CRAY C916™, CRAY C98™, CRAY C98D™, CRAY C94™, and CRAY C94D™ Site Planning Reference Manual

HR-04025-0B

Cray Research, Inc.

Requests for copies of Cray Research, Inc. publications should be directed to:

CRAY RESEARCH, INC.
Distribution
2360 Pilot Knob Road
Mendota Heights, MN 55120
800-284-2729 extension 35907

Comments about this publication should be directed to:

CRAY RESEARCH, INC.
Hardware Publications and Training
890 Industrial Blvd.
Chippewa Falls, WI 54729

Record of Revision

Each time this manual is updated with a change packet, a change to part of a text page is indicated by a change bar in the margin directly opposite the change. A change bar in the footer of a text page indicates that most, if not all, of the text is new. A change bar in the footer of a page composed primarily of a table and/or figure may indicate that a change was made to that table/figure or, it could indicate that the entire table/figure is new. Change packets are assigned a numerical designator, which is indicated in the publication number on each page of the change packet.

Each time this manual is fully revised and reprinted, all change packets to the previous version are incorporated into the new version, and the new version is assigned an alphabetical revision level, which is indicated in the publication number on each page of the manual. A revised manual does not usually contain change bars.

REVISION	DESCRIPTION
	Original printing. November 1991.
A	March 1993. Manual revised to include information about the CRAY C94 and CRAY C98 computer systems. The name of the CRAY Y-MP C90 system has been changed to the CRAY C916 system.
B	April 1994. Manual revised to include information about the CRAY D98 and CRAY D94 computer systems, line printer (LP-6), and the fiber-optic enclosure (FOE-1).

PREFACE

The *CRAY C916, CRAY C98, CRAY C98D, CRAY C94, and CRAY C94D Site Planning Reference Manual* contains the technical information needed to plan and prepare a site for the installation of a CRAY C916 (C916), CRAY C98 (C98), CRAY C98D (D98), CRAY C94 (C94), or CRAY C94D (D94) computer system. This manual is intended for management and personnel responsible for the planning and preparation process.

NOTE: The CRAY C98D and the CRAY C94D computer systems will hereafter be referred to as the CRAY D98 and CRAY D94 computer systems respectively.

This manual provides information about the site planning and preparation process and the operational requirements for all five computer systems. It also includes individual computer system configurations, specifications, electrical requirements, separation limits, and floor preparation information. This manual also includes information about peripheral devices and support equipment that can be configured with your computer system.

Related site planning information is referenced in this manual. Refer to the bibliography for a description of these manuals, related publications, and ordering information.

CONTENTS

3 CRAY C916 COMPUTER SYSTEM (continued)

4 CRAY C98 AND CRAY D98 COMPUTER SYSTEMS

4 CRAY C98 AND CRAY D98 COMPUTER SYSTEMS (continued)

5 CRAY C94 AND CRAY D94 COMPUTER SYSTEMS

6 PERIPHERAL EQUIPMENT

7 SUPPORT EQUIPMENT

FIGURES

FIGURES (continued)

TABLES

1 SITE PLANNING AND PREPARATION

Proper site planning and preparation is important for the successful installation of your CRAY C916 (C916), CRAY C98 (C98), CRAY D98 (D98), CRAY C94 (C94), or CRAY D94 (D94) computer system. This section describes various considerations and requirements involved in the site planning and preparation process.

Cray Research site planning personnel will assist you with the site planning process. Each site has different site planning characteristics to be considered. You can ensure effective site planning by identifying your initial system configuration as well as any upgrade plans.

Allow at least 6 months to plan and prepare your facility for the installation of a Cray Research computer system. Qualified electrical and mechanical facility engineers should be involved early in the site planning process.

Prior to any site preparation activities, you must prepare electrical and mechanical design drawings to be approved by Cray Research site planning personnel.

Site Planning Meetings

Site planning meetings establish communications between you and Cray Research. Cray Research site planning personnel will schedule a minimum of three site planning meetings with you at your facility. The purpose of these meetings is to answer questions and discuss concerns you may have about the site planning and preparation process.

