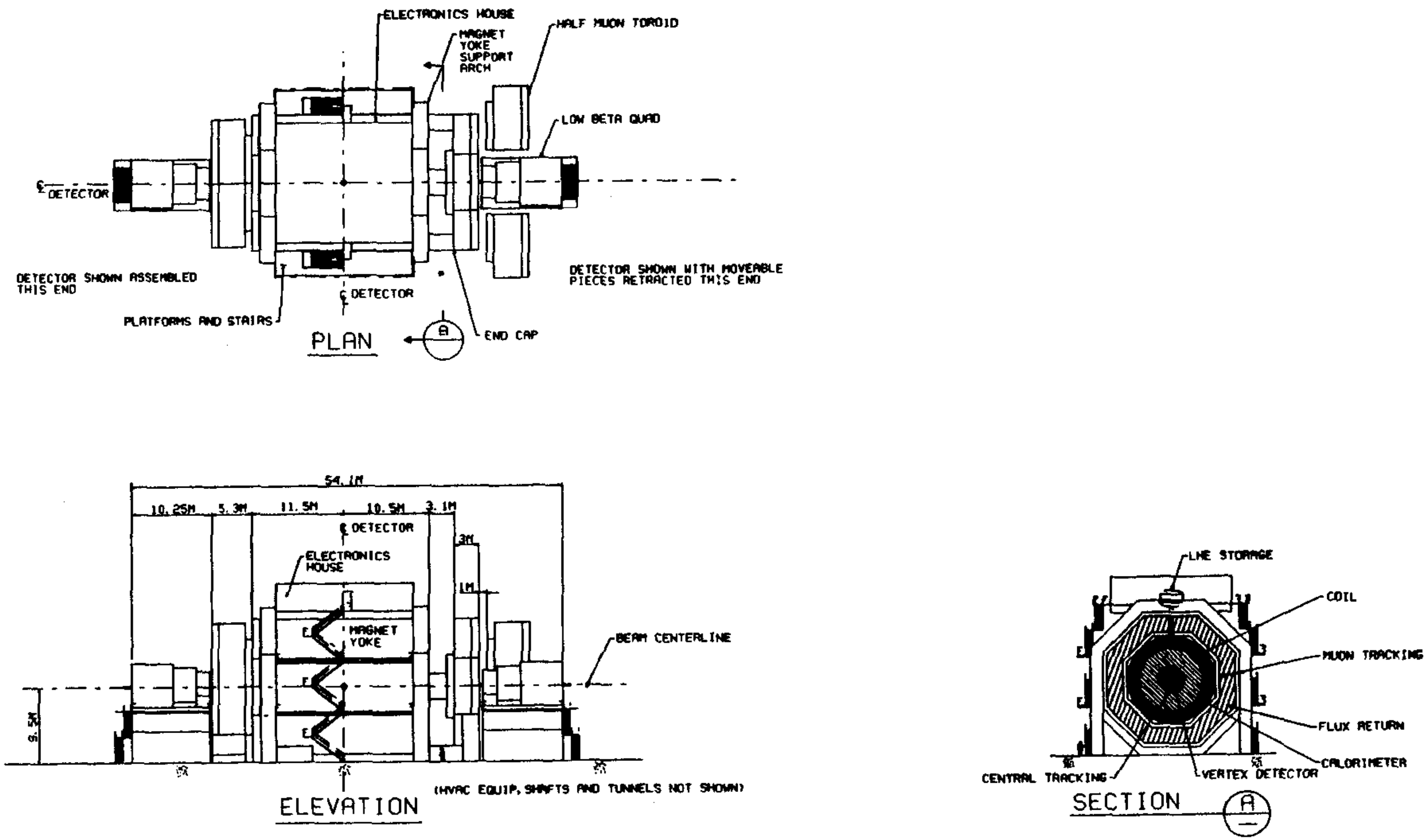
Scale: 1 week per character

TIME LINE Gantt Chart Report, Strip 1, Page 2



LARGE SOLENOID DETECTOR MODEL
EXPLODED VIEW
01-M-05

Figure 2-1



LARGE SOLONOID DETECTOR
GENERAL ARRANGEMENT - PLAN & SECTIONS
01-M-07

Figure 2-2

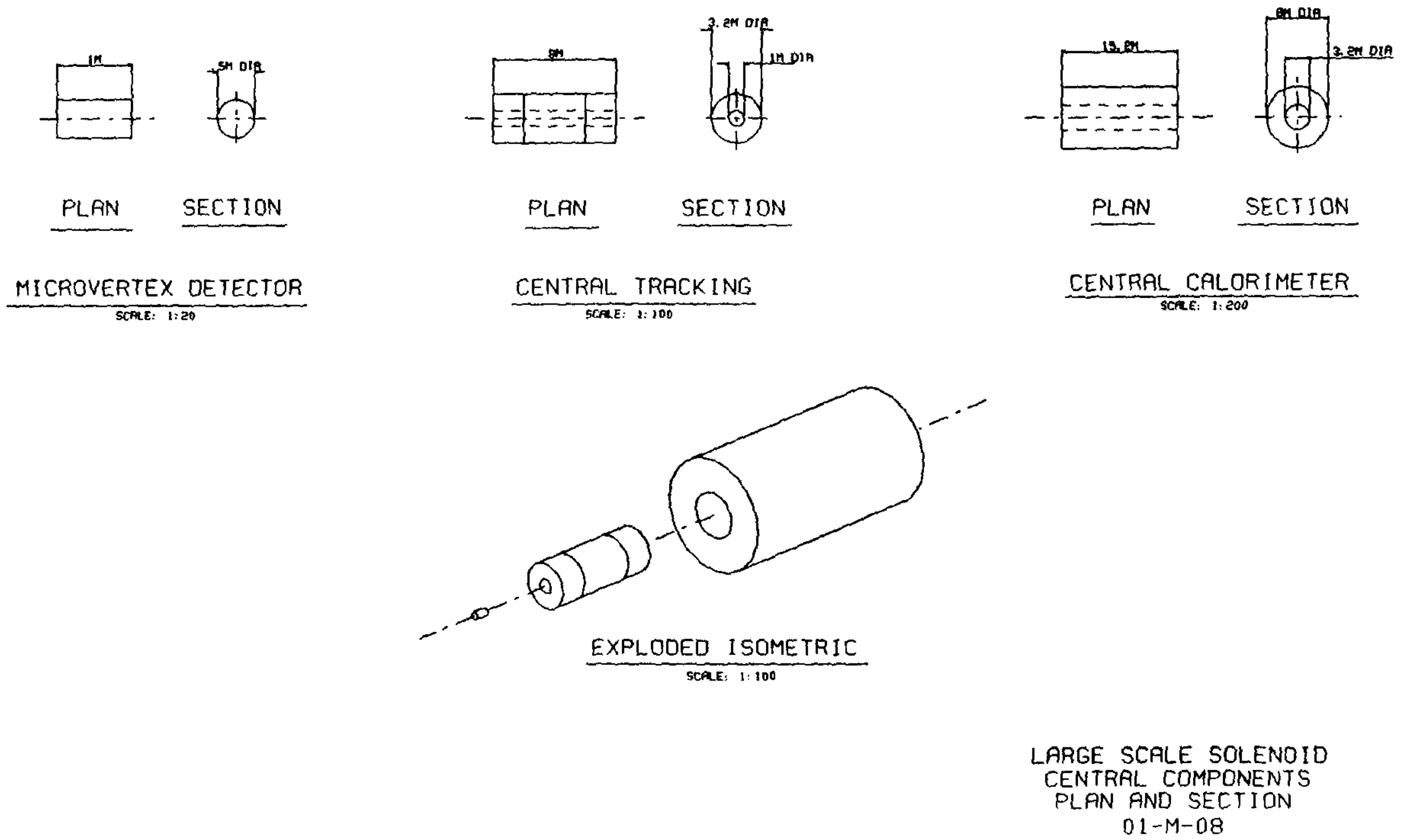

1M
.5M DIA
PLAN
SECTION
MICROVERTEX DETECTOR
SCALE: 1:20
8M
3.2M DIA
1M DIA
PLAN
SECTION
CENTRAL TRACKING
SCALE: 1:100
8M DIA
3.2M DIA
PLAN
SECTION
CENTRAL CALORIMETER
SCALE: 1:200
EXPLODED ISOMETRIC
SCALE: 1:100
LARGE SCALE SOLENOID
CENTRAL COMPONENTS
PLAN AND SECTION
01-M-08

Figure 2-3

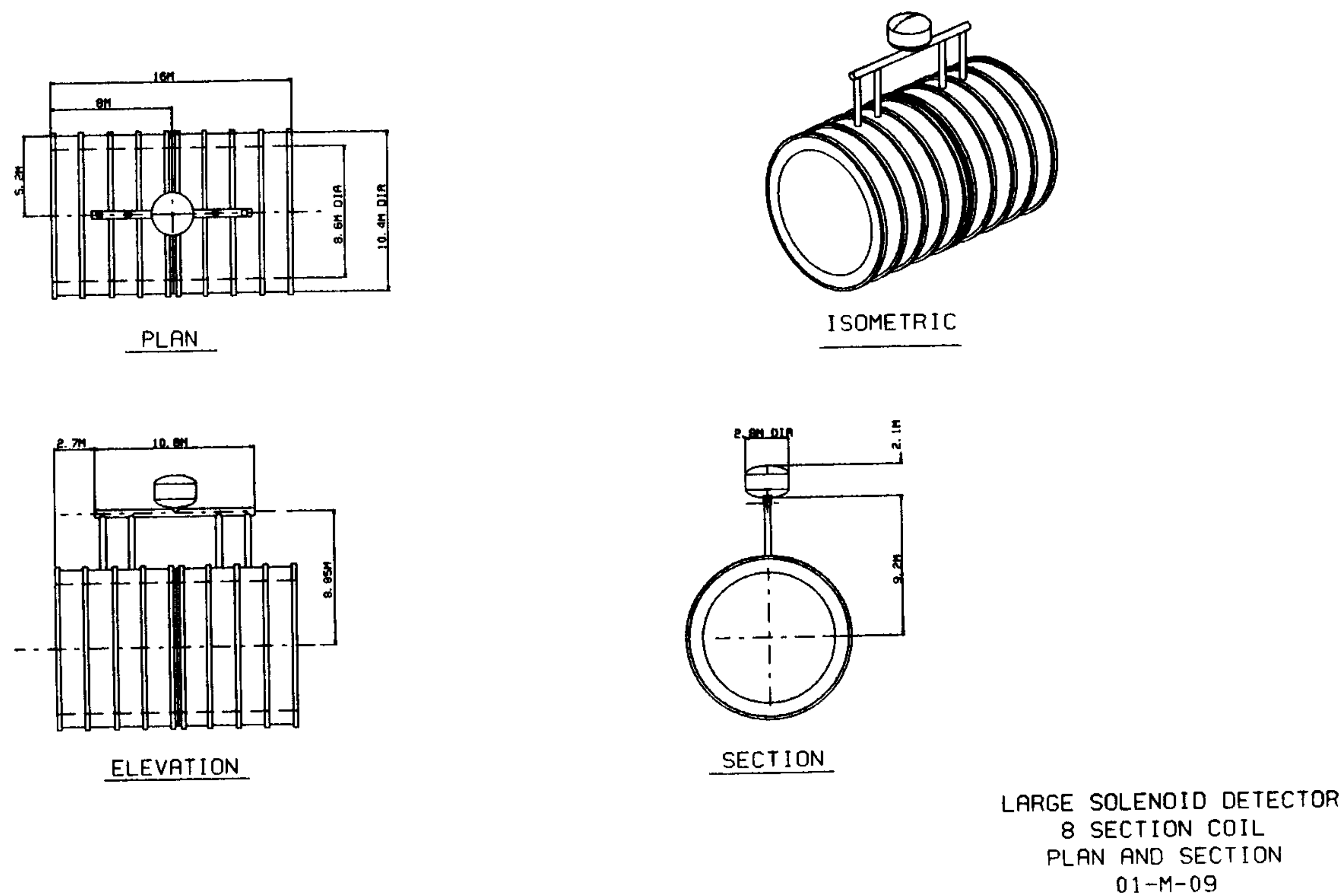
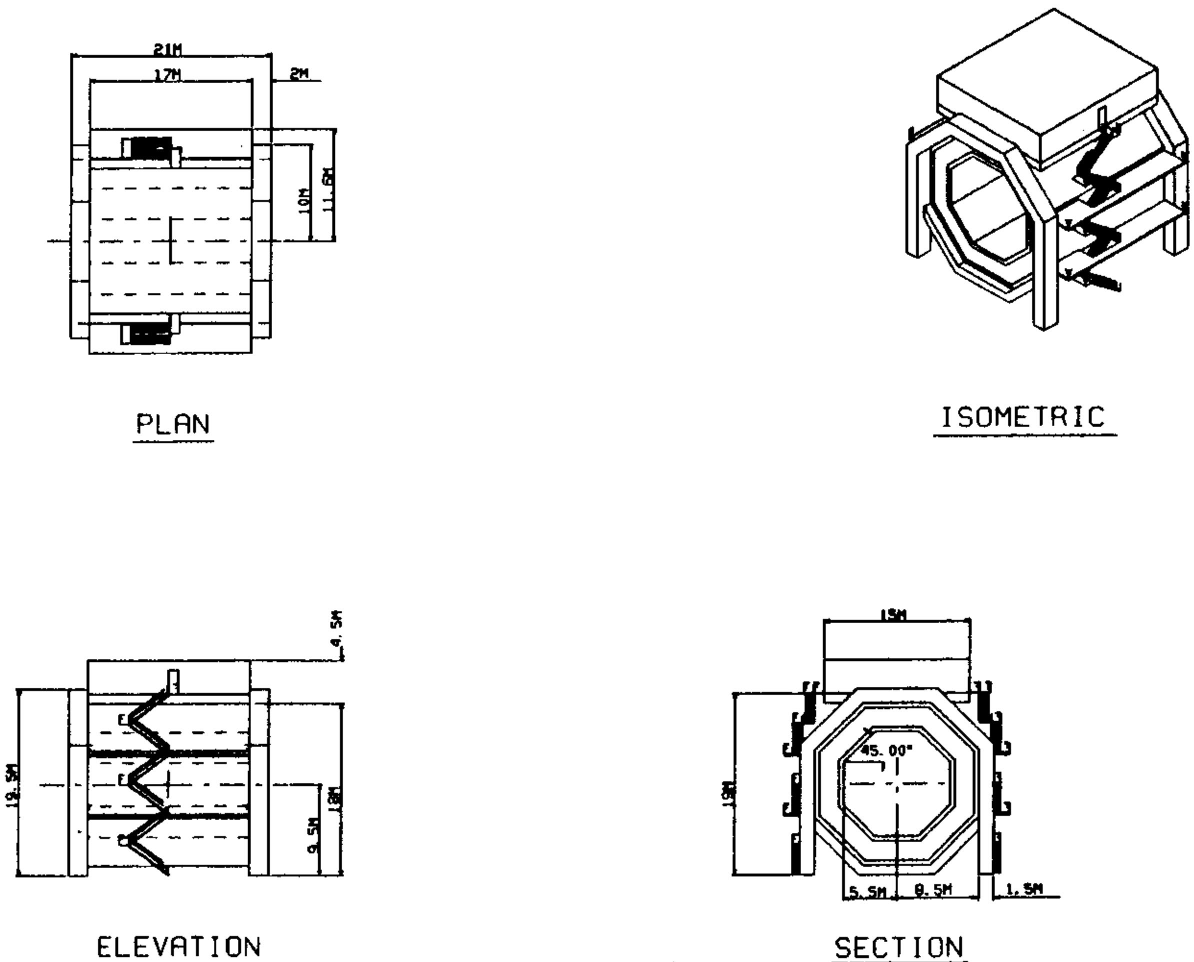

16M
8M
5.2M
8.6M DIA
10.4M DIA
PLAN
ISOMETRIC
2.7M
10.8M
8.85M
ELEVATION
2.8M DIA
2.1M
9.2M
SECTION
LARGE SOLENOID DETECTOR
8 SECTION COIL
PLAN AND SECTION
01-M-09

Figure 2-4



LARGE SOLENOID DETECTOR
FLUX RETURN MUON TRACK SUPPORT
PLAN AND SECTION
01-M-10

Figure 2-5

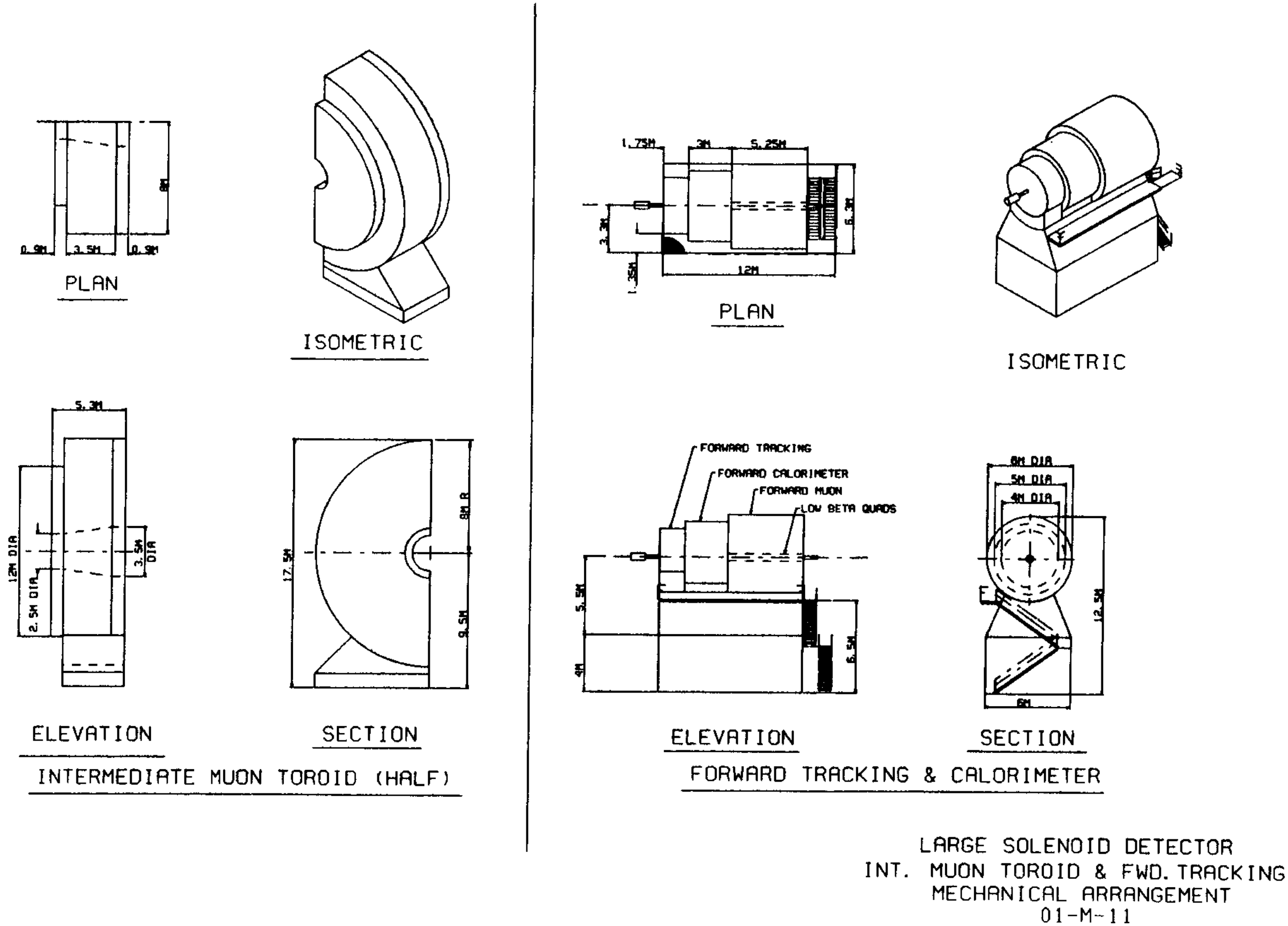
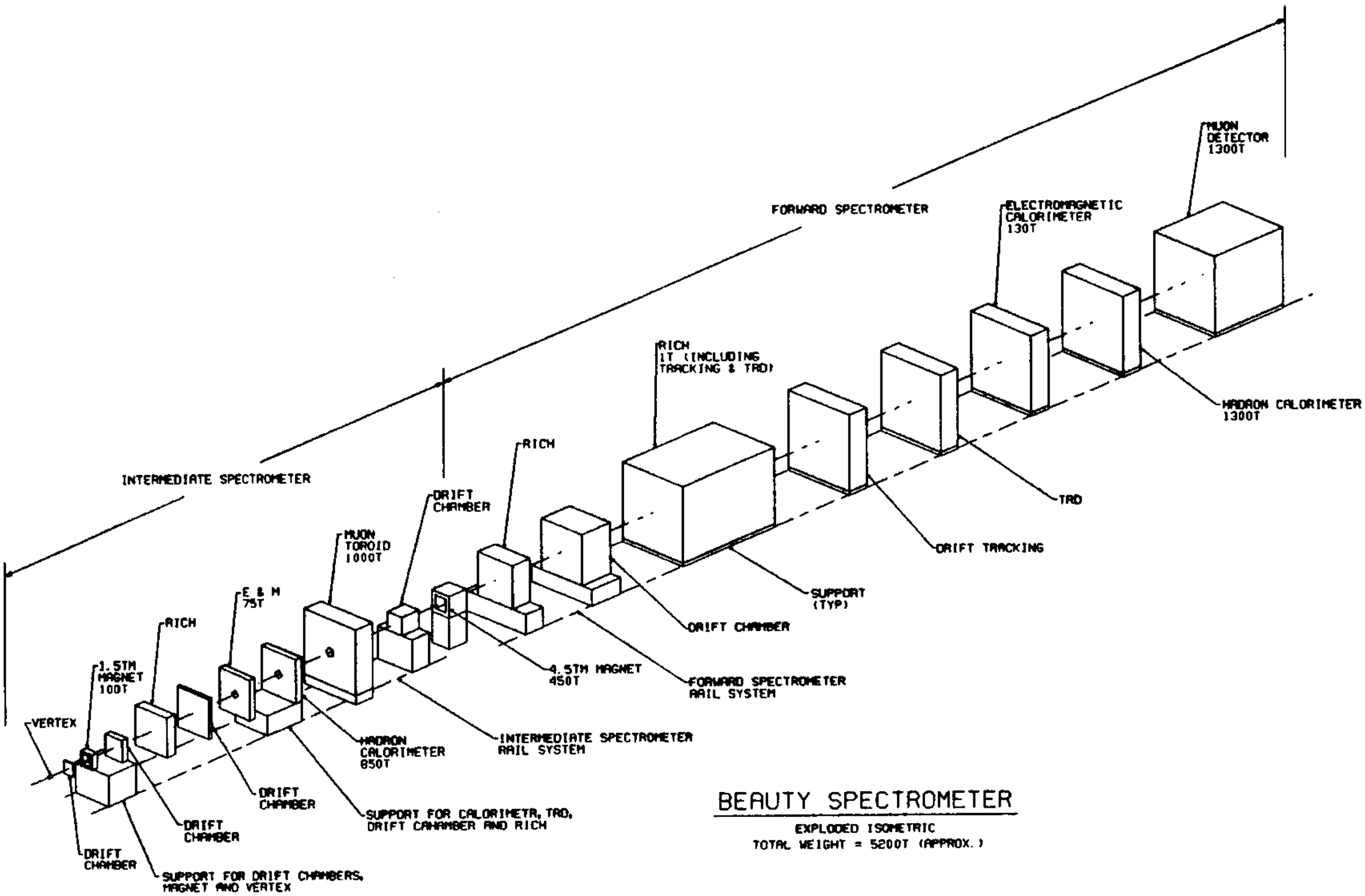
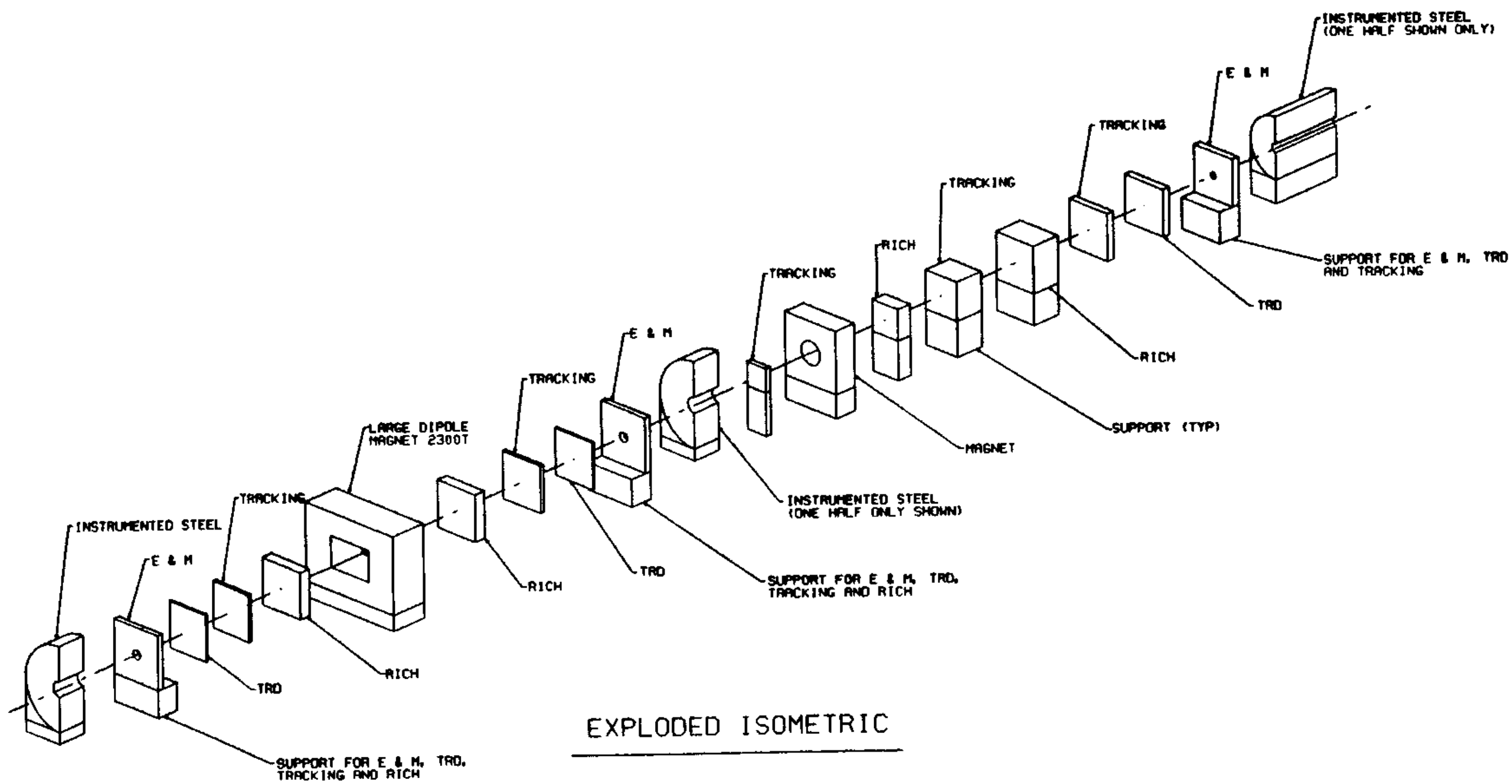