Site Evaluation

Site evaluation is important in the site planning and preparation process. Some considerations that might help you in your site selection include:

- Electrical power quality. Electrical requirements are discussed in Section 2 of this manual, "Operational Requirements."
- Cooling water quality. Refer to *Water Quality Requirements*, Site Engineering document number 10658280, for information on water quality requirements.
- Air quality. Refer to the "Computer Room Environment" subsection in Section 2 for more information about air quality requirements.
- Vibration sources (such as heavy industrial traffic). Refer to *Vibration and Shock Limits for Installed Computer Systems*, Site Engineering document number 10658300, for information on vibration limits for computer equipment.
- Structural strength. The floor loading requirements of the equipment to be installed must be examined to ensure that the building structure will support the computer equipment.

Refer to the *Principles of Computer Room Design*, Cray Research publication number HR-04013, for a complete list and explanation of possible site selection concerns.

Site Access Requirements

Prior to system installation, your site must meet certain site access requirements. This subsection explains these requirements and provides specifications.

Your building should have a loading dock approximately 46 in. to 50 in. (117 cm to 127 cm) high for computer system delivery. The loading dock should not open directly into the computer room because the computer room environment must be carefully controlled. You should take special precautions when moving equipment if the loading dock or access route has an engraved floor pattern; an engraved pattern could cause vibration damage to computer equipment on casters.

If no loading dock exists or if your loading dock does not meet site engineering specifications, you will have to provide a forklift to unload computer equipment. Refer to *Forklift Size Requirements for the Handling of Cray Research Equipment*, Site Engineering document number 10658374, for information on forklift requirements.

The entire access route to your computer room should meet the following specific requirements:

- Minimum ceiling and door height - 80 in. (203 cm)
- Minimum hallway and door width - 60 in. (152 cm)
- Maximum delivery route slope - One unit of height for every six units of length

If your computer room is on a different level than your loading dock, an elevator will be needed to move the computer system to the proper floor level. If your building doesn't have an elevator, you may have to arrange for a crane or other special handling equipment to lift the computer equipment to the same level as your computer room. Refer to the appropriate computer system "Specifications" subsection in this manual for shipping weights and sizes.

Computer Room Design

Computer room design is important because proper design can minimize problems with static electricity, security, personnel safety, and air contamination. The following list contains important considerations for designing your computer room:

- Personnel safety
- Security
- Air quality
- Positive air pressure
- Future computer equipment plans
- Seismic vibration
- Raised flooring
- Sound reduction
- Lighting
- Handicapped personnel access
- Layout

Refer to the *Principles of Computer Room Design*, Cray Research publication number HR-04013, for a complete explanation of these considerations and for proper construction procedures.

Service Personnel Office Requirements

Cray Research provides trained hardware and software service personnel on a contractual basis to support the computer system. The following subsections provide information about preparing your facility if you choose to have on-site service.

Hardware Service Personnel Office

You must provide the hardware service personnel with a locking office, approximately 150 ft^2 (14 m^2), or two offices approximately 75 ft^2 to 100 ft^2 (7 m^2 to 9 m^2) each. The office should be in a quiet environment and contain the following items:

- Two desks with locks
- One locking 4-drawer file cabinet
- One computer terminal table
- Three chairs
- One telephone

Additional items might be required depending on your system configuration. Check with your site planning representative for any additional items necessary for the hardware service personnel office.

Hardware Service Repair Shop

You must provide the hardware service personnel with a locking maintenance repair shop, approximately 150 ft^2 (14 m^2). It must be equipped with adequate lighting and power outlets for tools and test equipment. The repair shop should be adjacent to the hardware service personnel office and close to the computer room. The repair shop must include the following items:

- One workbench with power outlets and a static-dissipative work surface
- One workbench chair with static-dissipative casters

- Three locking parts cabinets, approximately 36 in. x 72 in. (91 cm x 183 cm)
- Two 3-shelf bookcases
- One locking 4-drawer file cabinet
- One worktable, 30 in. x 60 in. (76 cm x 152 cm), with a static-dissipative work surface
- One chair with static-dissipative casters
- One telephone with a data-quality telephone line

Additional items might be required depending on your system configuration. Check with your site planning representative for any additional items necessary for your computer system.

Software Service Personnel Office

You must provide the software service personnel with a locking office, approximately 150 ft^2 (14 m^2), or two offices approximately 75 ft^2 to 100 ft^2 (7 m^2 to 9 m^2) each. The office should be in a quiet environment and contain the following items:

- Two locking desks
- Two 3-shelf bookcases
- One locking 4-drawer file cabinet
- One worktable, 30 in. x 60 in. (76 cm x 152 cm)
- Four chairs
- Two telephones
- One terminal connected to the Cray Research system
- One terminal connected to the front-end systems

Modem Requirements

Cray Research systems support personnel use a modem data communications link to administrate, troubleshoot, and maintain Cray Research computer systems.

If site security regulations permit the use of a modem, contact the local telephone company well in advance of system delivery to arrange for installation of the telephone line required for the modem. You must

supply a private, analog telephone line that is not routed through a PBX telephone system. Make arrangements with Cray Research for your payment of monthly service charges.

Cray Research supplies the Microcom QX Series of Protocol Modems, Model QX4232hs, for systems located in the United States and Canada. For computer system installations outside of the United States and Canada, contact your local Cray Research field engineer's office for the modem type and telephone line requirements.

Telephone company representatives might request information about modem requirements. Table 1-1 provides the modem requirements.

Table 1-1. Modem Requirements

Option	Specification
FCC registration number	CLB772-10785-MD-E
Transmission rate	V.32/V.42bis (9,600 bps)
The modem uses a standard telephone with a voice grade line; jack type	RJ11C
Touch tone/rotary dial	Touch tone preferred
Ringer equivalence	1.6 Bd
External/internal clock	Internal
Grounding	Chassis ground to signal ground
Transmit level	Up to 38.4 kbps
Private/dial-up line	Dial-up line
Receive long space disconnect	Disabled
Transmit long space disconnect	Disabled
Data terminal ready disconnect	Enabled
Carrier fail disconnect	Enabled
Auto-answer/manual-answer	Auto-answer
Make busy in analog loopback	Disabled
Permanent/DTR controlled auto-answer	DTR controlled auto-answer
Synchronous/asynchronous	Asynchronous
9-bit/10-bit/11-bit character	10-bit character

Cray Research also supplies the Telebit NetBlazer dial-up router, which is used in conjunction with the Microcom modem to provide Transmission Control Protocol/Internet Protocol (TCP/IP) dial-up access to the Cray Research Area Service Centers. Refer to Figure 1-1 for an illustration of the Telebit NetBlazer. The NetBlazer dial-up router is positioned on top of the maintenance workstation (MWS). Table 1-2 provides the specifications for the NetBlazer dial-up router.

Table 1-2. NetBlazer Specifications

Characteristic	Specification
Height	3.25 in. (8 cm)
Width	15.00 in. (38 cm)
Depth	15.00 in. (38 cm)
Weight	14 lbs. (6 kg)
Power cable	8-ft (2.4-m) plug-compatible drop cord
Power receptacle: North American International	 NEMA# 5-15R or equivalent IEC 309, single phase, 16 amp