PLAN
ISOMETRIC
ELEVATION
SECTION
INTERMEDIATE MUON TOROID (HALF)
0.9M
3.5M
0.9M
8M
5.3M
12M DIA
2.5M DIA
3.5M DIA
17.5M
8M R
9.5M
PLAN
ISOMETRIC
ELEVATION
SECTION
FORWARD TRACKING & CALORIMETER
1.75M
3M
5.25M
6.3M
3.3M
1.35M
12M
FORWARD TRACKING
FORWARD CALORIMETER
FORWARD MUON
LOW BETA QUADS
5.5M
4M
6.5M
8M DIA
5M DIA
4M DIA
12.5M
6M
LARGE SOLENOID DETECTOR
INT. MUON TOROID & FWD. TRACKING
MECHANICAL ARRANGEMENT
01-M-11

Figure 2-6



BEAUTY SPECTROMETER
EXPLODED ISOMETRIC
03-M-04

Figure 2-7



BOTTOM COLLIDER SPECTROMETER
EXPLODED ISOMETRIC
05-M-05

Figure 2-8

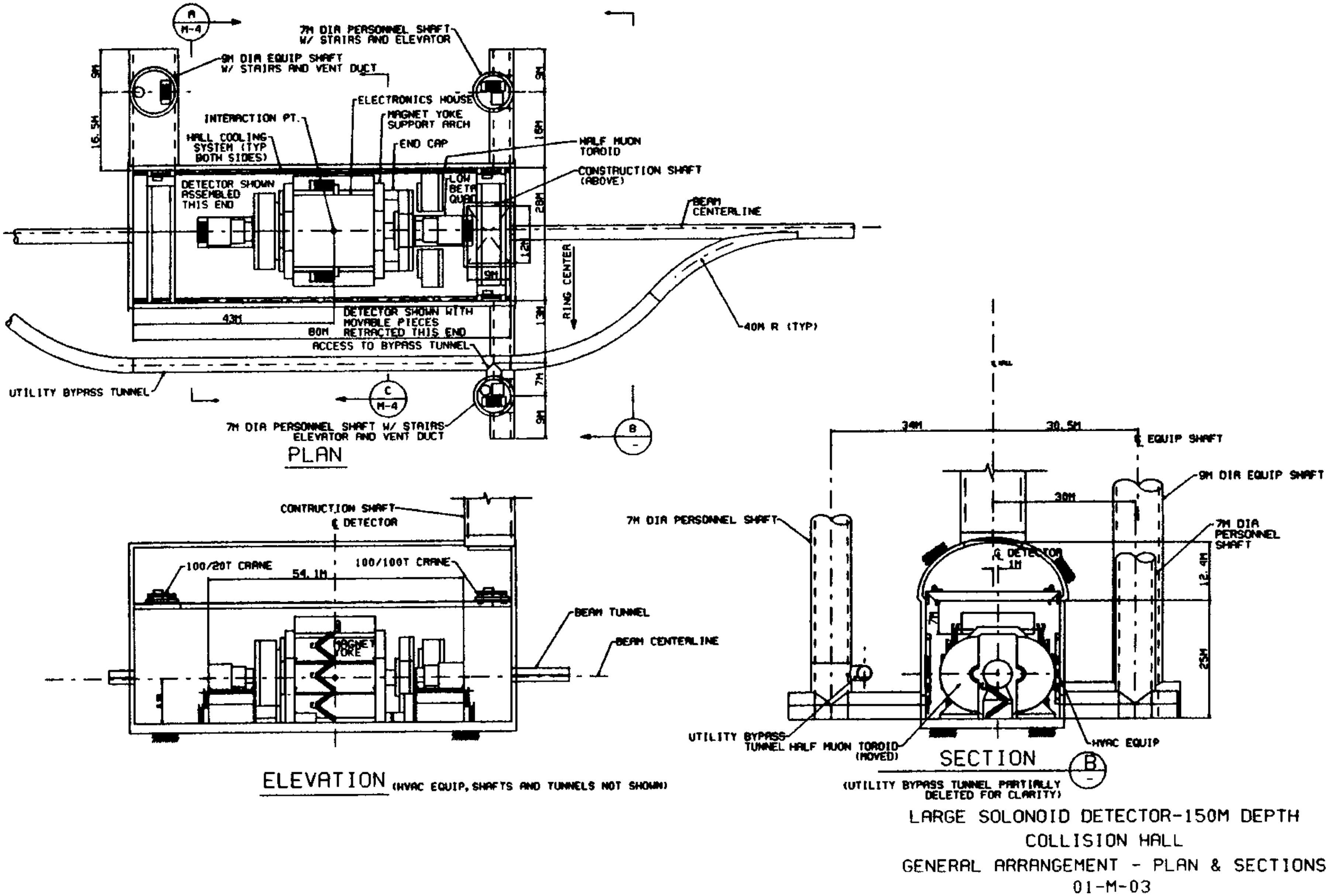
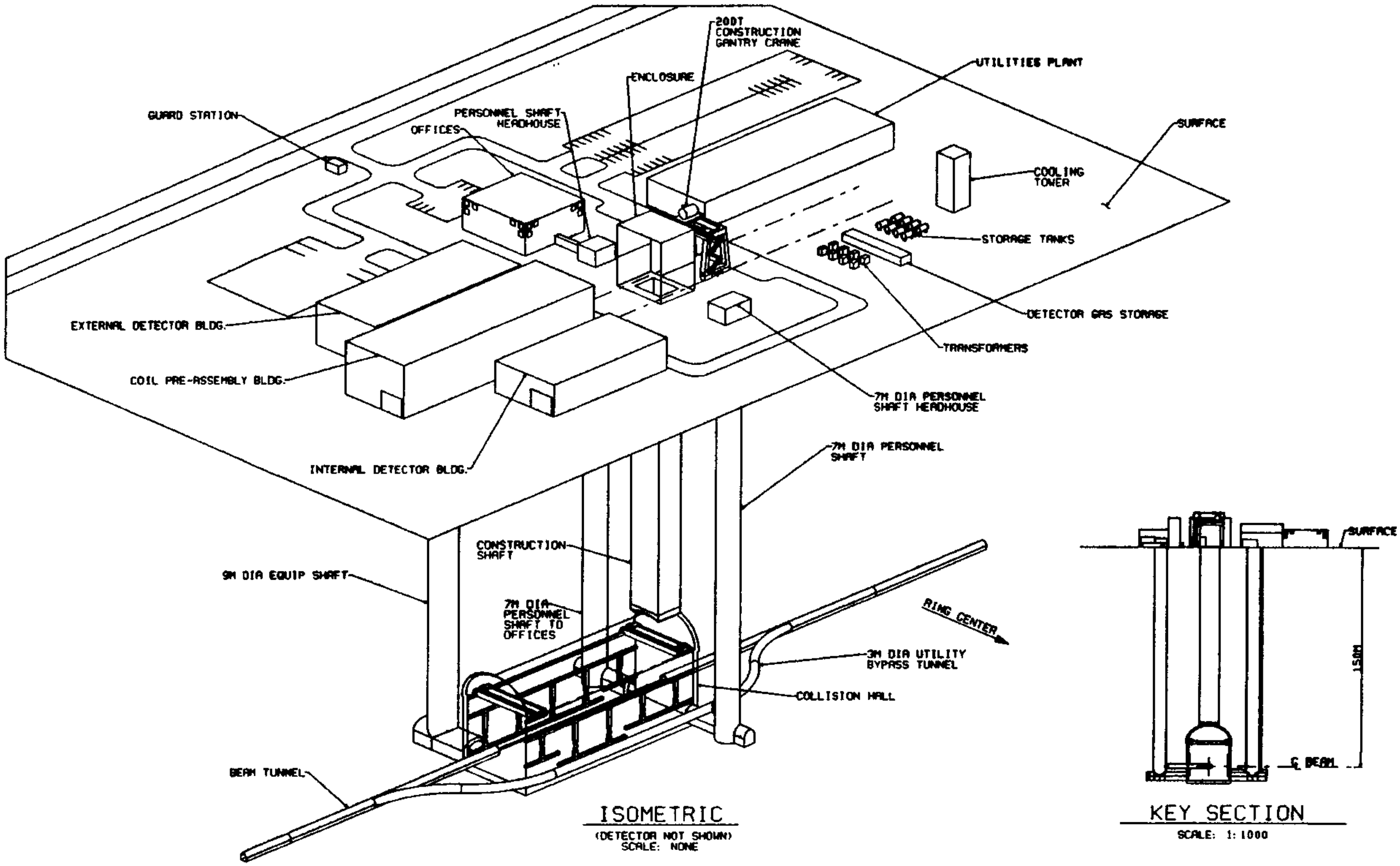
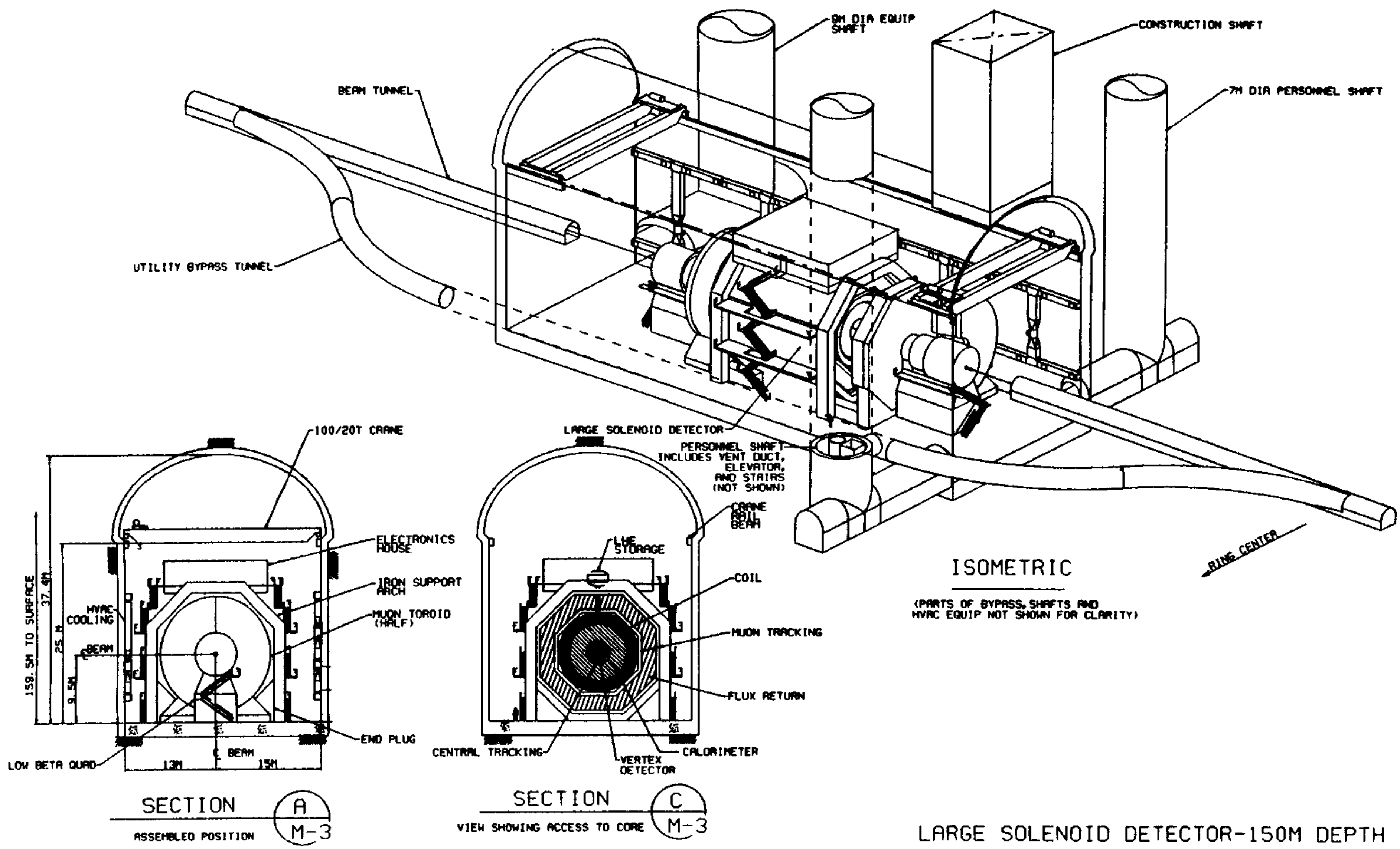

7M DIA PERSONNEL SHAFT W/ STAIRS AND ELEVATOR
9M DIA EQUIP SHAFT W/ STAIRS AND VENT DUCT
ELECTRONICS HOUSE
INTERACTION PT.
MAGNET YOKE SUPPORT ARCH
HALL COOLING SYSTEM (TYP BOTH SIDES)
END CAP
HALF MUON TOROID
CONSTRUCTION SHAFT (ABOVE)
DETECTOR SHOWN ASSEMBLED THIS END
LOW BETA QUAD
BEAM CENTERLINE
RING CENTER
40M R (TYP)
DETECTOR SHOWN WITH MOVABLE PIECES RETRACTED THIS END
43M
80M
ACCESS TO BYPASS TUNNEL
UTILITY BYPASS TUNNEL
7M DIA PERSONNEL SHAFT W/ STAIRS ELEVATOR AND VENT DUCT
PLAN
CONTRUCTION SHAFT
℄ DETECTOR
100/20T CRANE
100/100T CRANE
54.1M
MAGNET YOKE
BEAM TUNNEL
BEAM CENTERLINE
ELEVATION (HVAC EQUIP, SHAFTS AND TUNNELS NOT SHOWN)
34M
30.5M
℄ EQUIP SHAFT
9M DIA EQUIP SHAFT
30M
7M DIA PERSONNEL SHAFT
7M DIA PERSONNEL SHAFT
℄ DETECTOR
1M
12.4M
25M
UTILITY BYPASS TUNNEL
HALF MUON TOROID (MOVED)
HVAC EQUIP
SECTION
(UTILITY BYPASS TUNNEL PARTIALLY DELETED FOR CLARITY)
LARGE SOLONOID DETECTOR-150M DEPTH
COLLISION HALL
GENERAL ARRANGEMENT - PLAN & SECTIONS
01-M-03

Figure 3-1



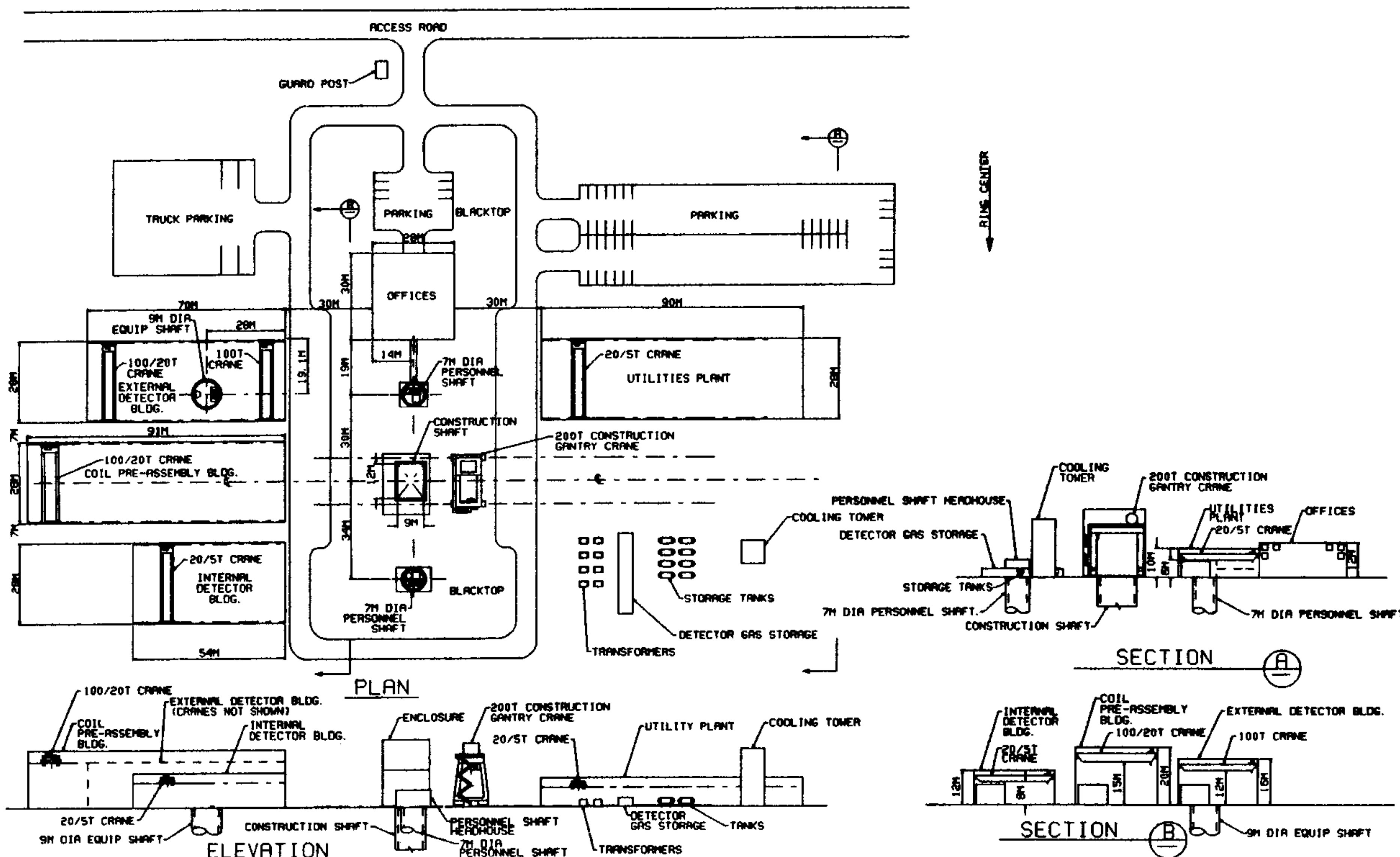
LARGE SOLENOID DETECTOR-150M DEPTH
FACILITIES ARRANGEMENT
ISOMETRIC AND KEY SECTION
01-M-01

Figure 3-3



LARGE SOLENOID DETECTOR-150M DEPTH
COLLISION HALL
GEN. ARRG'T. SECTIONS AND ISOMETRIC
01-M-04

Figure 3-2



LARGE SOLENOID DETECTOR-150M DEPTH
SURFACE FACILITIES
GENERAL ARRANGEMENT
01-M-02

Figure 3-4

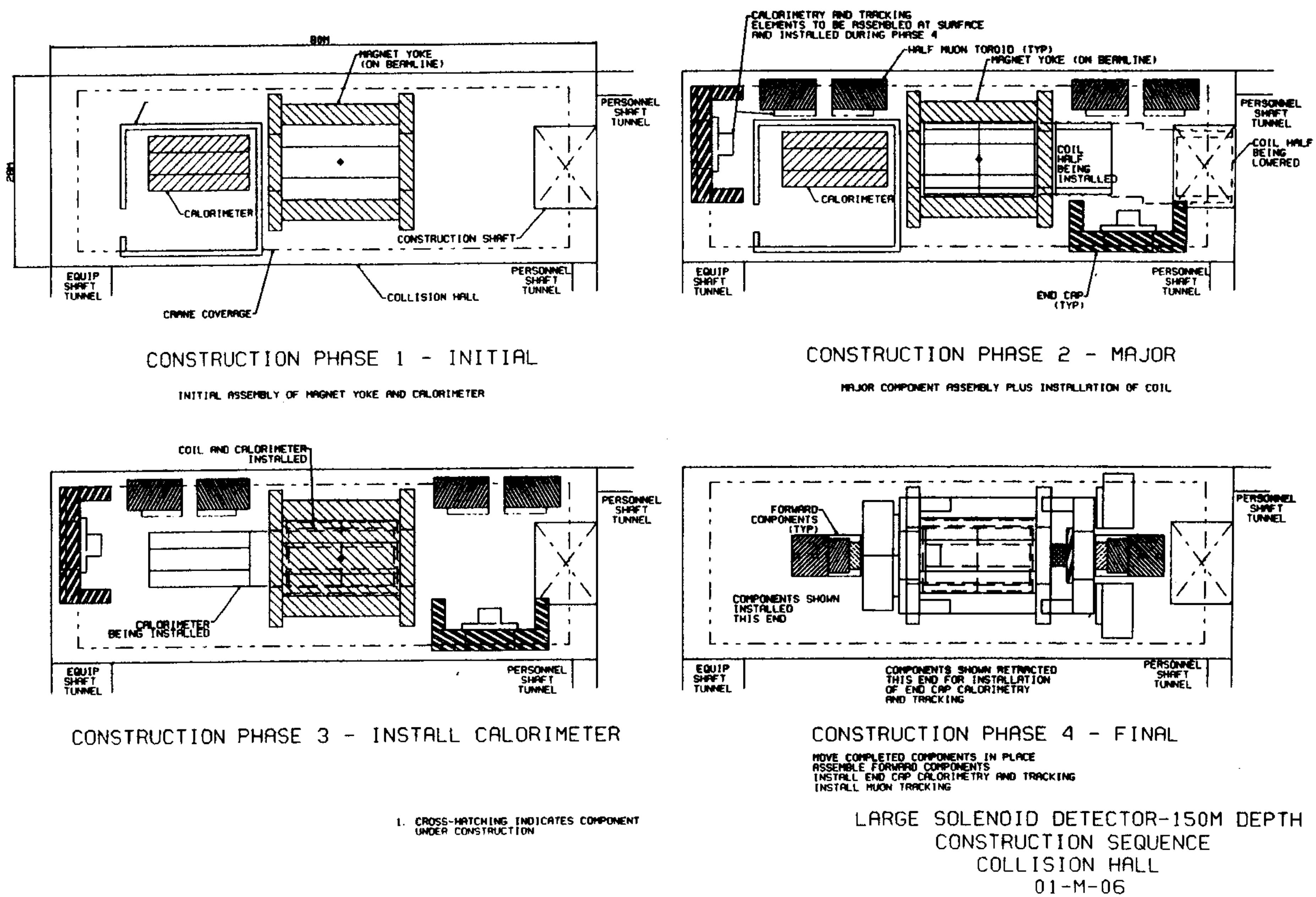
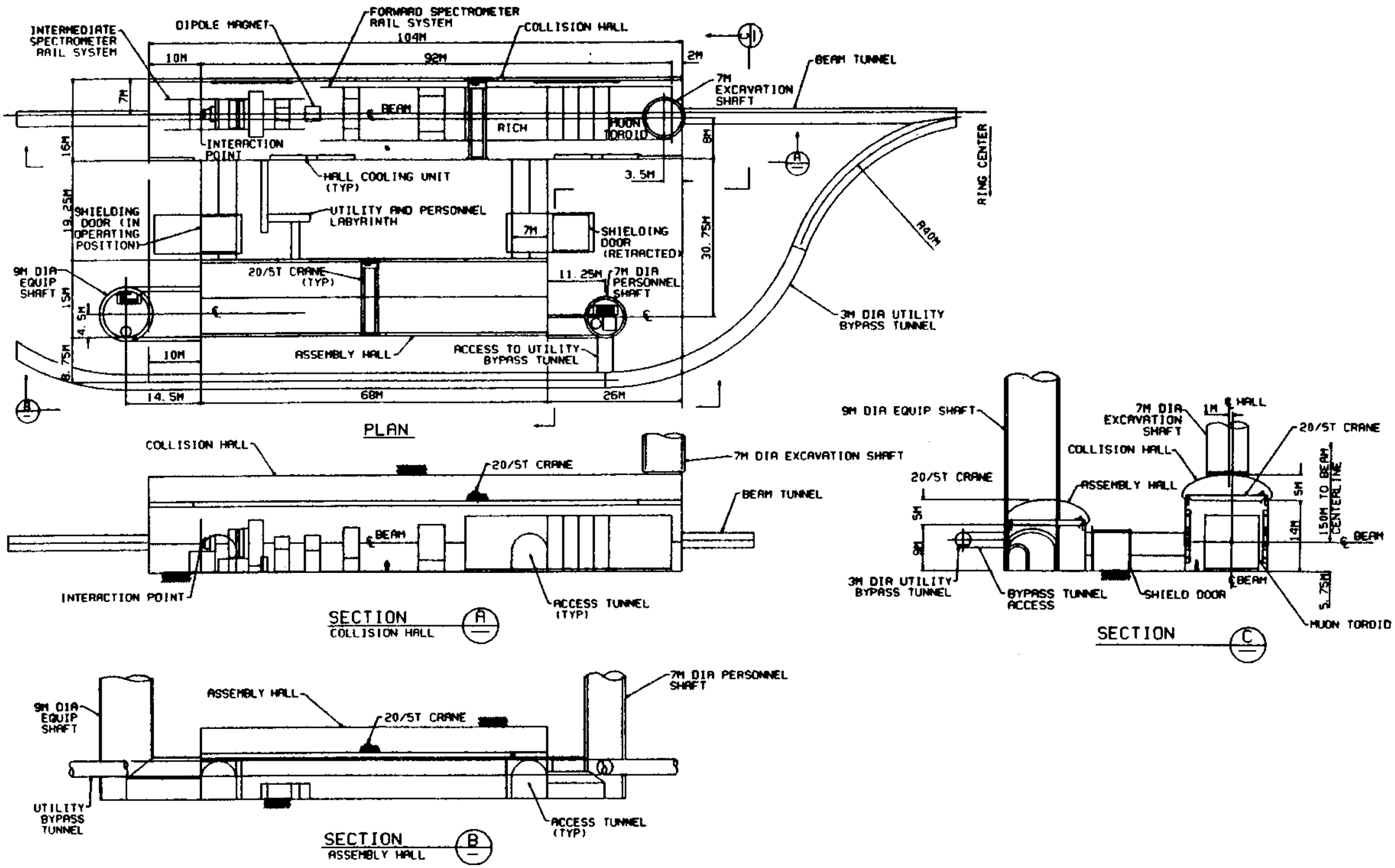
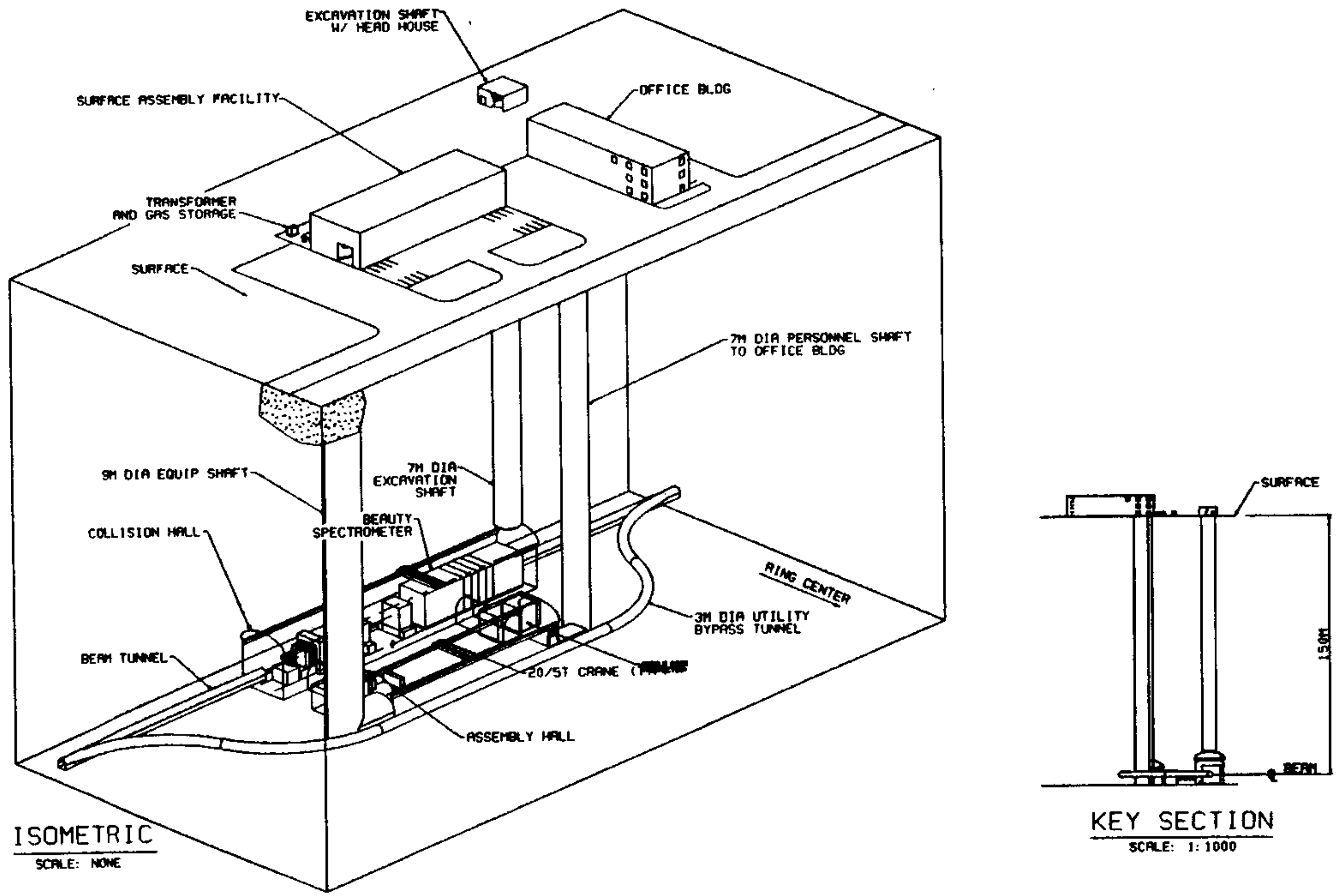

CONSTRUCTION PHASE 1 - INITIAL
INITIAL ASSEMBLY OF MAGNET YOKE AND CALORIMETER
80M
28M
MAGNET YOKE (ON BEAMLINE)
CALORIMETER
CONSTRUCTION SHAFT
PERSONNEL SHAFT TUNNEL
EQUIP SHAFT TUNNEL
CRANE COVERAGE
COLLISION HALL
CONSTRUCTION PHASE 2 - MAJOR
MAJOR COMPONENT ASSEMBLY PLUS INSTALLATION OF COIL
CALORIMETRY AND TRACKING ELEMENTS TO BE ASSEMBLED AT SURFACE AND INSTALLED DURING PHASE 4
HALF MUON TOROID (TYP)
MAGNET YOKE (ON BEAMLINE)
COIL HALF BEING INSTALLED
COIL HALF BEING LOWERED
END CAP (TYP)
CONSTRUCTION PHASE 3 - INSTALL CALORIMETER
COIL AND CALORIMETER INSTALLED
CALORIMETER BEING INSTALLED
CONSTRUCTION PHASE 4 - FINAL
FORWARD COMPONENTS (TYP)
COMPONENTS SHOWN INSTALLED THIS END
COMPONENTS SHOWN RETRACTED THIS END FOR INSTALLATION OF END CAP CALORIMETRY AND TRACKING
MOVE COMPLETED COMPONENTS IN PLACE
ASSEMBLE FORWARD COMPONENTS
INSTALL END CAP CALORIMETRY AND TRACKING
INSTALL MUON TRACKING
1. CROSS-HATCHING INDICATES COMPONENT UNDER CONSTRUCTION
LARGE SOLENOID DETECTOR-150M DEPTH
CONSTRUCTION SEQUENCE
COLLISION HALL
01-M-06

Figure 3-5



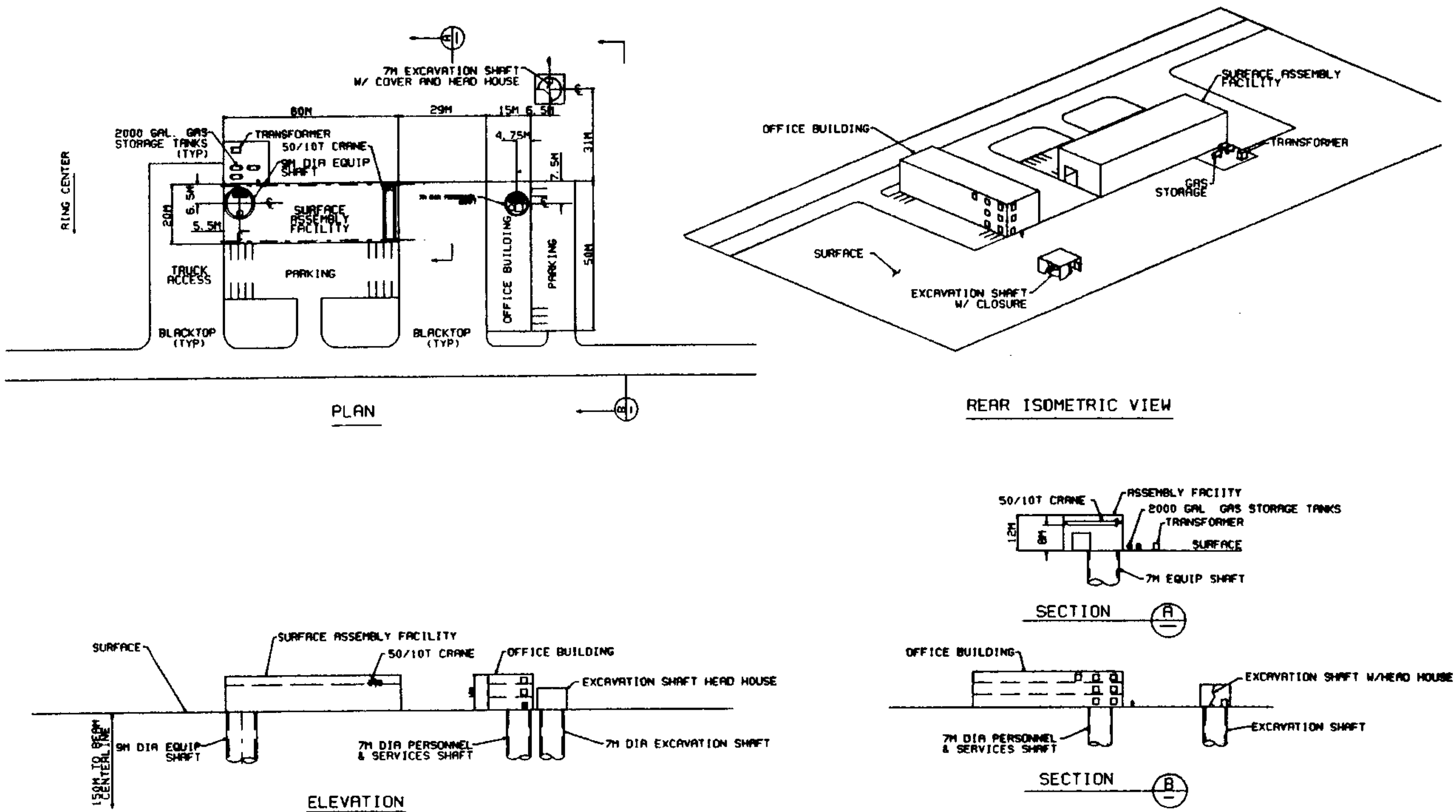
BEAUTY SPECTROMETER-150M DEPTH
COLLISION AND ASSEMBLY HALLS
GENERAL ARRG'T - PLAN & SECTIONS
03-M-03

Figure 3-6



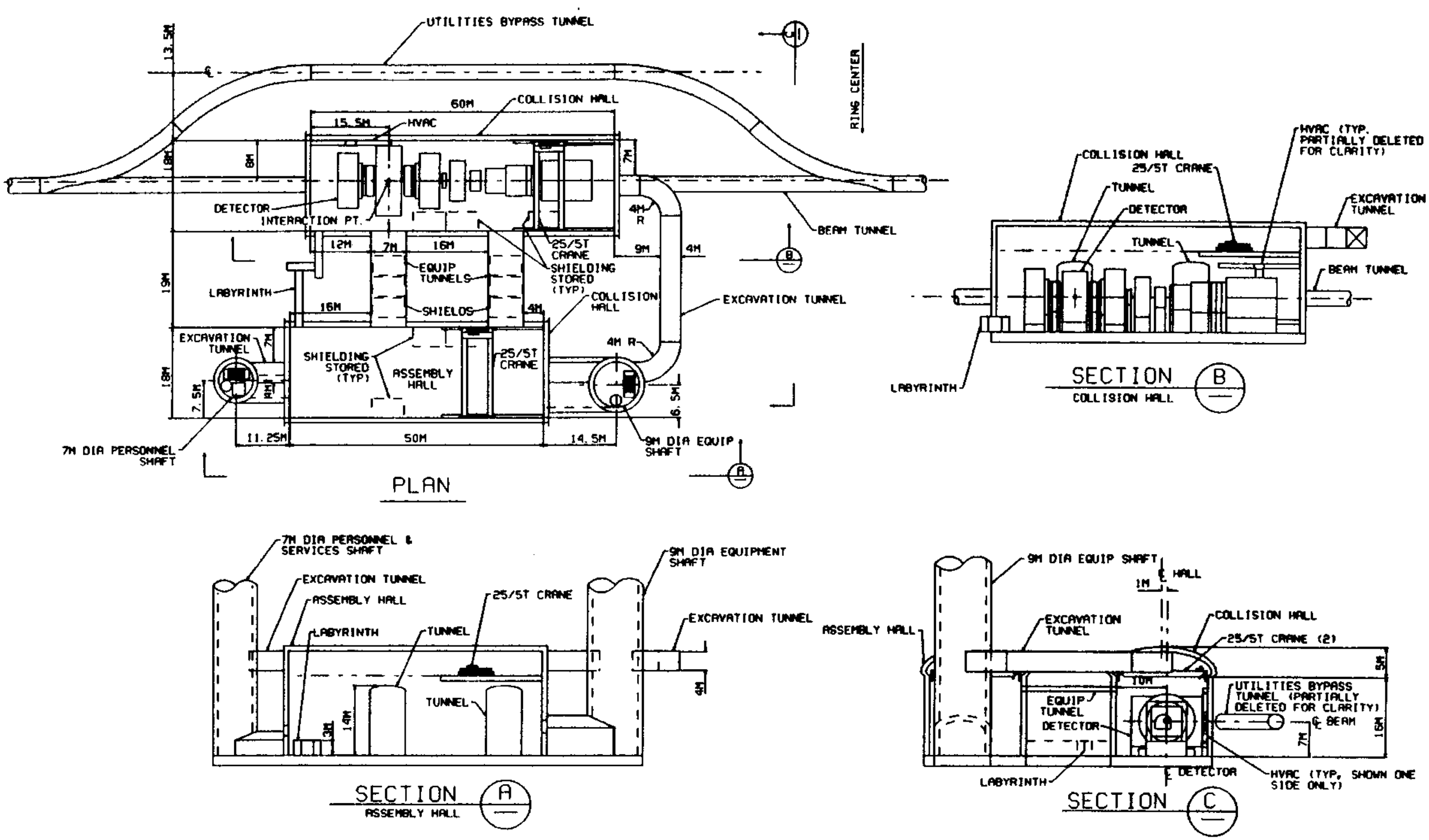
BEAUTY SPECTROMETER-150M DEPTH
FACILITIES ARRANGEMENT
ISOMETRIC AND KEY SECTION
03-M-01