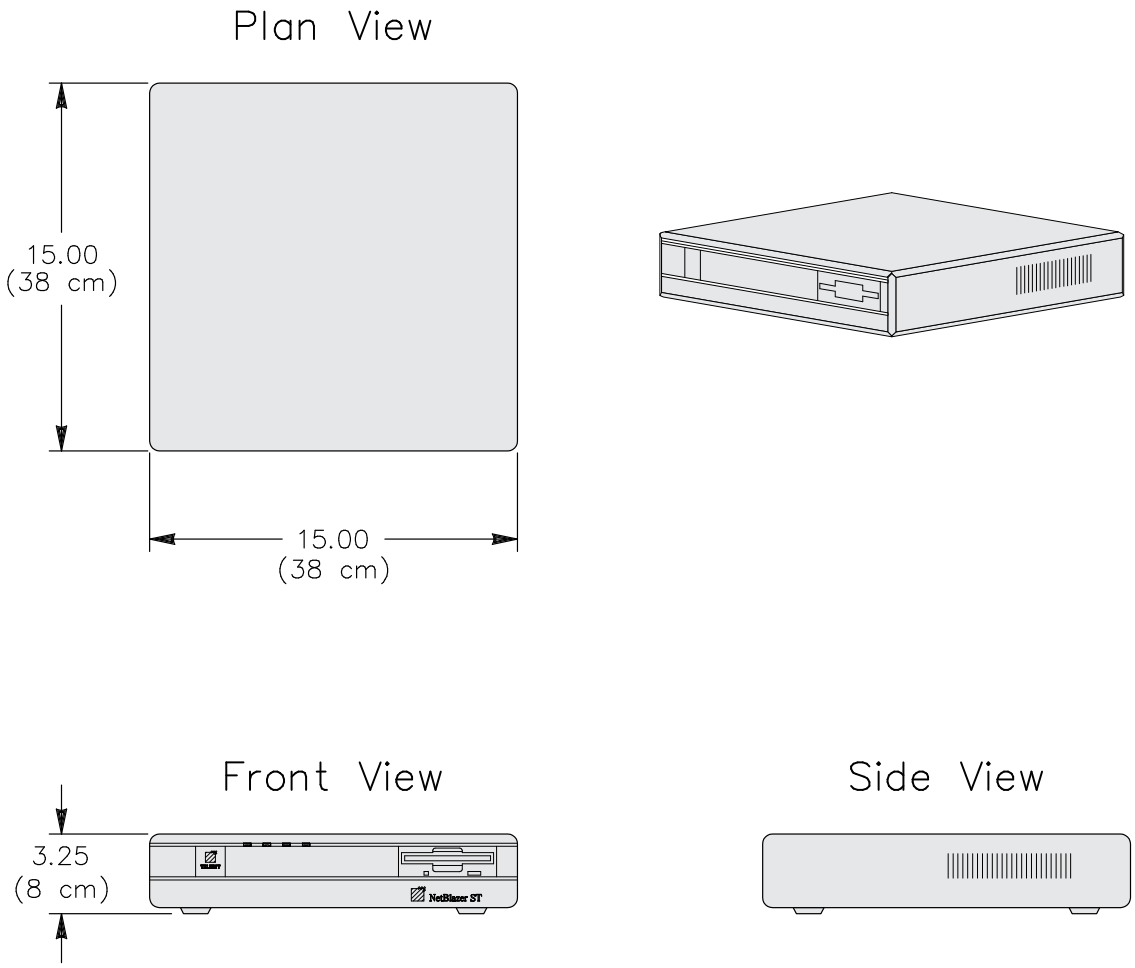


Figure 1-1. NetBlazer Dial-up Router

System Installation Overview

The installation of a Cray Research computer system consists of the following stages:

- Shipping and installing the support equipment
- Preparing the system for shipping
- Transporting the system
- Installing the system
- Starting up and stabilizing the system
- Assuring system on-site quality
- Preparing system operations

Approximately 8 weeks prior to system delivery, Cray Research delivers all necessary support equipment (motor-generator sets, refrigeration condensing units), refrigeration piping kits, mainframe power box assembly (if necessary), and mainframe support pedestals (if necessary) through a commercial transportation company. You are responsible for receiving, unloading, and installing the support equipment without Cray Research attendance or supervision.

Approximately 1 week before delivery, Cray Research prepares the computer system for shipment. Major components are protectively packaged into their shipping configuration. Cabling and miscellaneous materials are packaged and labeled for shipment.

The system equipment is transported to your facility by a dedicated commercial tractor-trailer semi with air-suspension ride and climate control. For intercontinental shipments, the equipment is prepared for shipment and transported by commercial cargo-carrying aircraft and then transported to your facility by a tractor-trailer semi.

Under Cray Research supervision, you will unload and move the system equipment into your computer room. If needed, you must make arrangements for any special equipment (such as forklifts, cranes, or platforms) required to unload the computer system.

Cray Research installation personnel perform the following tasks:

- Position all equipment in designated locations
- Reassemble the computer system
- Connect all logic cables
- Attach refrigeration hoses and dielectric-coolant hoses

Upon completion of these tasks, Cray Research personnel perform system start-up and power and cooling stabilization tests. You must provide personnel to correct any problems involving contractor-installed electrical, refrigeration, or cooling water circuitry that might occur during these tests.

Cray Research declares the system ready for use upon satisfactory completion of all quality assurance functions. At this point, Cray Research personnel install the operating system software to prepare the system for customer acceptance.

2 OPERATIONAL REQUIREMENTS

Cray Research computer equipment is designed to operate within specific ranges of air quality, temperature, and relative humidity levels. Significant variations of these levels in a computer room environment could cause disruptions in equipment operation and decrease the life of the equipment. To ensure proper operation of the CRAY C916, CRAY C98, CRAY D98, CRAY C94, or CRAY D94 computer system, your facility must meet the operational requirements outlined in the following subsections.