Figure 3-7



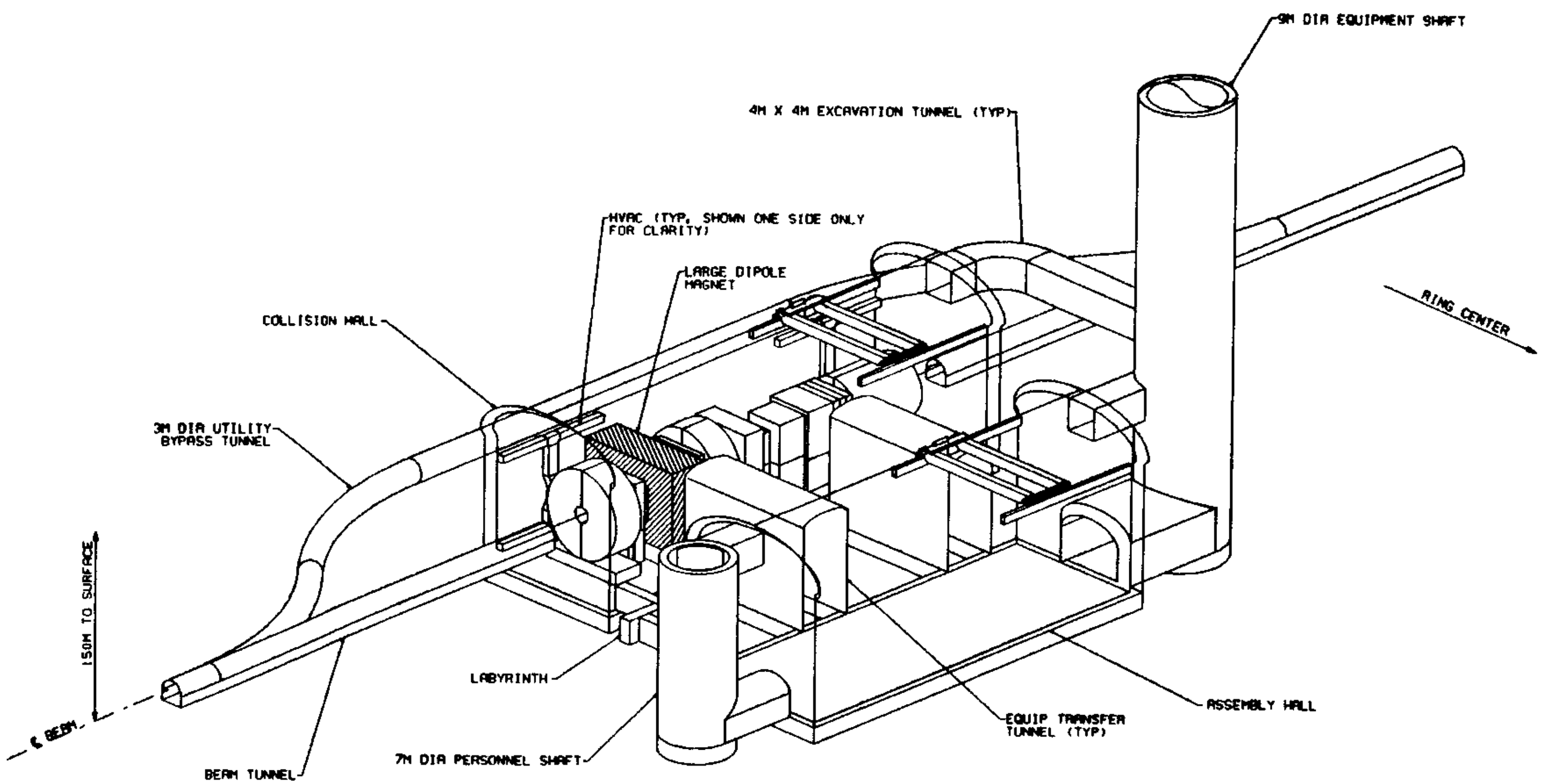
BEAUTY SPECTROMETER-150M DEPTH
SURFACE FACILITIES
GENERAL ARRANGEMENT
03-M-02

Figure 3-8



BOTTOM COLLIDER DETECTOR-150M DEPTH
PLAN AND SECTION AT HALLS
GENERAL ARRANGEMENT
05-M-03

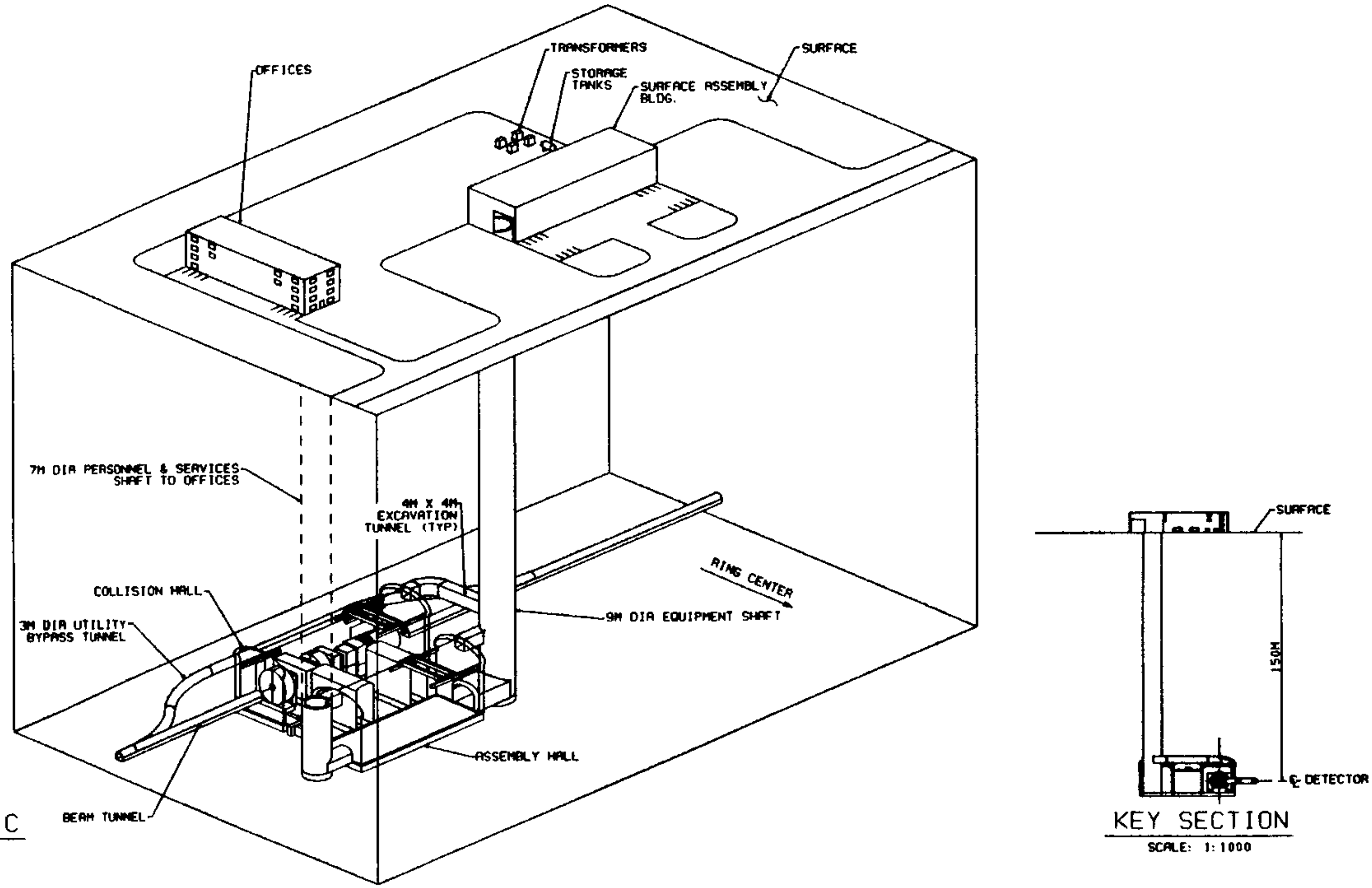
Figure 3-9



ISOMETRIC

BOTTOM COLLIDER DETECTOR-150M DEPTH
ISOMETRIC AT HALLS
05-M-04

Figure 3-10

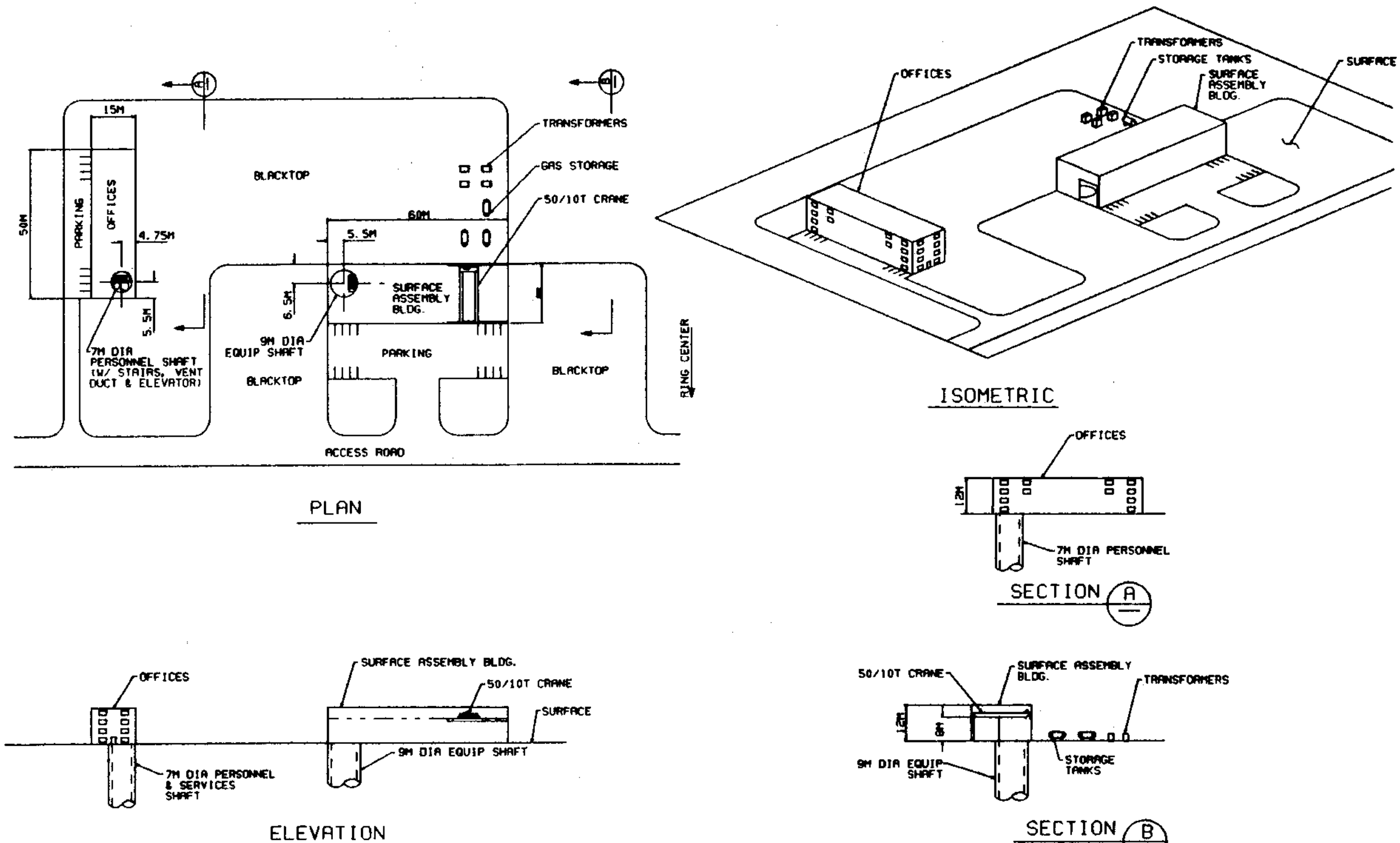


ISOMETRIC

SCALE: NONE

BOTTOM COLLIDER DETECTOR-150M DEPTH
ISOMETRIC AND KEY SECTION
05-M-01

Figure 3-11



BOTTOM COLLIDER DETECTOR-150M DEPTH
SURFACE FACILITIES
GENERAL ARRANGEMENT
05-M-02

Figure 3-12

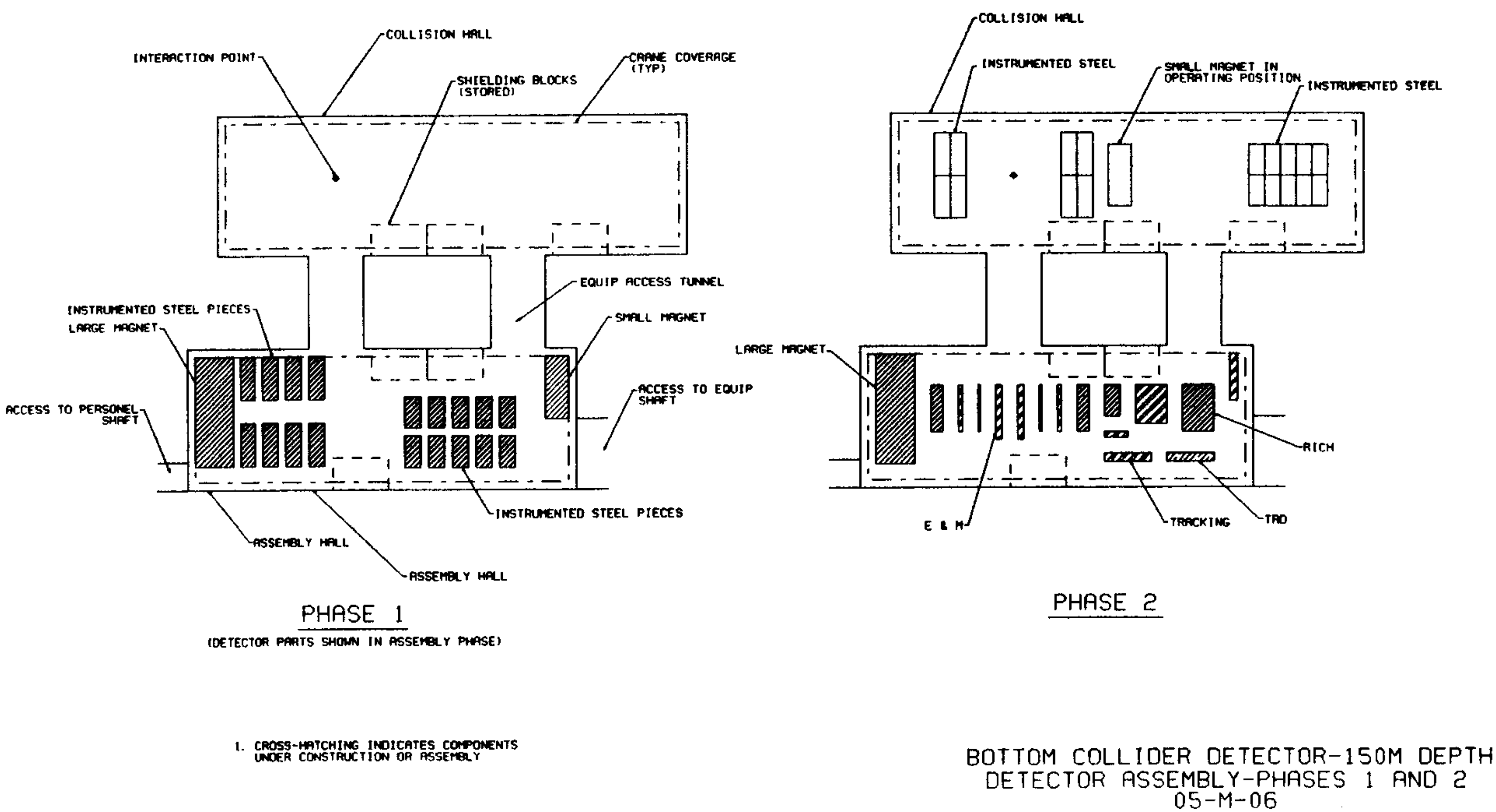
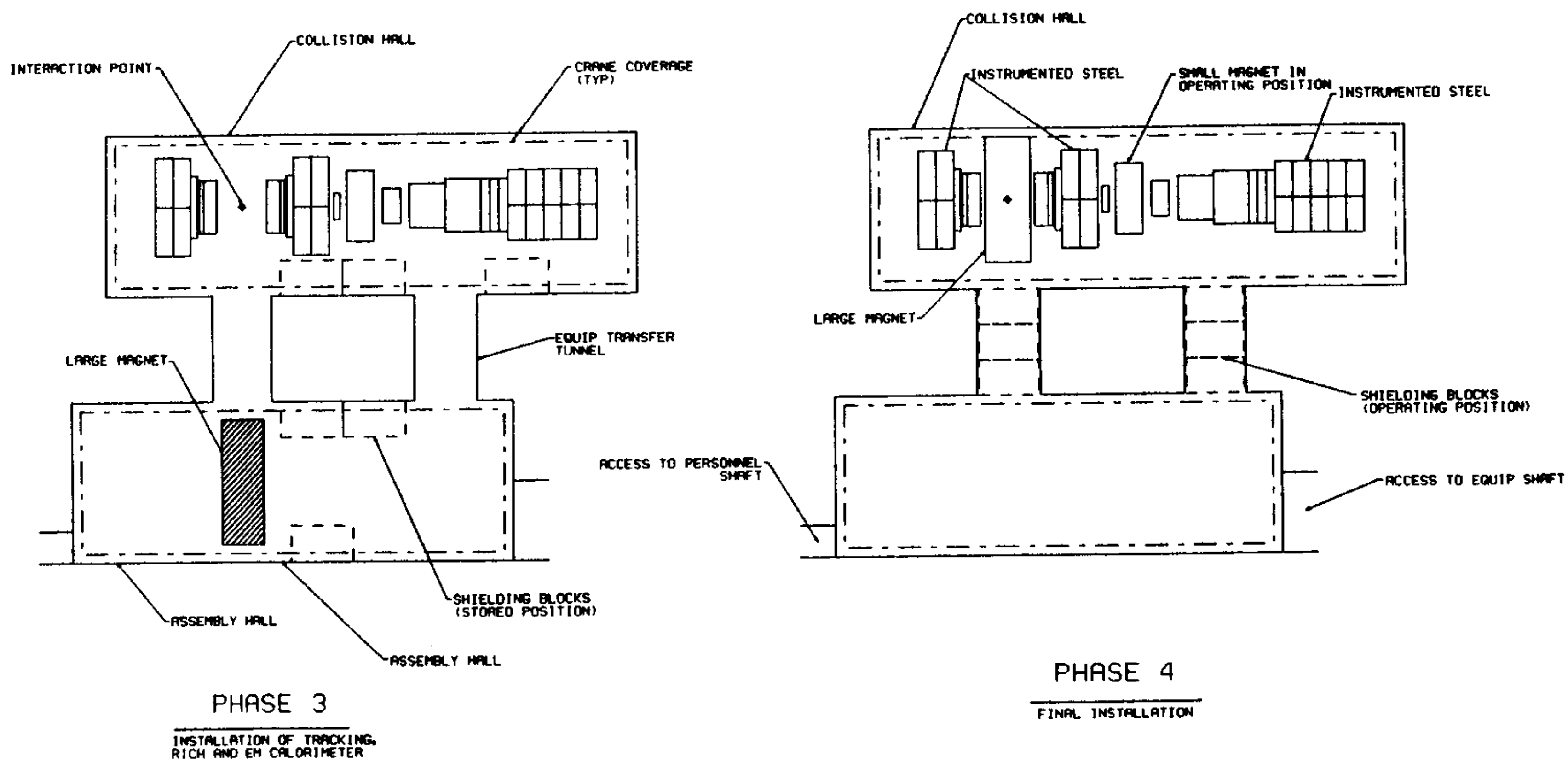

COLLISION HALL
INTERACTION POINT
CRANE COVERAGE (TYP)
SHIELDING BLOCKS (STORED)
EQUIP ACCESS TUNNEL
INSTRUMENTED STEEL PIECES
LARGE MAGNET
SMALL MAGNET
ACCESS TO PERSONEL SHAFT
ACCESS TO EQUIP SHAFT
INSTRUMENTED STEEL PIECES
ASSEMBLY HALL
ASSEMBLY HALL
PHASE 1
(DETECTOR PARTS SHOWN IN ASSEMBLY PHASE)
COLLISION HALL
INSTRUMENTED STEEL
SMALL MAGNET IN OPERATING POSITION
INSTRUMENTED STEEL
LARGE MAGNET
RICH
E & M
TRACKING
TRD
PHASE 2
1. CROSS-HATCHING INDICATES COMPONENTS UNDER CONSTRUCTION OR ASSEMBLY
BOTTOM COLLIDER DETECTOR-150M DEPTH
DETECTOR ASSEMBLY-PHASES 1 AND 2
05-M-06