Computer Room Environment

Cray Research designs resilience into system hardware. However, your facility's environment must be properly maintained to ensure that hardware reliability is not adversely affected.

The Cray Research computer system must operate in a controlled computer room environment. Although the requirements outlined in this section encompass the overall computer room, they particularly affect air-cooled devices such as disk drives, printers, and graphics display terminals. Therefore, the design and layout of your environmental control equipment (such as computer room air-conditioning units) must ensure that inlet air to the air-cooled device meets the specified environmental requirements.

The CRAY C916, C98, D98, C94, or D94 computer system requires a computer room environment controlled within the following ranges:

- Temperature: 60 ºF to 83 ºF (16 ºC to 28 ºC)
  The maximum temperature change in a 1-hour period is 3 ºF (2 ºC). The rate of change cannot exceed 10 ºF (6 ºC) per hour.
- Humidity: 35% to 65% relative humidity (noncondensing)
  The maximum rate of change of relative humidity is 5% per hour.

- Dewpoint: 60 ºF (16 ºC) maximum (CRAY C916 system)
  70 ºF (21º C) maximum
  (CRAY C98, D98, C94, and D94 systems)
- Air quality: For particles greater than 0.5 micron in size, the concentration must not exceed 1.0×10^5 particles/ft^3 (3.5×10^6 particles/m^3).

  For particles greater than 1.0 micron in size, the concentration must not exceed 2.0×10^4 particles/ft^3 (7.1×10^5 particles/m^3).

  For particles greater than 5.0 microns in size, the concentration must not exceed 6.5×10^2 particles/ft^3 (2.3×10^4 particles/m^3).

Strictly monitor and control the computer room environment. One fresh air change per hour is required in the computer room. Do not allow smoking, food, or beverages in the vicinity of Cray Research equipment.

Computer Room Floor

You must prepare the computer room with a static-dissipative raised-floor system that provides a minimum 18-in. (46-cm) free clearance between the subfloor and the underside of the raised-floor panels. Any floor clearance that is less than 18 in. (46 cm) must be reviewed and approved by Cray Research site planning personnel. This clearance accommodates routing of the power circuits, signal cables, and cooling components. All Cray Research equipment requires floor cutouts for power wiring, signal-cable entrances, and in some cases, dielectric-hose or refrigerant-line entrances. In addition, some equipment requires reinforcement of the raised floor because of concentrated floor loading conditions. Refer to the “Floor Preparation” section in this manual for specific requirements.

The raised-floor panels described in this manual are 24 in. x 24 in. Floor plans with raised-floor panels other than those measuring 24 in. x 24 in. must be reviewed by Cray Research site engineering personnel for placement of equipment, floor cutouts, and refrigeration piping.

Plant Equipment Room Environment

Some customers choose to place their support equipment [motor-generator sets (MGSs) and refrigeration condensing units (RCUs)] in the computer room. The MGSs are contained within a sound-attenuated enclosure to reduce noise. If the RCUs are located in the computer room, Cray Research will supply optional noise-reduction panels for the unit. However, facility constraints sometimes make it necessary to place the support equipment in a plant equipment room. The plant equipment room must meet the following environmental specifications:

- Temperature: 65 ºF to 95 ºF (18 ºC to 35 ºC); the maximum rate of change must not exceed 20 ºF (11 ºC) per hour
- Humidity: 30% to 80% relative humidity (noncondensing)
- Air quality: A clean, dirt- and dust-free environment

The plant equipment room should be located as close as possible to the computer room. Refer to the "Equipment Separation Limits" subsection in this manual for specific information.

Electrical Requirements

Cray Research makes every effort to minimize the effects of power failures and interruptions to the hardware. However, if the computer equipment is subjected to repeated power interruptions and fluctuations, it will be susceptible to a higher component failure rate than it would with a stable power source. Cray Research encourages you to provide a stable power source, such as an uninterruptable power system, to reduce the possibility of component failures.

Cray Research computer equipment has certain voltage, frequency, and grounding requirements. These requirements are provided in the following subsections.