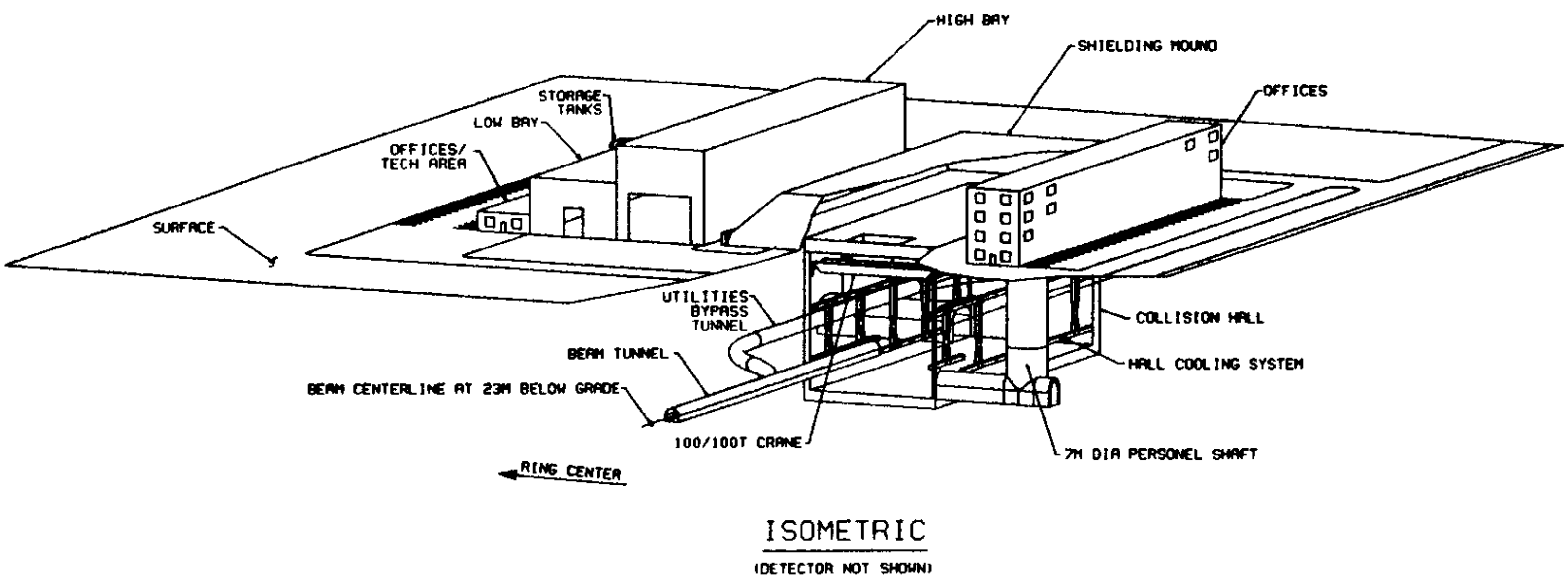
Figure 3-13



1. CROSS-HATCHING INDICATES COMPONENTS UNDER CONSTRUCTION OR ASSEMBLY

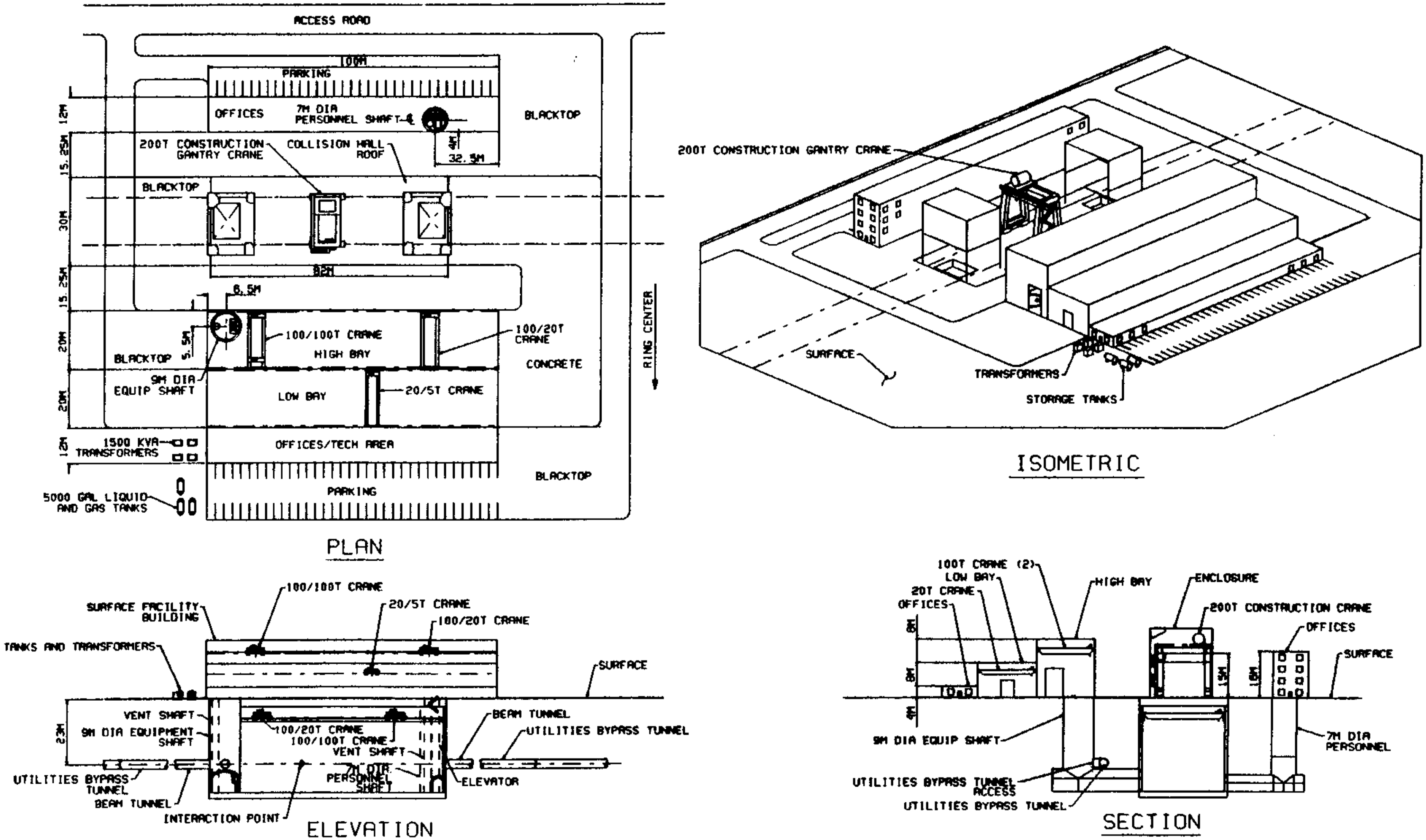
BOTTOM COLLIDER DETECTOR-150M DEPTH
DETECTOR ASSEMBLY-PHASES 3 AND 4
05-M-07

Figure 3-14



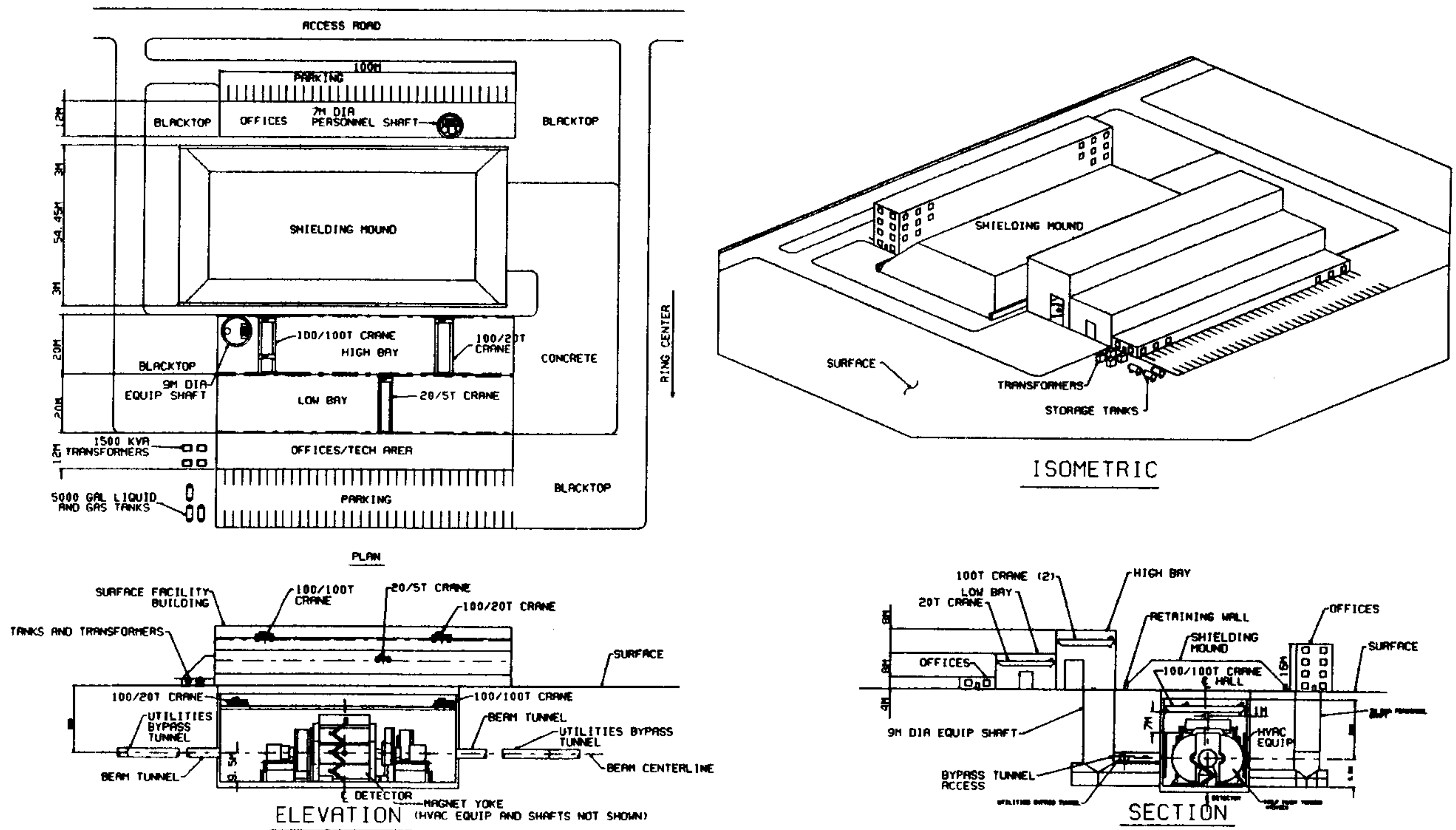
LARGE SOLENOID DETECTOR-23M DEPTH
FACILITIES ARRANGEMENT
ISOMETRIC
02-M-01

Figure 4-1



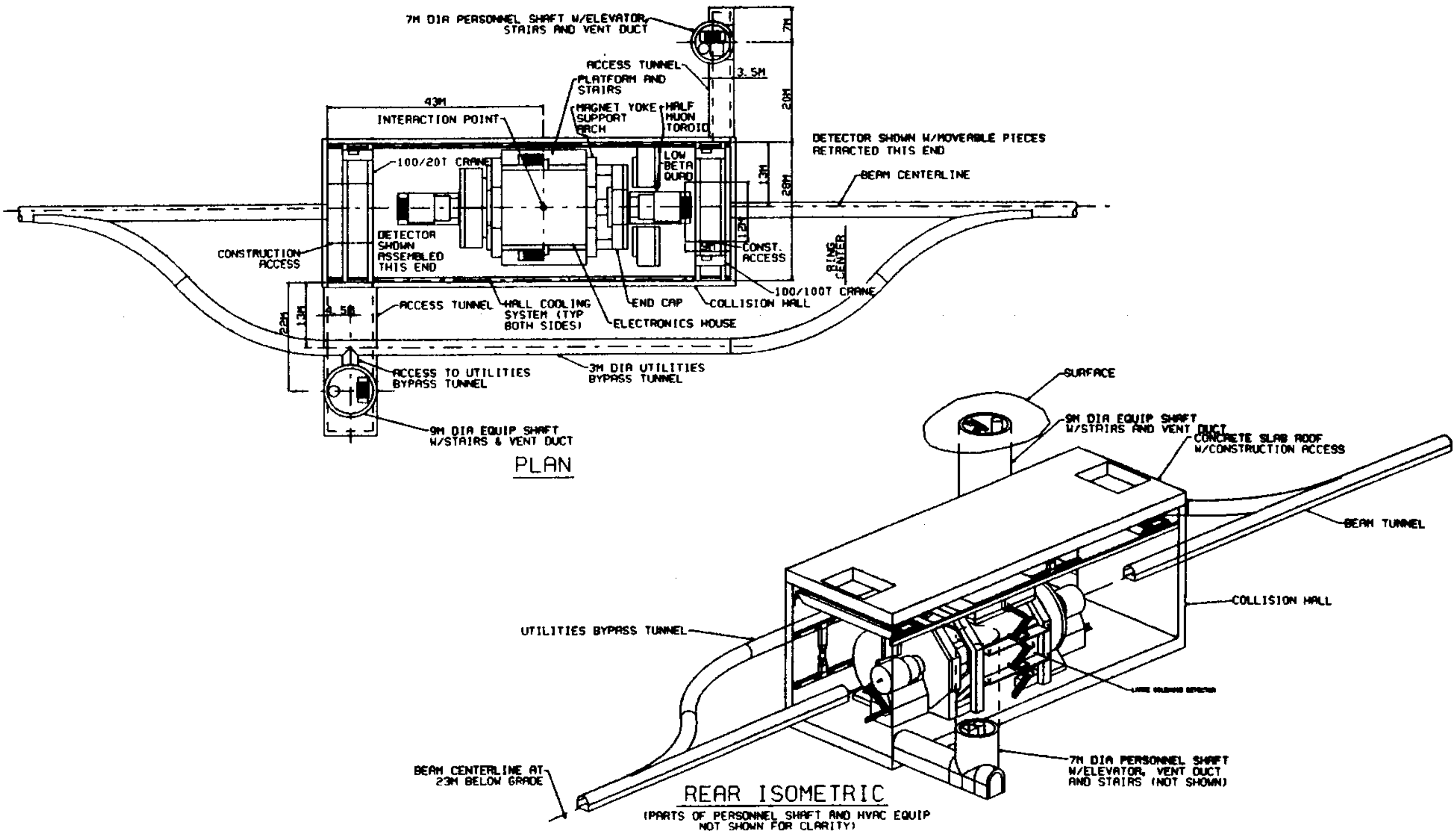
LARGE SOLENOID DETECTOR-23M DEPTH
FACILITIES ARRANGEMENT
INSTALLATION PHASE
02-M-02

Figure 4-2



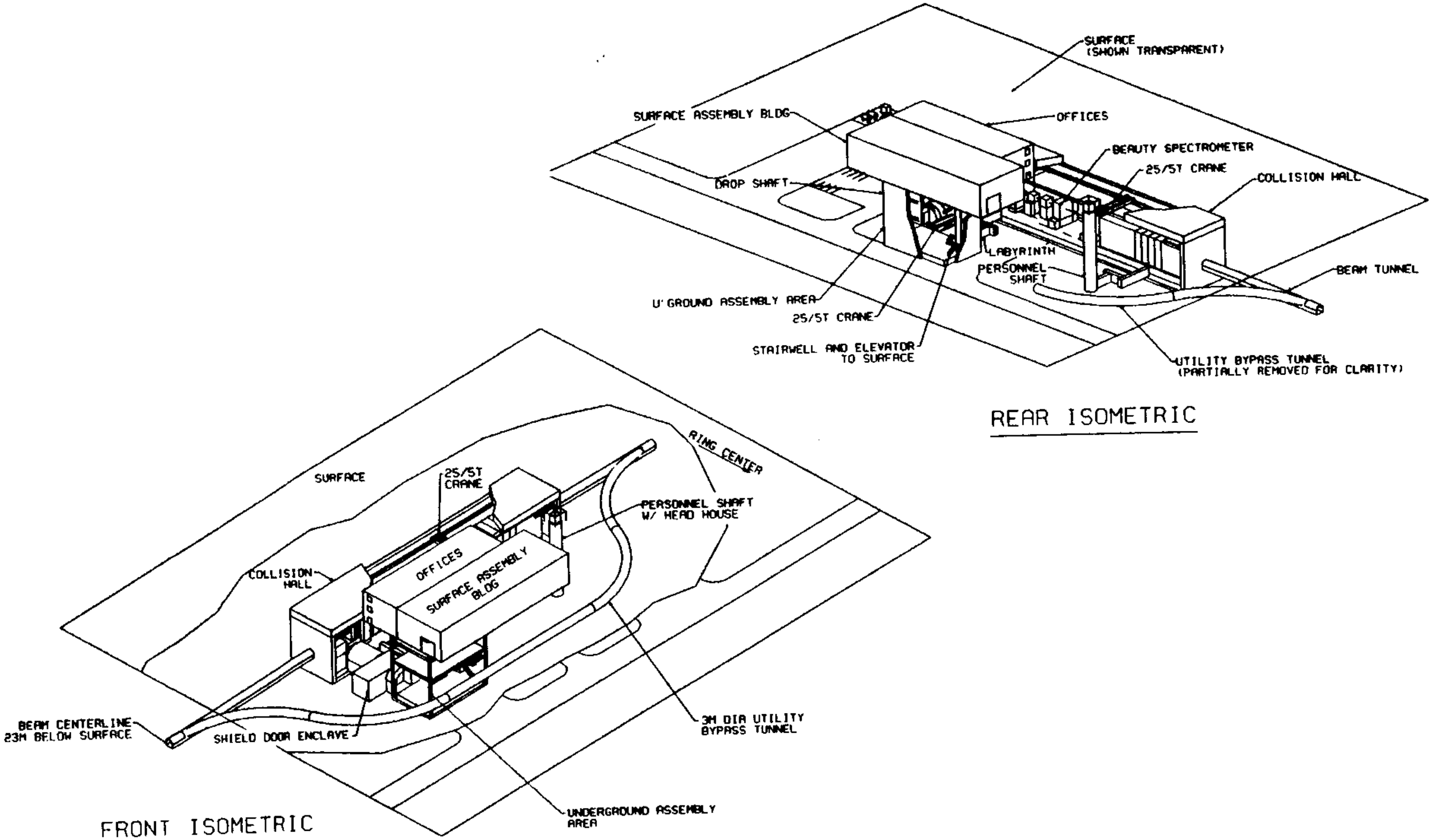
LARGE SOLENOID DÈTECTOR-23M DEPTH
FACILITIES ARRANGEMENT
OPERATING PHASE
02-M-03

Figure 4-3



LARGE SOLENOID DETECTOR-23M DEPTH
COLLISION HALL
GEN. ARRG'T. PLAN AND ISOMETRIC
02-M-04

Figure 4-4



BEAUTY SPECTROMETER 23M DEPTH
GENERAL ARRANGEMENT
ISOMETRIC VIEWS
04-M-01

Figure 4-5

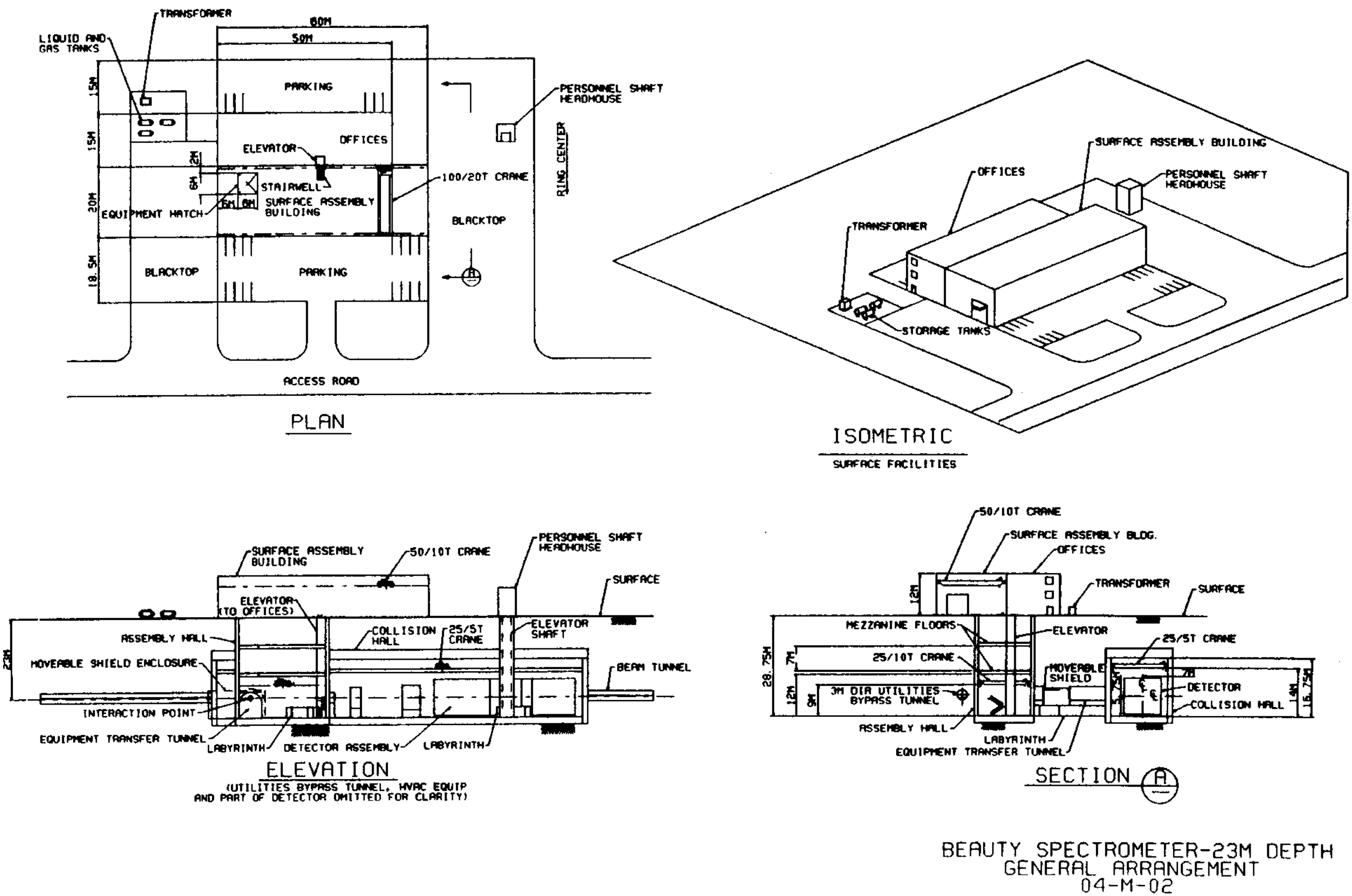
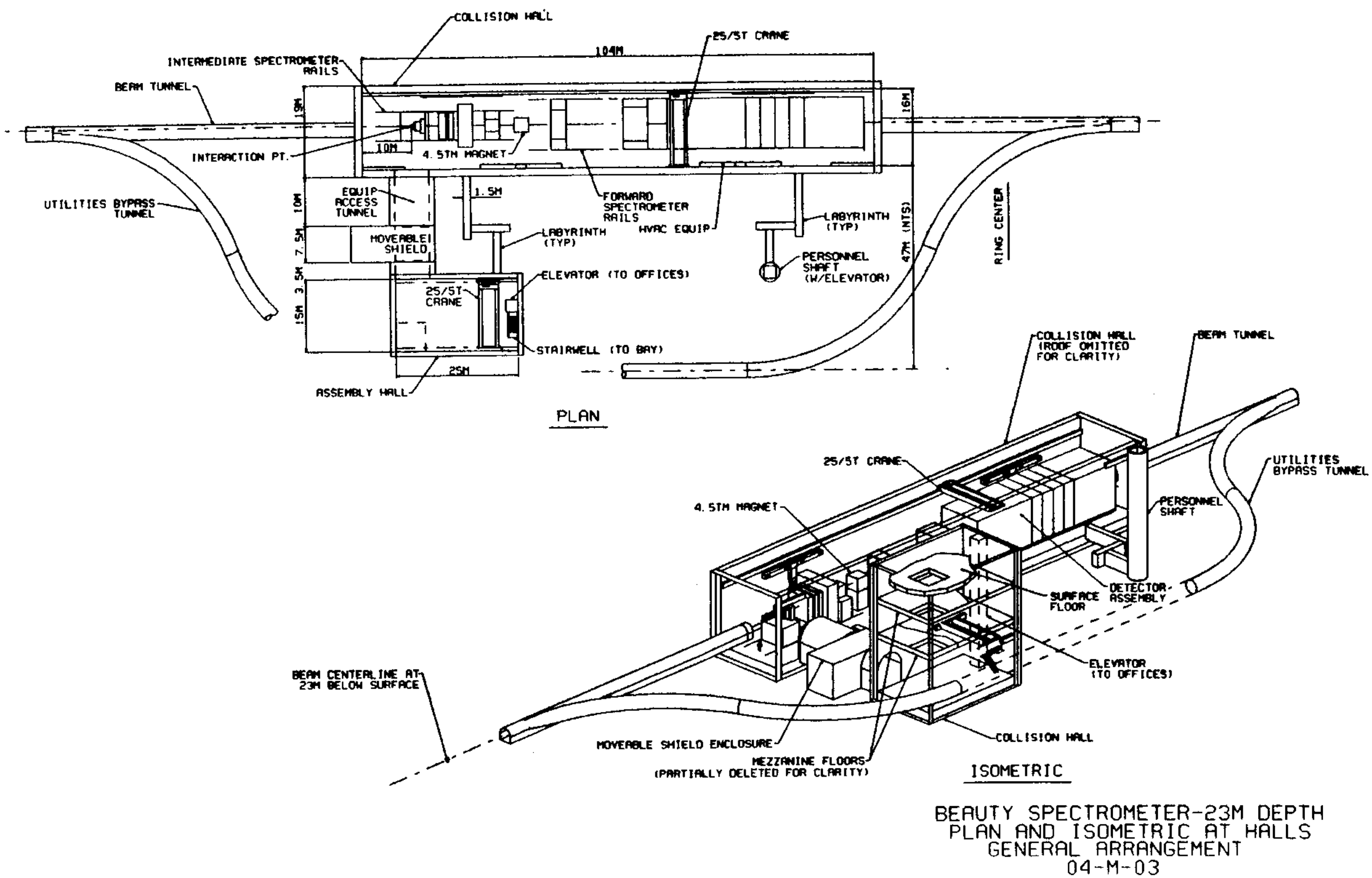
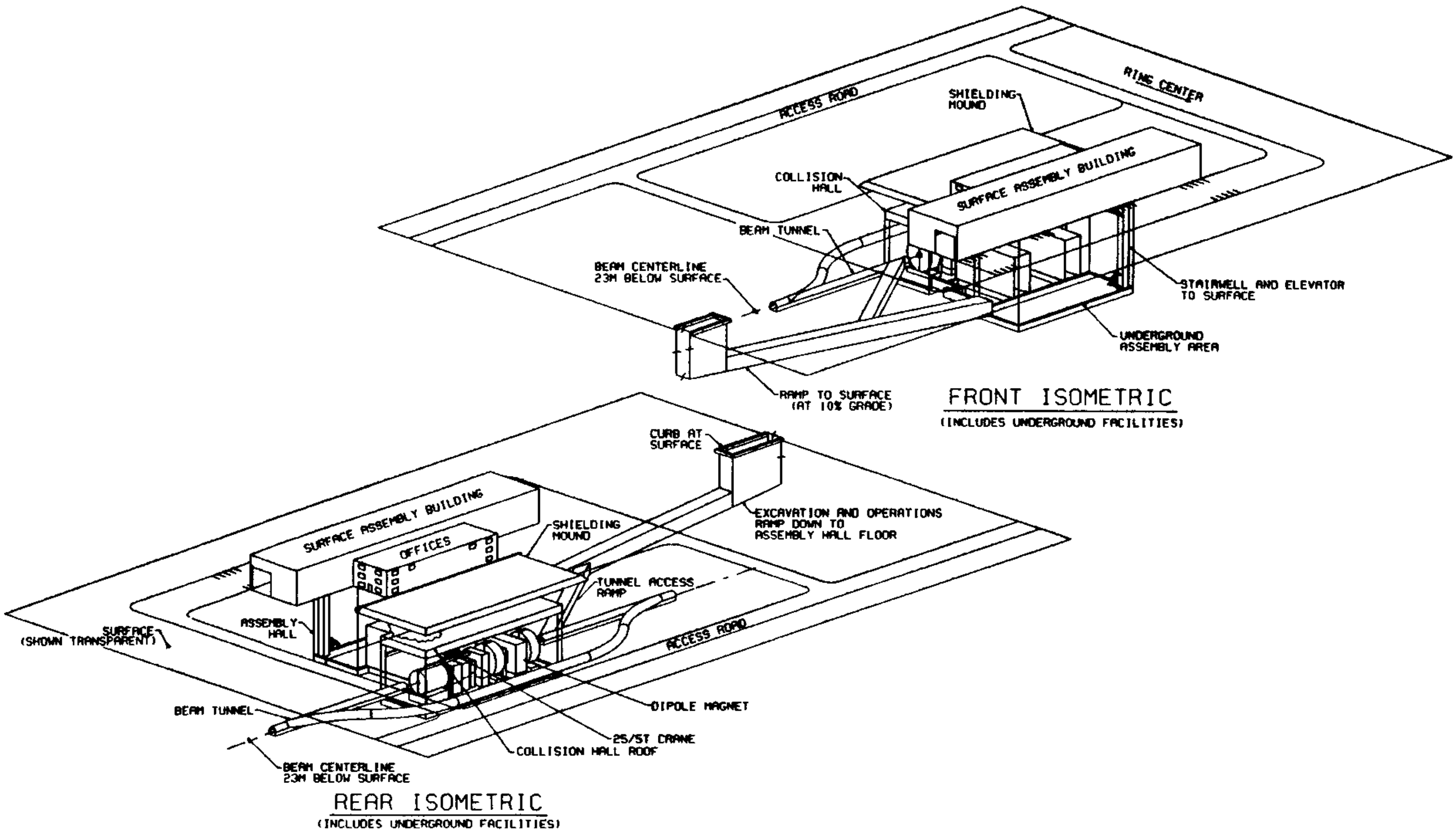

TRANSFORMER
LIQUID AND GAS TANKS
60M
50M
15M
15M
20M
18.5M
PARKING
OFFICES
ELEVATOR
2M
6M
STAIRWELL
6M
6M
SURFACE ASSEMBLY BUILDING
EQUIPMENT HATCH
100/20T CRANE
BLACKTOP
BLACKTOP
PARKING
PERSONNEL SHAFT HEADHOUSE
RING CENTER
ACCESS ROAD
PLAN
SURFACE ASSEMBLY BUILDING
OFFICES
PERSONNEL SHAFT HEADHOUSE
TRANSFORMER
STORAGE TANKS
ISOMETRIC
SURFACE FACILITIES
SURFACE ASSEMBLY BUILDING
50/10T CRANE
PERSONNEL SHAFT HEADHOUSE
SURFACE
ELEVATOR (TO OFFICES)
ASSEMBLY HALL
COLLISION HALL
25/5T CRANE
ELEVATOR SHAFT
23M
MOVEABLE SHIELD ENCLOSURE
BEAM TUNNEL
INTERACTION POINT
EQUIPMENT TRANSFER TUNNEL
LABYRINTH
DETECTOR ASSEMBLY
LABYRINTH
ELEVATION
(UTILITIES BYPASS TUNNEL, HVAC EQUIP AND PART OF DETECTOR OMITTED FOR CLARITY)
50/10T CRANE
SURFACE ASSEMBLY BLDG.
OFFICES
TRANSFORMER
SURFACE
12M
MEZZANINE FLOORS
ELEVATOR
25/5T CRANE
25/10T CRANE
28.75M
7M
12M
9M
3M DIA UTILITIES BYPASS TUNNEL
MOVEABLE SHIELD
DETECTOR
COLLISION HALL
14M
16.75M
ASSEMBLY HALL
LABYRINTH
EQUIPMENT TRANSFER TUNNEL
SECTION A
BEAUTY SPECTROMETER-23M DEPTH
GENERAL ARRANGEMENT
04-M-02

Figure 4-6



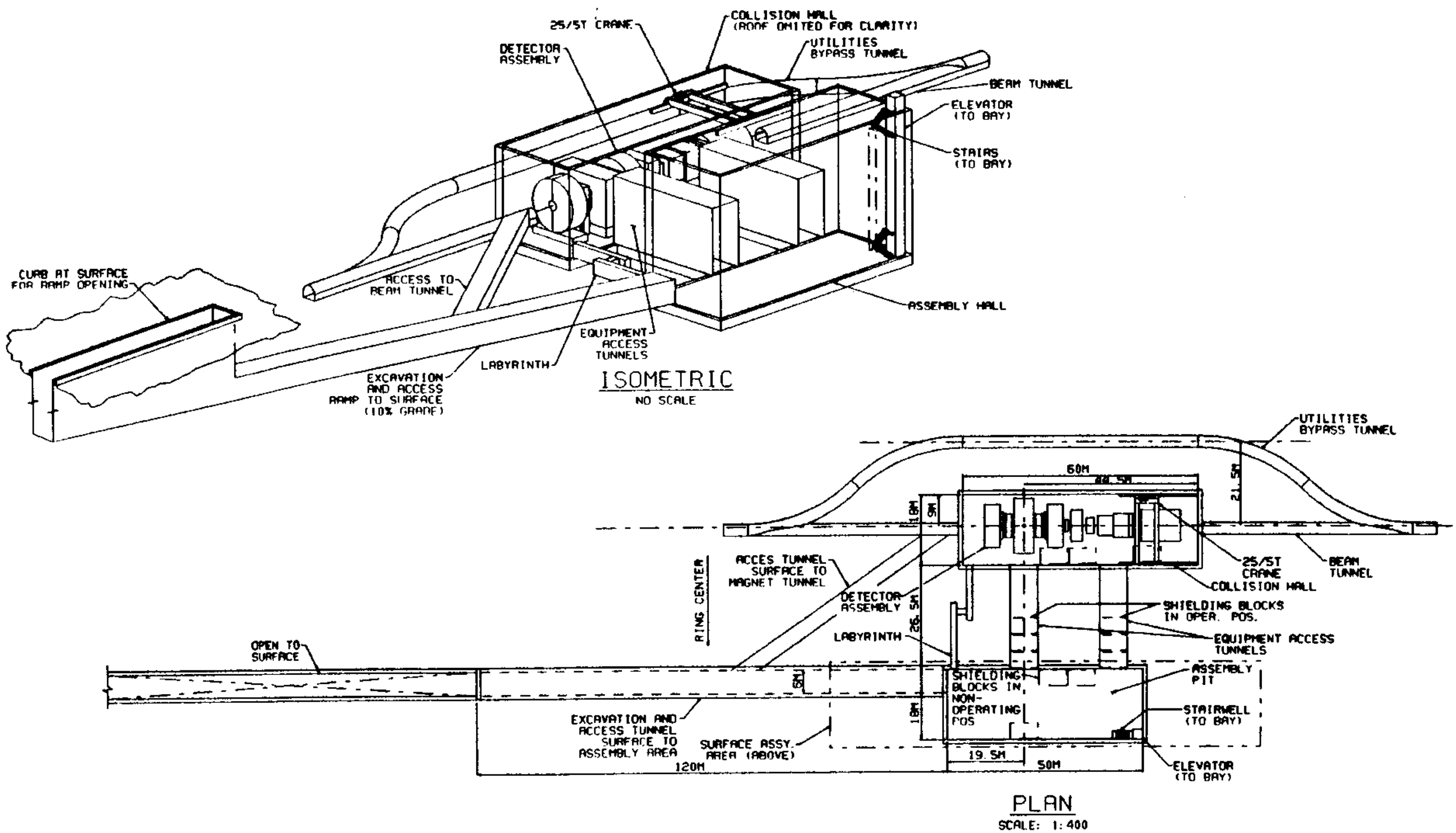
COLLISION HALL
INTERMEDIATE SPECTROMETER RAILS
BEAM TUNNEL
104M
25/5T CRANE
19M
16M
INTERACTION PT.
10M
4.5TM MAGNET
UTILITIES BYPASS TUNNEL
EQUIP ACCESS TUNNEL
MOVEABLE SHIELD
1.5M
FORWARD SPECTROMETER RAILS
HVAC EQUIP
LABYRINTH (TYP)
PERSONNEL SHAFT (W/ELEVATOR)
47M (NTS)
RING CENTER
ELEVATOR (TO OFFICES)
25/5T CRANE
STAIRWELL (TO BAY)
25M
ASSEMBLY HALL
10M
7.5M
3.5M
15M
PLAN
COLLISION HALL (ROOF OMITTED FOR CLARITY)
BEAM TUNNEL
UTILITIES BYPASS TUNNEL
25/5T CRANE
4.5TM MAGNET
PERSONNEL SHAFT
DETECTOR ASSEMBLY
SURFACE FLOOR
ELEVATOR (TO OFFICES)
BEAM CENTERLINE AT 23M BELOW SURFACE
MOVEABLE SHIELD ENCLOSURE
MEZZANINE FLOORS (PARTIALLY DELETED FOR CLARITY)
COLLISION HALL
ISOMETRIC
BEAUTY SPECTROMETER-23M DEPTH
PLAN AND ISOMETRIC AT HALLS
GENERAL ARRANGEMENT
04-M-03