Voltage and Frequency

The motor-generator sets (MGSs), refrigeration condensing units (RCUs), and heat exchanger units (HEUs) used with the CRAY C916, C98, D98, C94, and D94 computer systems require one of the following voltages:

- 460 ± 10% Vac, 3 phase, 60 ± 3 Hz
- 398 ± 5% Vac, 3 phase, 50 ± 3 Hz

The operator workstation (OWS) and the maintenance workstation (MWS) require 120- or 220-Vac, 50- or 60-Hz single-phase power.

Disk enclosure units (DE-60s and DE-100s) and network disk arrays (ND-12s and ND-14s) require either 208-Vac or 398-Vac, 50- or 60-Hz, 3-phase power.

Table 2-1 provides the specifications for all electrical services.

Table 2-1. Electrical Service Requirements

Electrical Service	Requirement
Voltage tolerance	±10%
Phase imbalance	5% maximum (line-to-line, line-to-line neutral)
Voltage harmonics	5% maximum total, 3% largest
Voltage deviation from sine wave	5% to –10%
Voltage modulation	3% maximum
Transient voltage surges	+5%
Transient voltage sags	–5%
Frequency tolerance	±5%
Frequency rate of change	Less than 1.0 Hz during any 10-cycle period

Total kilowatt power requirements depend on system configuration and equipment upgrades. Cray Research will provide documentation during the initial site planning meeting that you can use to estimate the power requirements for your specific system configuration.

Equipment Grounding

Cray Research provides the document *Equipment Grounding for Cray Research Computer Systems*, Site Engineering document number 10658002, during the initial site planning meeting. This document describes the grounding system requirements and identifies alternative methods for providing the signal reference grid. In addition, the document describes electrostatic discharge (ESD) precautions and maintenance of the facility's grounding systems. You must provide, install, and maintain the approved grounding systems as described in the equipment grounding document and this subsection.

All Cray Research computer equipment requires a protective power safety-ground system. The power safety-ground system protects personnel from shock hazards and protects the computer equipment from damage caused by electrical malfunctions. The power safety-ground system is regulated by local and national electrical codes.

All Cray Research computer equipment also requires a signal reference grid. The signal reference grid establishes an equipotential reference plane for high-frequency digital signals between interconnected computer equipment. All Cray Research equipment (except graphics display terminals and line printers) is supplied with braided ground straps. You are responsible for connecting the ground straps to the signal reference grid.

Dielectric Coolant

The CRAY C916, C98, D98, C94, and D94 computer systems use dielectric coolant (Fluorinert Liquid) to cool the mainframe (MFC) and input/output subsystem and SSD solid-state storage device (IOS/SSD). Heat dissipated from the integrated circuit modules and power supplies within the MFC and IOS/SSD chassis is absorbed by the dielectric coolant. The dielectric coolant is circulated through the MFC or IOS/SSD by a pump located within the heat exchanger unit (HEU). The HEU also contains a heat exchanger that transfers heat from the dielectric coolant to the refrigeration circuit of the RCU.

NOTE: The number of HEUs used depends upon your system configuration. Refer to the appropriate computer system section in this manual for information about system configurations.

You must ensure that there is one fresh air change per hour in the computer room and that there are no sources of excessive heat that might cause Fluorinert Liquid to decompose. Smoking must not be allowed in the computer room or any other areas where Fluorinert Liquid is used or stored. Refer to the “Computer Room Environment” subsection in this section for more information.

NOTE: Fluorinert Liquid is a safe product when used properly. When exposed to a source of excessive heat, Fluorinert Liquid can decompose and produce hazardous by-products. Refer to *Safe Use and Handling of Fluorinert Liquids*, Cray Research publication number HR-00306, for information on Fluorinert Liquid properties and precautionary requirements. All personnel must read this publication before working in a CRAY C916, C98, D98, C94, or D94 computer room.

Cooling Water Supply

The Cray Research computer systems require that an adequate source of clean cooling water be supplied to the RCUs. Cray Research provides the document *Water Quality Requirements*, Site Engineering document number 10658280, during the initial site planning meeting. This document identifies the water quality requirements necessary to operate the computer system.

You must meet Cray Research water quality requirements described in both the Site Engineering document and this subsection. A closed-loop cooling water system might be necessary to meet these requirements. An open system (such as a cooling tower) might not comply with the water quality requirements.