Figure 4-7



BOTTOM COLLIDER DETECTOR-23M DEPTH
GENERAL ARRANGEMENT
ISOMETRIC VIEWS
06-M-01

Figure 4-8



BOTTOM COLLIDER DETECTOR - 23M DEPTH
BELOW SURFACE FACILITIES
06-M-03

Figure 4-10

Figure 5-1 Surface Facility Organization

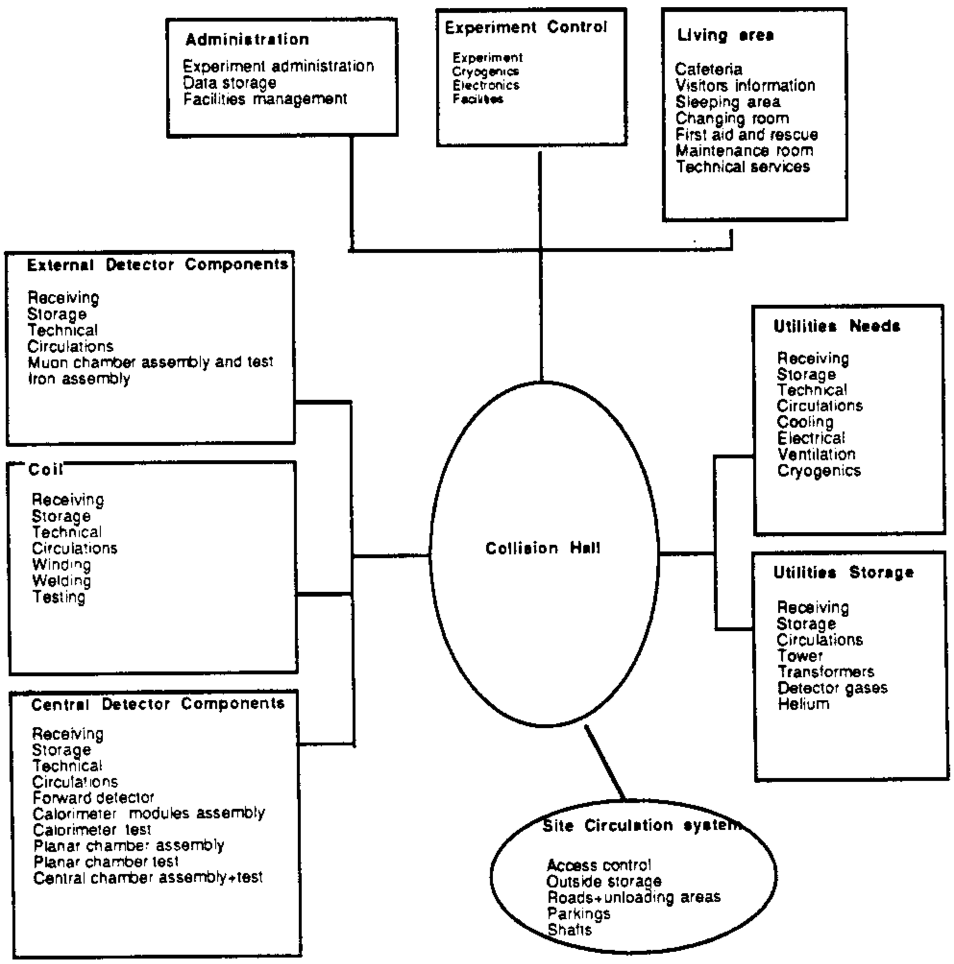


Figure 5-2 Experimental Area Cross Section

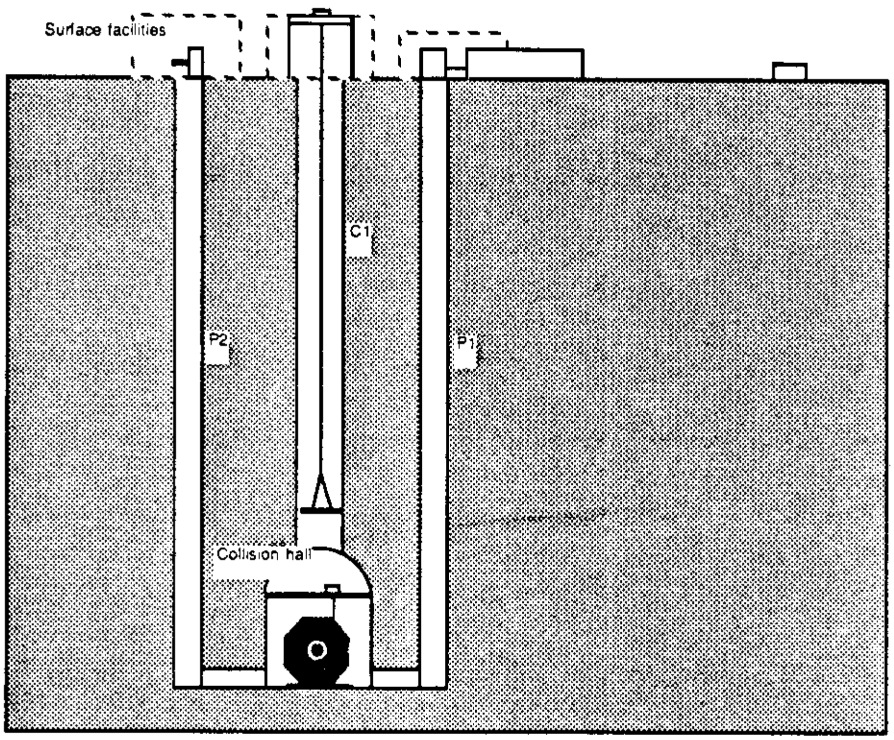


Figure 5-3 Underground Facilities

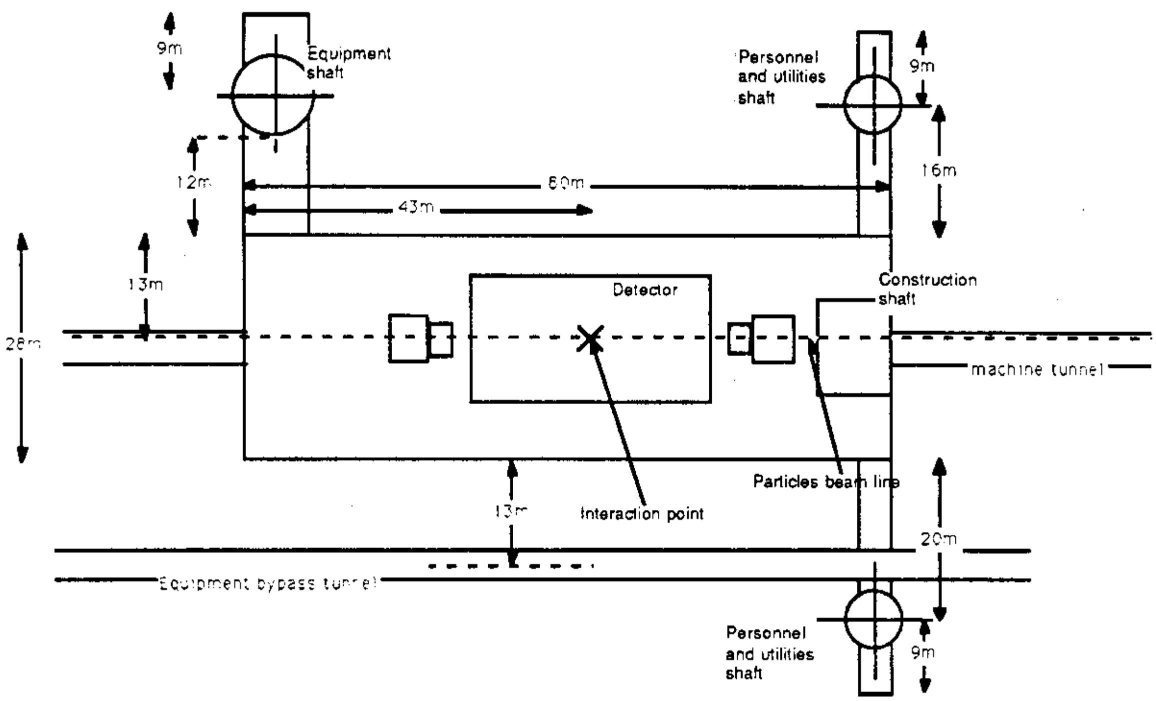


Figure 5-4 Personnel and Utilities Shaft

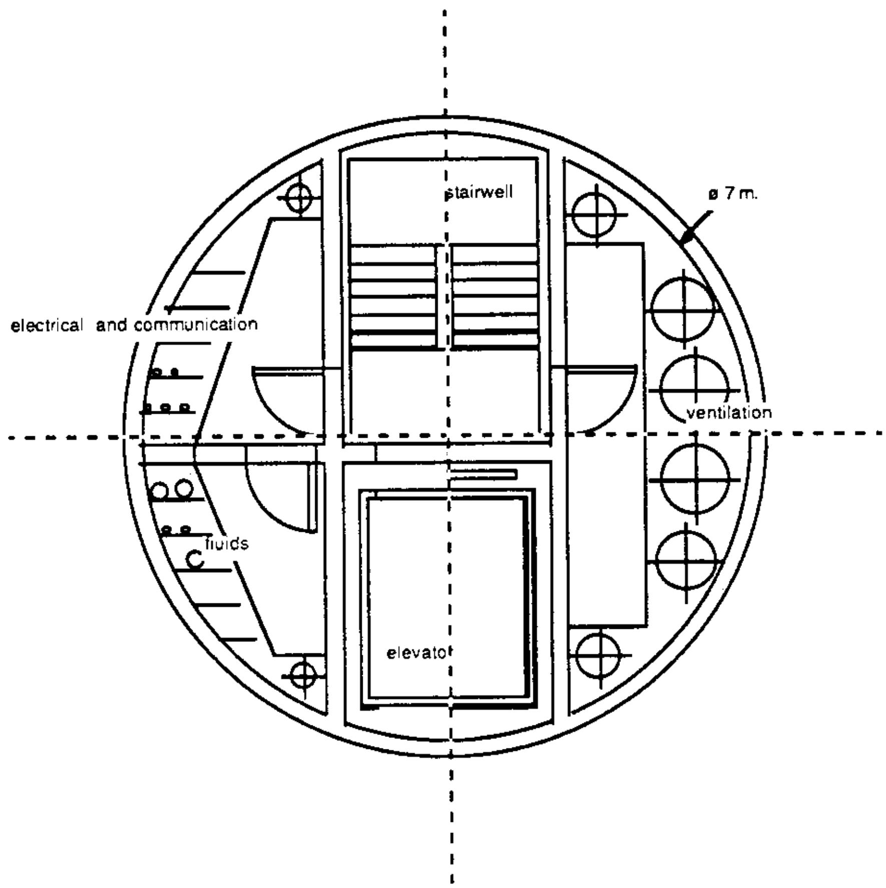


Figure 5-5 Surface Plan During Underground Construction

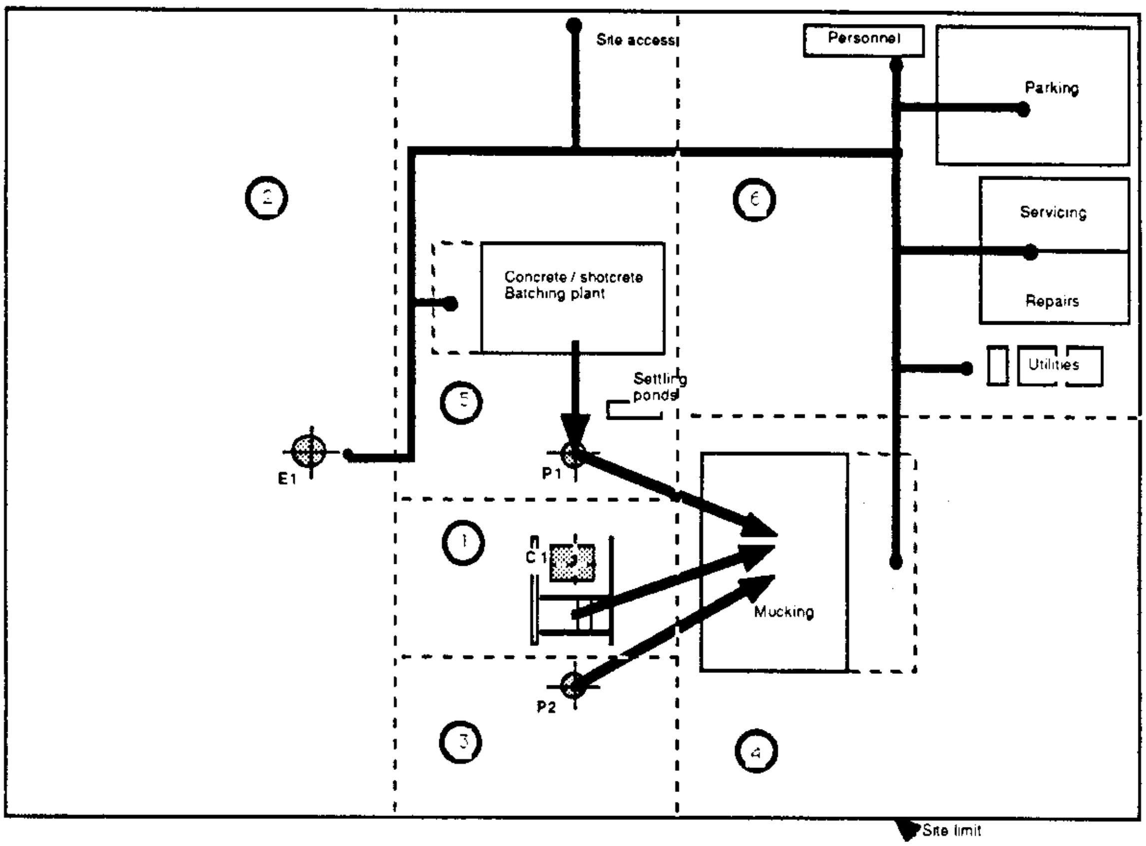


Figure 5-6 Surface Organization

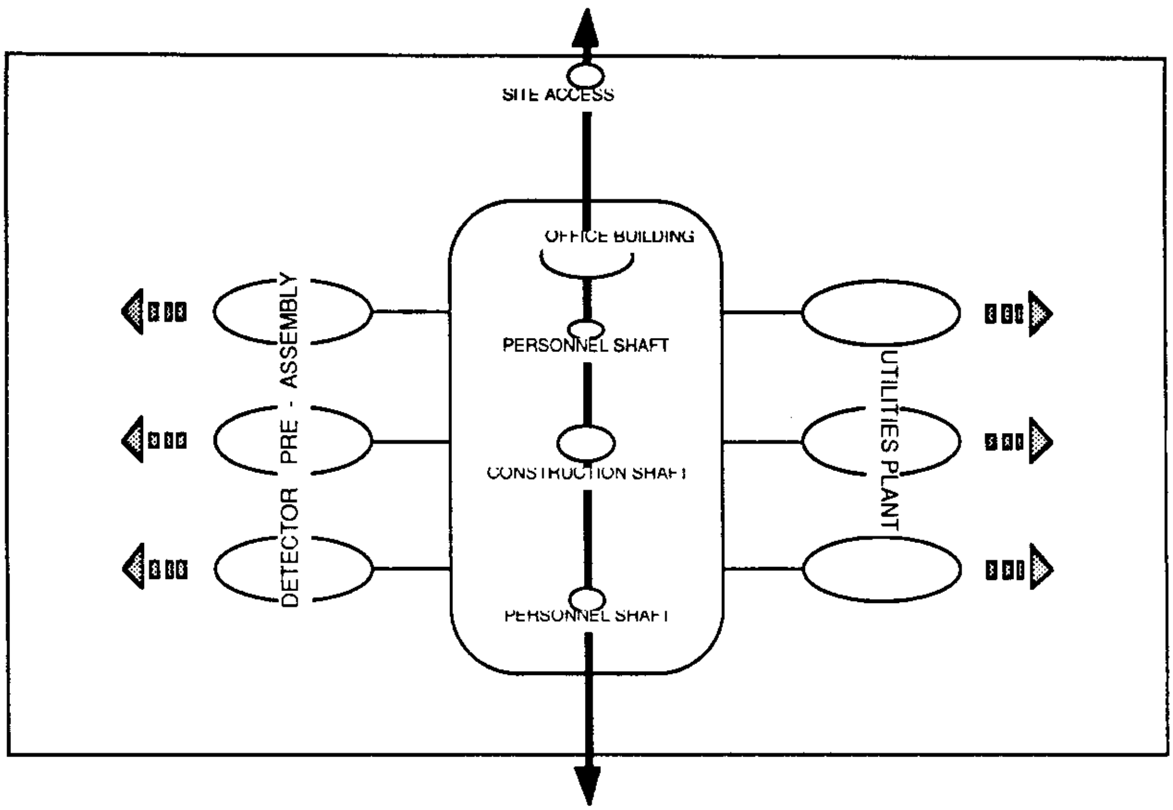


Figure 5-7 Surface Plan During Operation

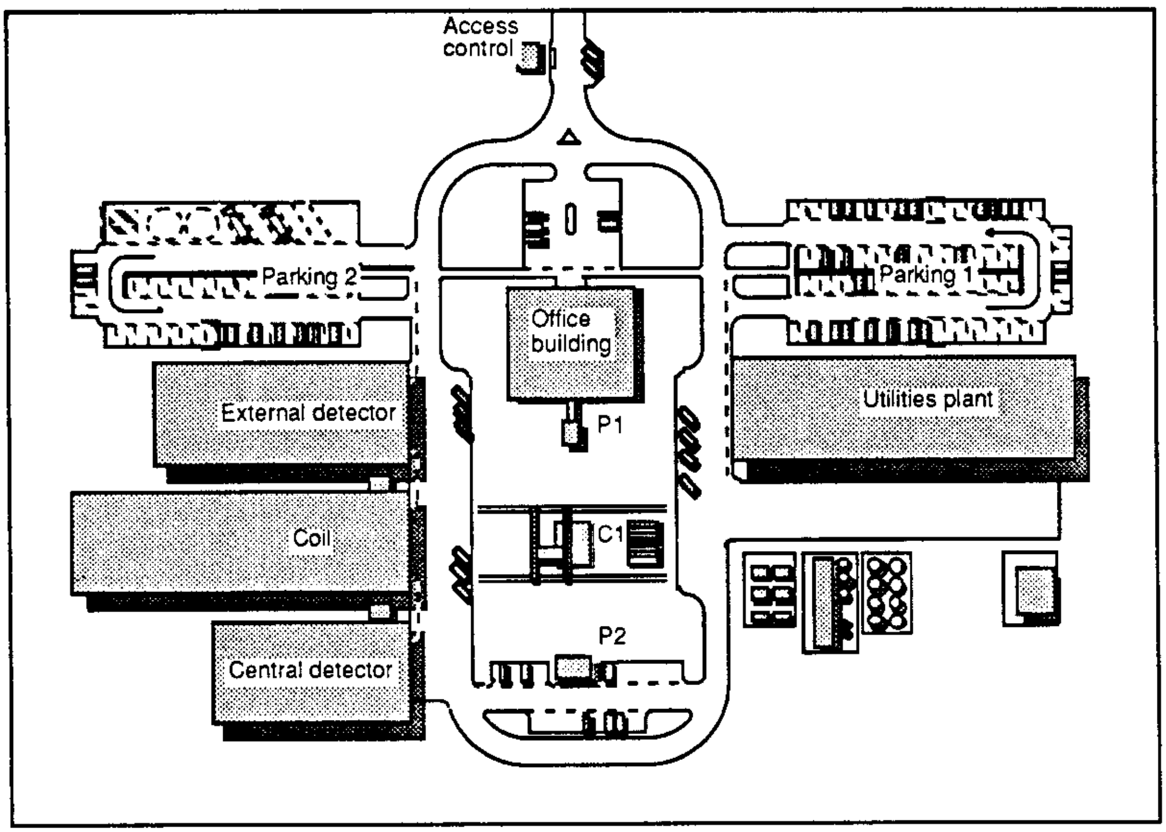


Figure 5-8 Detector Preassembly Building

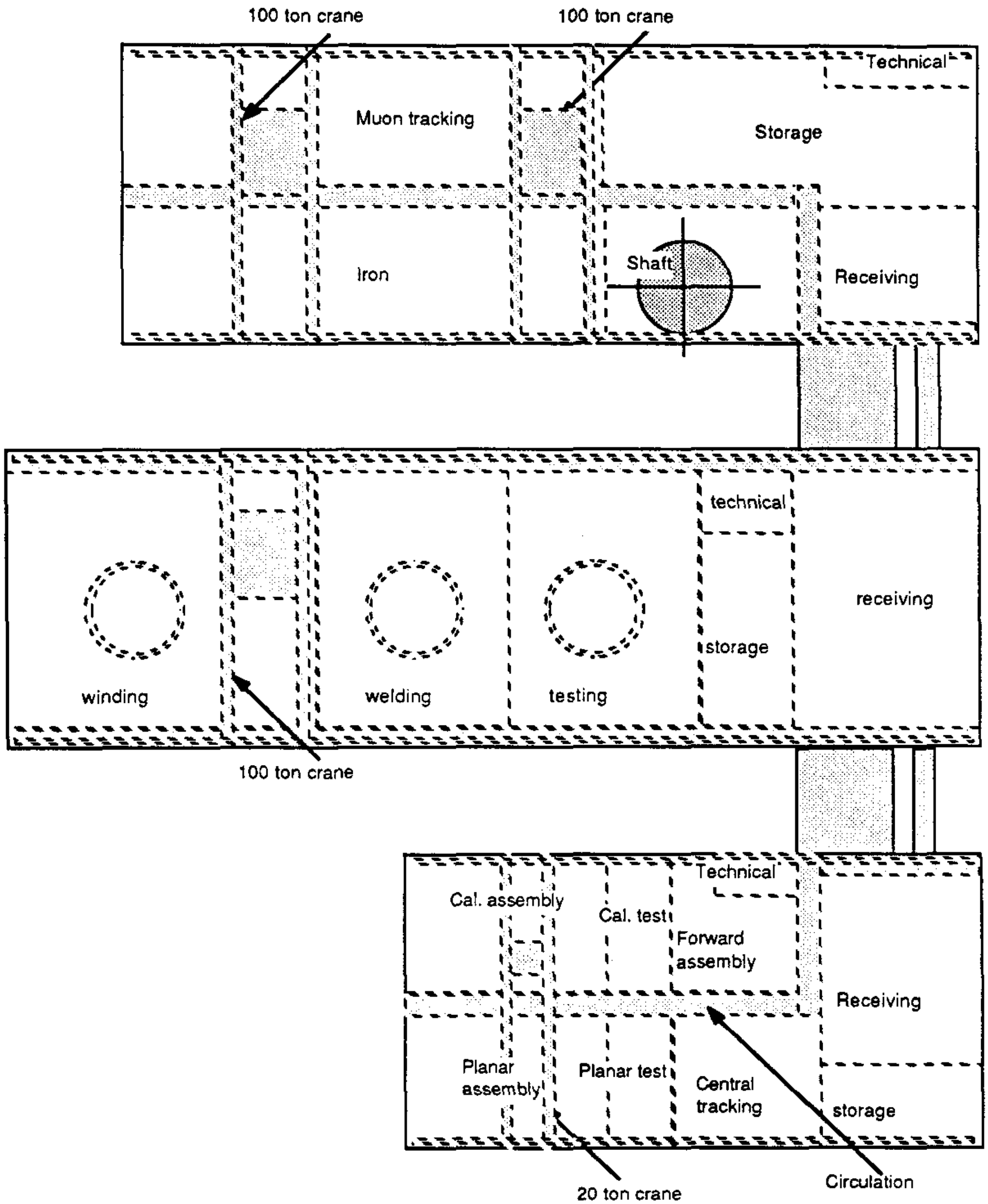


Figure 5-9 Utilities Plant

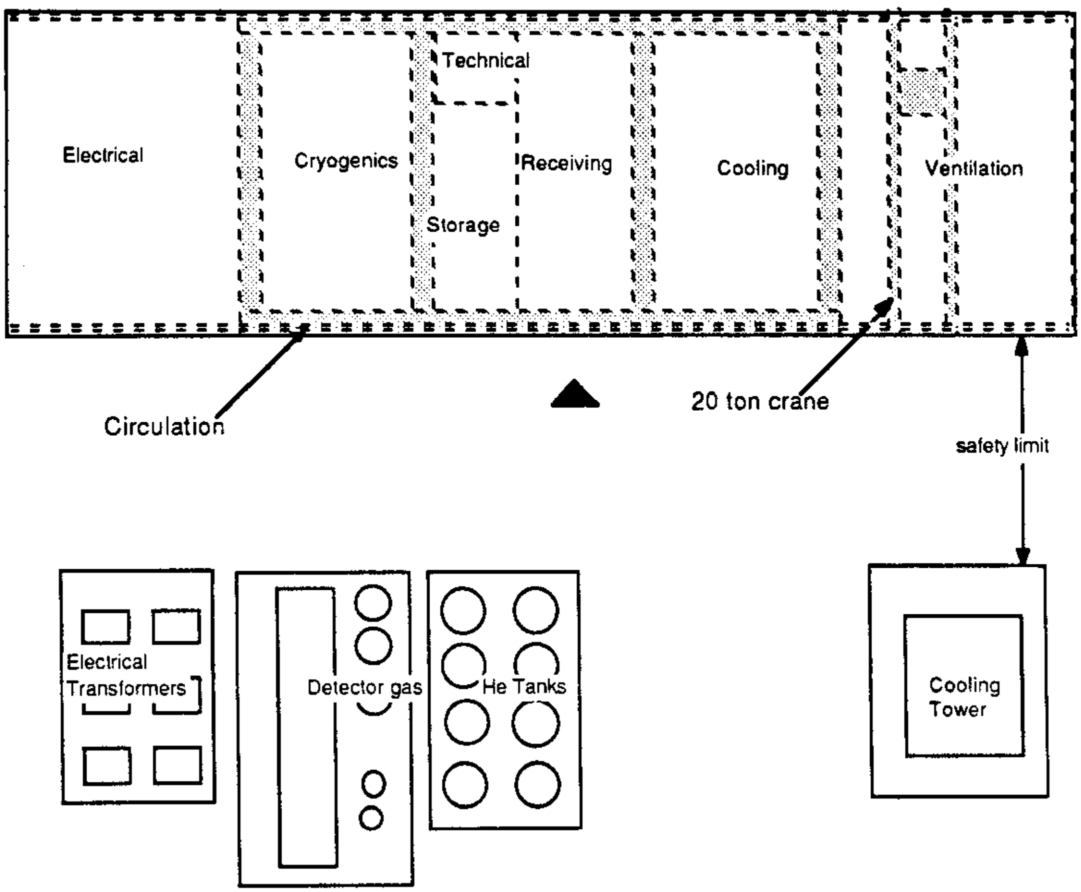


Figure 5-10 Office Building Cross Section

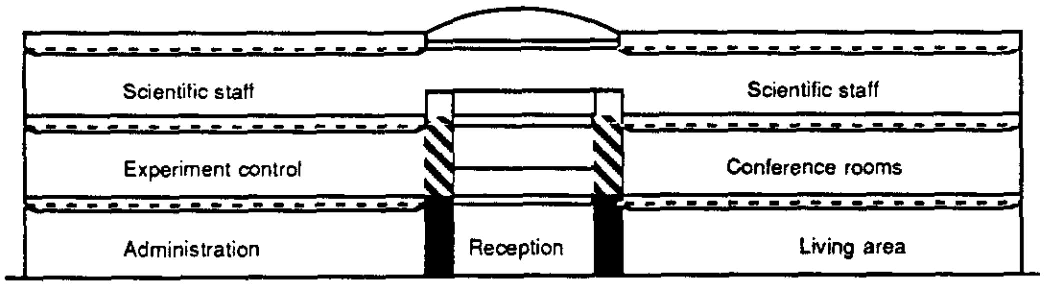


Figure 5-11 Office Building 1st Floor

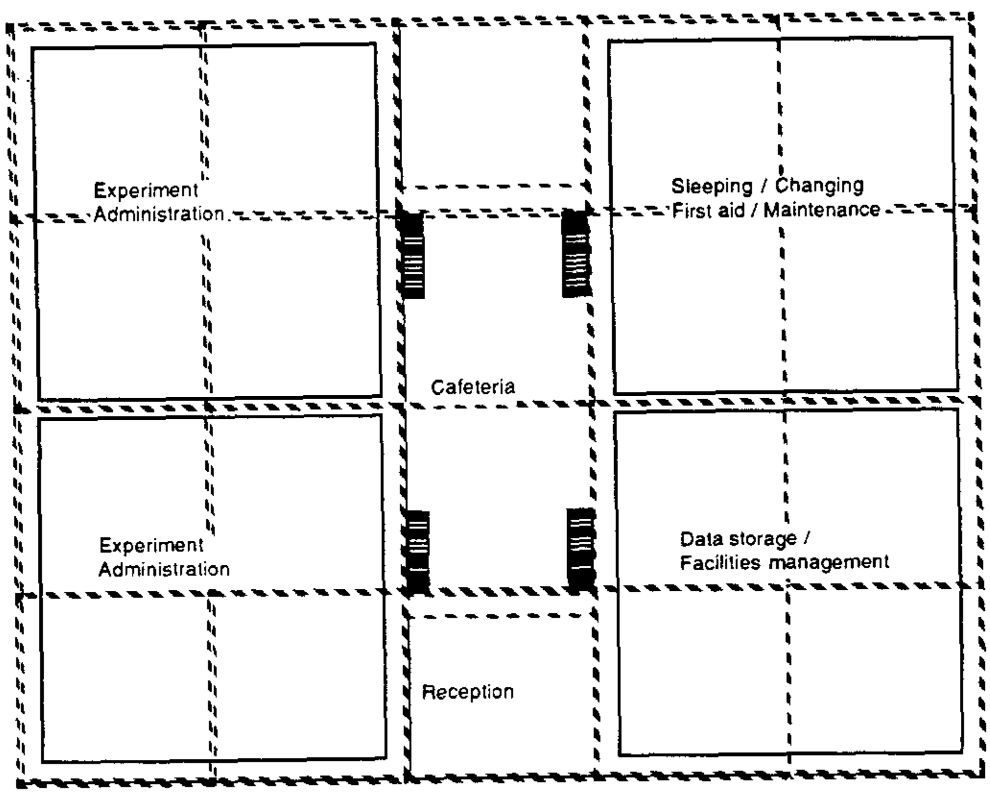


Figure 5-12 Office Building 2nd Floor

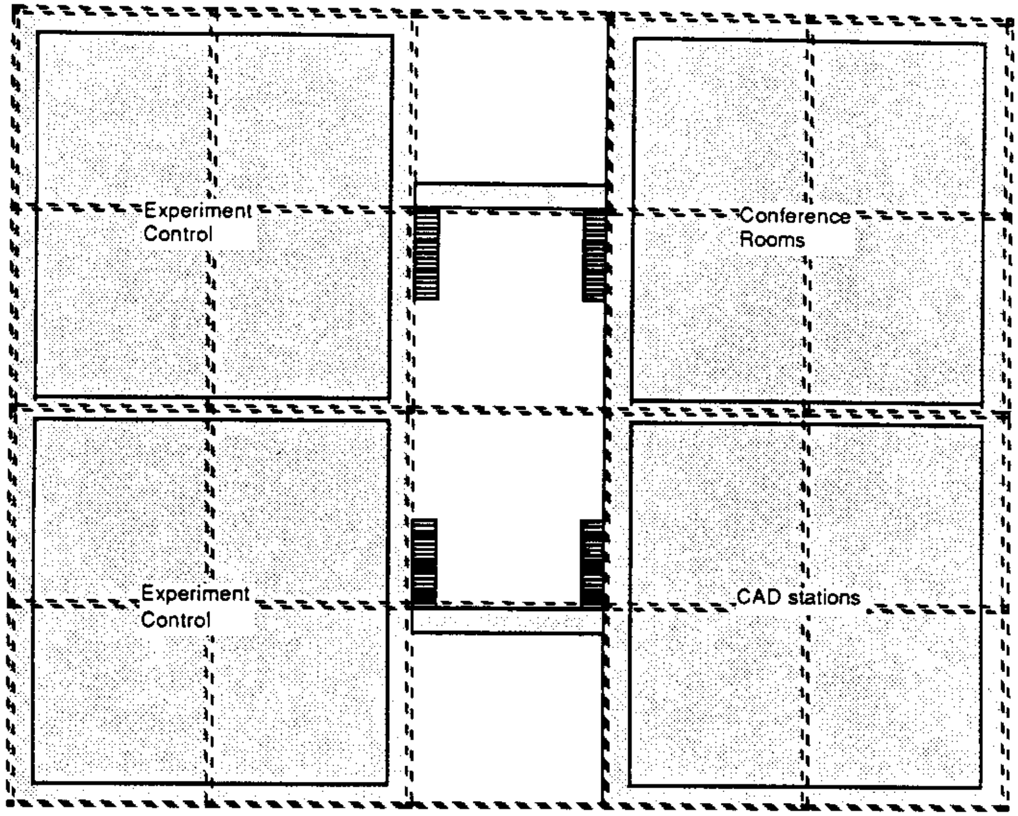
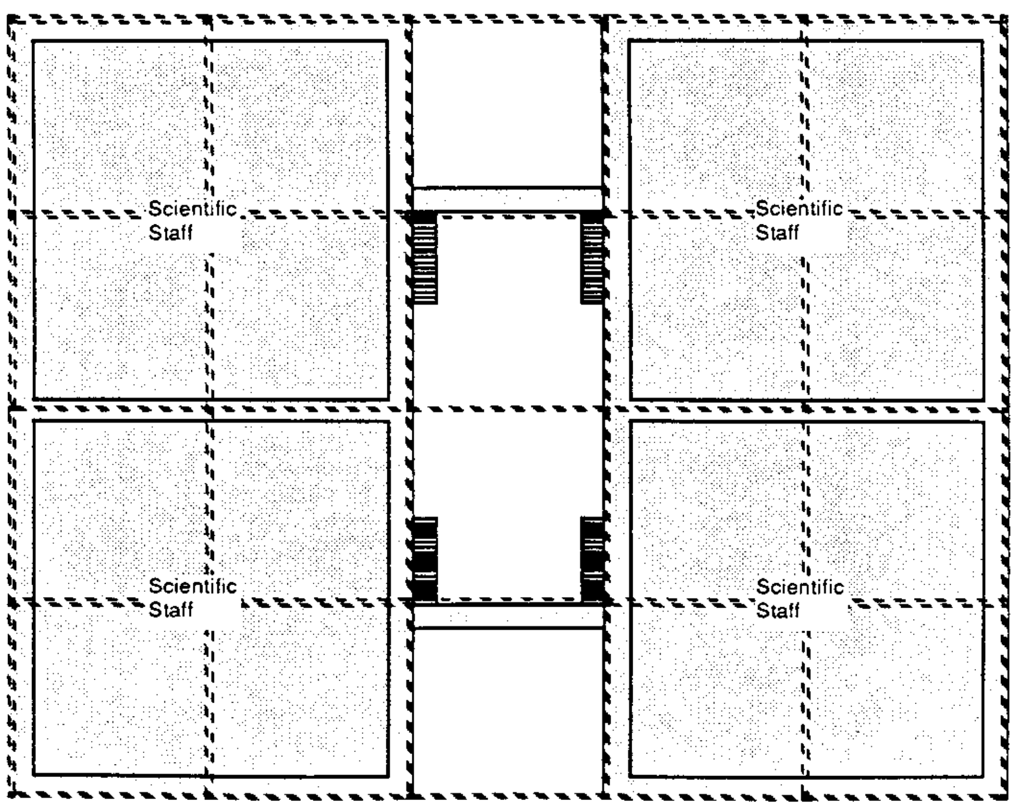


Figure 5-13 Office Building 3rd Floor



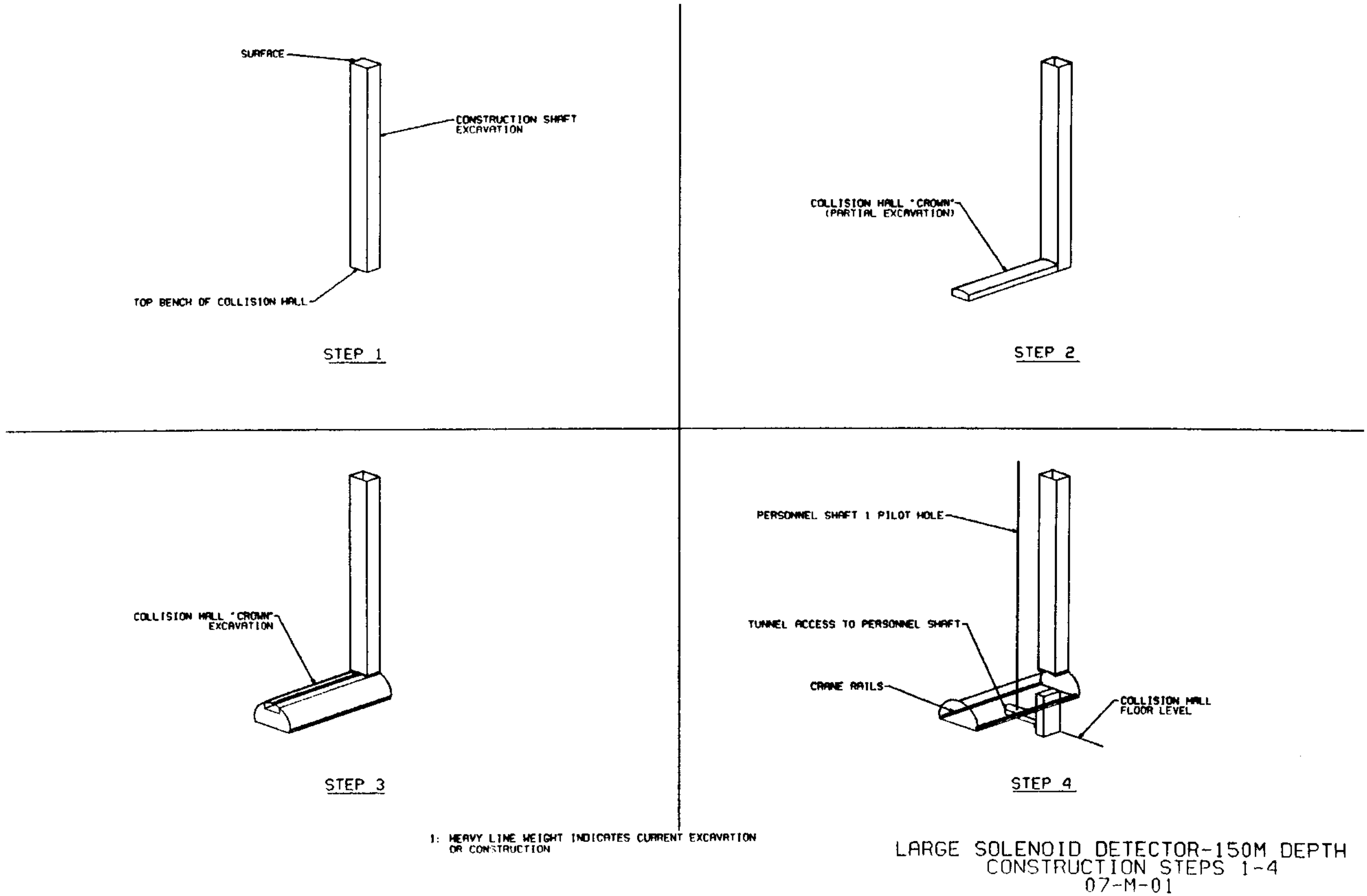

SURFACE
CONSTRUCTION SHAFT EXCAVATION
TOP BENCH OF COLLISION HALL
STEP 1
COLLISION HALL 'CROWN' (PARTIAL EXCAVATION)
STEP 2
COLLISION HALL 'CROWN' EXCAVATION
STEP 3
PERSONNEL SHAFT 1 PILOT HOLE
TUNNEL ACCESS TO PERSONNEL SHAFT
CRANE RAILS
COLLISION HALL FLOOR LEVEL
STEP 4
1: HEAVY LINE WEIGHT INDICATES CURRENT EXCAVATION OR CONSTRUCTION
LARGE SOLENOID DETECTOR-150M DEPTH
CONSTRUCTION STEPS 1-4
07-M-01

Figure 6-1

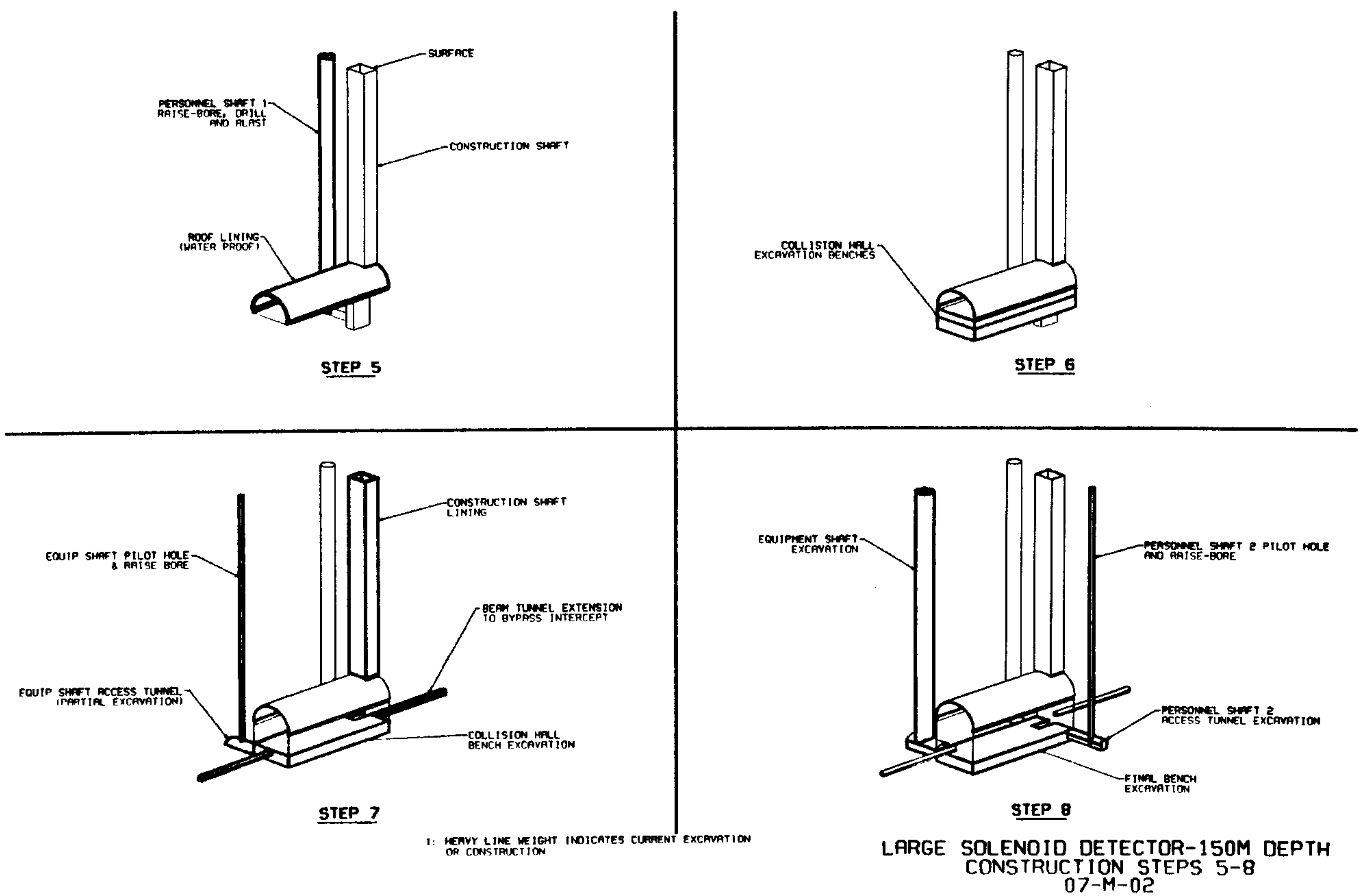

SURFACE
PERSONNEL SHAFT 1 RAISE-BORE, DRILL AND BLAST
CONSTRUCTION SHAFT
ROOF LINING (WATER PROOF)
STEP 5
COLLISION HALL EXCAVATION BENCHES
STEP 6
CONSTRUCTION SHAFT LINING
EQUIP SHAFT PILOT HOLE & RAISE BORE
BEAM TUNNEL EXTENSION TO BYPASS INTERCEPT
EQUIP SHAFT ACCESS TUNNEL (PARTIAL EXCAVATION)
COLLISION HALL BENCH EXCAVATION
STEP 7
EQUIPMENT SHAFT EXCAVATION
PERSONNEL SHAFT 2 PILOT HOLE AND RAISE-BORE
PERSONNEL SHAFT 2 ACCESS TUNNEL EXCAVATION
FINAL BENCH EXCAVATION
STEP 8
1: HEAVY LINE WEIGHT INDICATES CURRENT EXCAVATION OR CONSTRUCTION
LARGE SOLENOID DETECTOR-150M DEPTH
CONSTRUCTION STEPS 5-8
07-M-02

Figure 6-2

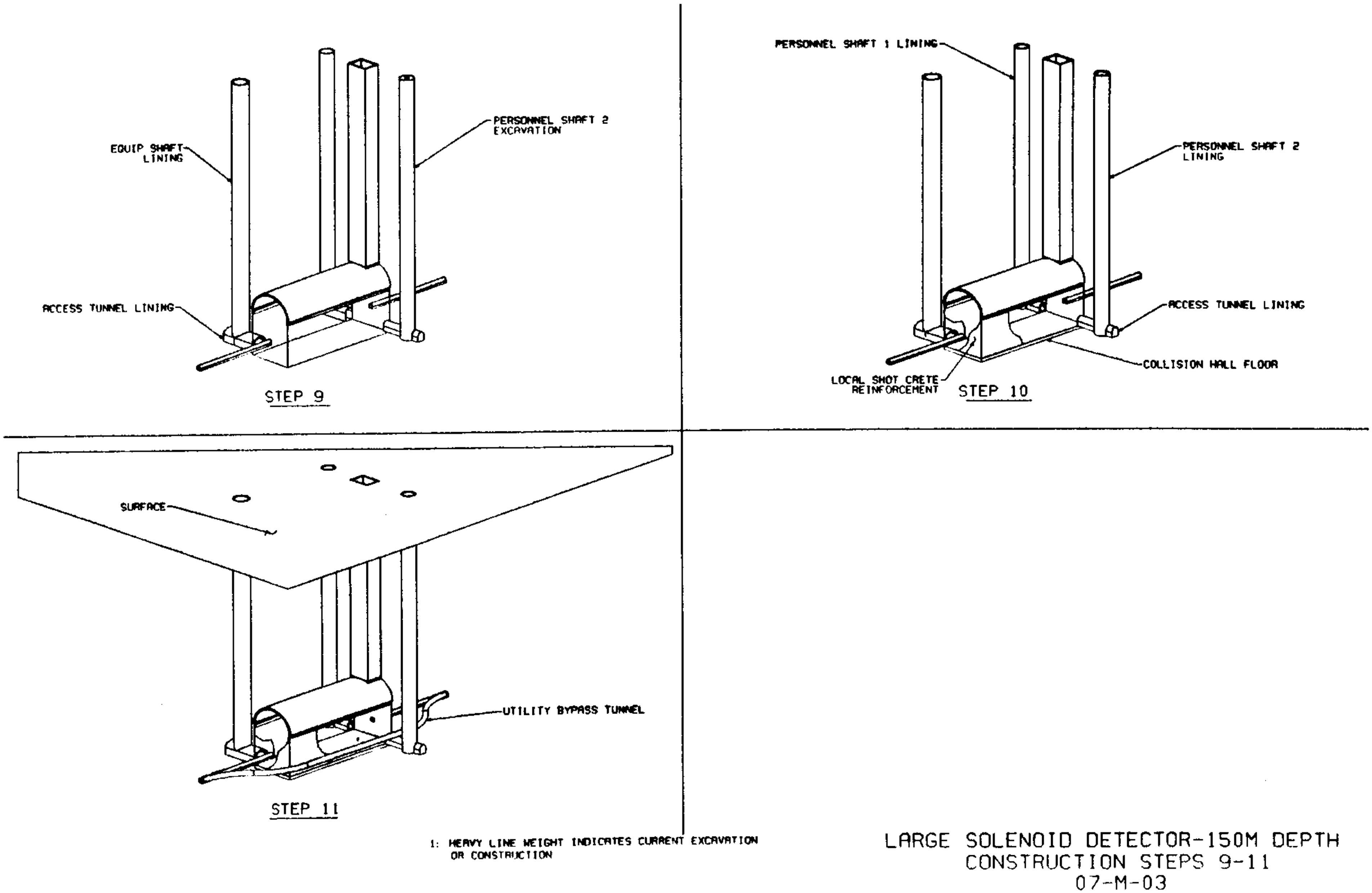

EQUIP SHAFT LINING
PERSONNEL SHAFT 2 EXCAVATION
ACCESS TUNNEL LINING
STEP 9
PERSONNEL SHAFT 1 LINING
PERSONNEL SHAFT 2 LINING
ACCESS TUNNEL LINING
COLLISION HALL FLOOR
LOCAL SHOT CRETE REINFORCEMENT
STEP 10
SURFACE
UTILITY BYPASS TUNNEL
STEP 11
1: HEAVY LINE WEIGHT INDICATES CURRENT EXCAVATION OR CONSTRUCTION
LARGE SOLENOID DETECTOR-150M DEPTH
CONSTRUCTION STEPS 9-11
07-M-03

Figure 6-3

FOOTNOTES AND REFERENCES

CHAPTER 1

1. Cost Estimate of Initial SSC Experimental Equipment, SSC-SR-1023, Central Design Group, Berkeley: June 1986.

2. Proceedings of the Workshop on Experiments, Detectors, and Experimental Areas for the Supercollider, R. Donaldson and M. Gilchriese, eds., World Scientific, Berkeley: 1988.

3. Proceedings of the 1984 Division of Particles and Fields Summer Study on the Design and Utilization of the Superconducting Super Collider, June 23 - July 11, 1984, Snowmass, Colorado: R. Donaldson and J. Morfin, eds., 1984.

4. Proceedings of the 1986 Division of Particles and Fields Summer Study on the Physics of the Superconducting Super Collider, June 23 - July 11, 1986, Snowmass, Colorado: R. Donaldson and J. Marx, eds., 1986.

5. Proceedings of the Summer Study on High Energy Physics in the 1990s, F. Gilman, ed., to be published in 1989.

CHAPTER 2

1. This detector is described in some detail in Reference 4. Additional details were supplied by Dennis Theriot, private communication, and one of the authors of this report, M. Gilchriese.

2. This detector is described in detail in Reference 2 of Chapter 1.

3. This detector is described in Reference 5 of Chapter 1. It is based on a similar detector for the Fermilab Tevatron described in a Letter of Intent for the BCD - A Bottom Collider Detector for the Fermilab Tevatron, October 1988. Additional details were provided by Nigel Lockyer and Ray Stefanski, private communications.

4. R. W. Fast et al., "Conceptual Design of the Superconducting Solenoid for a Magnetic SSC Detector," SSC-N-526, June 1988 and talk by Prof. Shigeki Mori at the Snowmass Summer Study on High Energy Physics in the 1990s, "Preliminary Results of Conceptual Design studies on Large Solenoids," July 7, 1988.

5. Dennis Theriot and Shigeki Mori, private communication July - Sept. 1988.

6. Stanford Linear Detector Design Report, Stanford Linear Accelerator Report 273, May 1984.

7. Bob Bell, Stanford Linear Accelerator, private communication to M. Gilchriese.

CHAPTER 5

1. Proceedings of the workshop on Experiments, Detectors, and Experimental areas for the Supercollider, R. Donaldson and M.G.D. Gilchriese, eds., World Scientific: Berkeley, 1987.

2. B. Gachy, Design, Installation Problems and Criteria Related to Large Accelerators. Proceedings of the 1987 Accelerator Conference, Washington D.C.: March 1987.

3. R.W. Fast et al., SSC Detector Solenoid. SSC-Note-553, Central Design Group, Berkeley: Sept. 1988.

4. Underground Area 2 Handbook, P. Darriulat, ed. CERN, Geneva: 1982.

5. Rapport Provisaire de Sureté du LEP, CERN, Geneva: 1987.