The cooling water temperature, measured at the inlet of the RCU, must not vary more than ±10 ^{o}F (6 ^{o}C) from the original design and start-up temperature. The rate of change must not exceed 5 ^{o}F (3 ^{o}C) per 15-minute cycle. Although the RCUs are designed to accommodate water supply temperatures from 40 ^{o}F to 70 ^{o}F (4 ^{o}C to 21 ^{o}C), Cray Research recommends a water supply temperature of 50 ^{o}F (10 ^{o}C).

The cooling water flow-rate requirements and pressure-drop values of the RCUs vary depending on the cooling water supply temperature and the percentage of treatment (antifreeze, corrosion inhibitors, etc.) in the water. During the initial site planning meeting, Cray Research provides flow-rate and pressure-drop values based on your system configuration and recommended water supply temperature.

3 CRAY C916 COMPUTER SYSTEM

Each computer system has slightly different site planning requirements. This section provides detailed site planning information for the CRAY C916 computer system, which includes system configurations, equipment separation limits, specifications, and floor preparation requirements, power wiring requirements, and cooling requirements.

System Configurations

The CRAY C916 computer system consists of a variety of standard and optional equipment. Each computer system has different configurations, depending on customer needs. The following subsections describe the standard equipment and separation limits for a standard CRAY C916 computer system.

Standard Equipment

A standard CRAY C916 computer system consists of the following components:

- Mainframe chassis (MFC)
- Combined input/output subsystem and SSD solid-state storage device (IOS/SSD) chassis
- Heat exchanger units (HEU-C90 and HEU-E/S)
- Maintenance workstation (MWS)
- Operator workstation (OWS)
- Disk drives and other peripheral equipment
- Motor-generator sets (MGSs)
- Refrigeration condensing units (RCUs)

The mainframe chassis (MFC) and IOS/SSD chassis house various configurations of logic and memory modules. For example, the SSD modules are optional. If your computer system is not configured with an SSD, the IOS/SSD chassis will contain only the IOS. This chassis can be upgraded to include SSD logic modules.

The CRAY C916 computer system uses two models of heat exchanger units: the HEU-C90 and HEU-E/S. The MFC is connected to the HEU-C90, and the IOS/SSD is connected to the HEU-E/S. The HEUs transfer heat generated by the components in the MFC and IOS/SSD chassis to the RCUs.

Cray Research hardware and software support personnel use the MWS for maintenance and troubleshooting. The OWS is dedicated for your computer operator. Both the MWS and OWS consist of a graphics display terminal (GDT-200), single display table (TBL-3), and a VME-based microcomputer (VBM-2). The MWS and OWS also share a single laser printer (LP-6).

Disk drives and other peripheral equipment are also used with the CRAY C916 computer system. The number of disk drives and other kinds of peripheral equipment depends on individual customer needs. However, a typical CRAY C916 computer system disk drive configuration includes disk enclosures (DE-60s and DE-100s) or network disk arrays (ND-12s and ND-14s).

Cray Research offers specially designed front-end interface (FEI) devices that provide a communication link between Cray Research computer systems and other computer systems used in your facility. The two communication mediums used are standard electronic signal wire and fiber-optic cabling. After the type of FEI has been determined, Cray Research will distribute power, cooling, and cabling information.

The CRAY C916 computer system has a number of different configurations for RCUs and MGSs. These configurations vary depending on the type of facility power source, access limitations, or previously installed equipment that you might have at your site.

The following list includes the devices that can be configured with computer systems in facilities that have a 60-Hz power source.

- One of the following power distribution devices:
  - Two MGS-4s with a motor-generator parallel cabinet (MGPC)
  - MGS-6 with a power distribution cabinet (PDC)
  - MGS-6A with a PDC

- RCU-5A

The following list includes the devices that can be configured with computer systems in facilities that have a 50-Hz power source.

- One of the following power distribution configurations:
  - Two MGS-4s with a motor-generator parallel cabinet (MGPC)
  - MGS-6A with a PDC

- RCU-5A
- RCU-9

NOTE: These devices are configured with the majority of CRAY C916 computer systems. However, some CRAY C916 computer systems may use different support equipment. If your computer system does not use these devices, refer to the *Cray Research Support Equipment Site Planning Reference Manual*, HR-00082, for planning and installation information.

Figure 3-1 illustrates a typical computer room floor plan for a CRAY C916 computer system. The computer system is configured on a 28 ft x 32 ft (8.5 m x 9.8 m) floor with 24 in. x 24 in. floor panels.

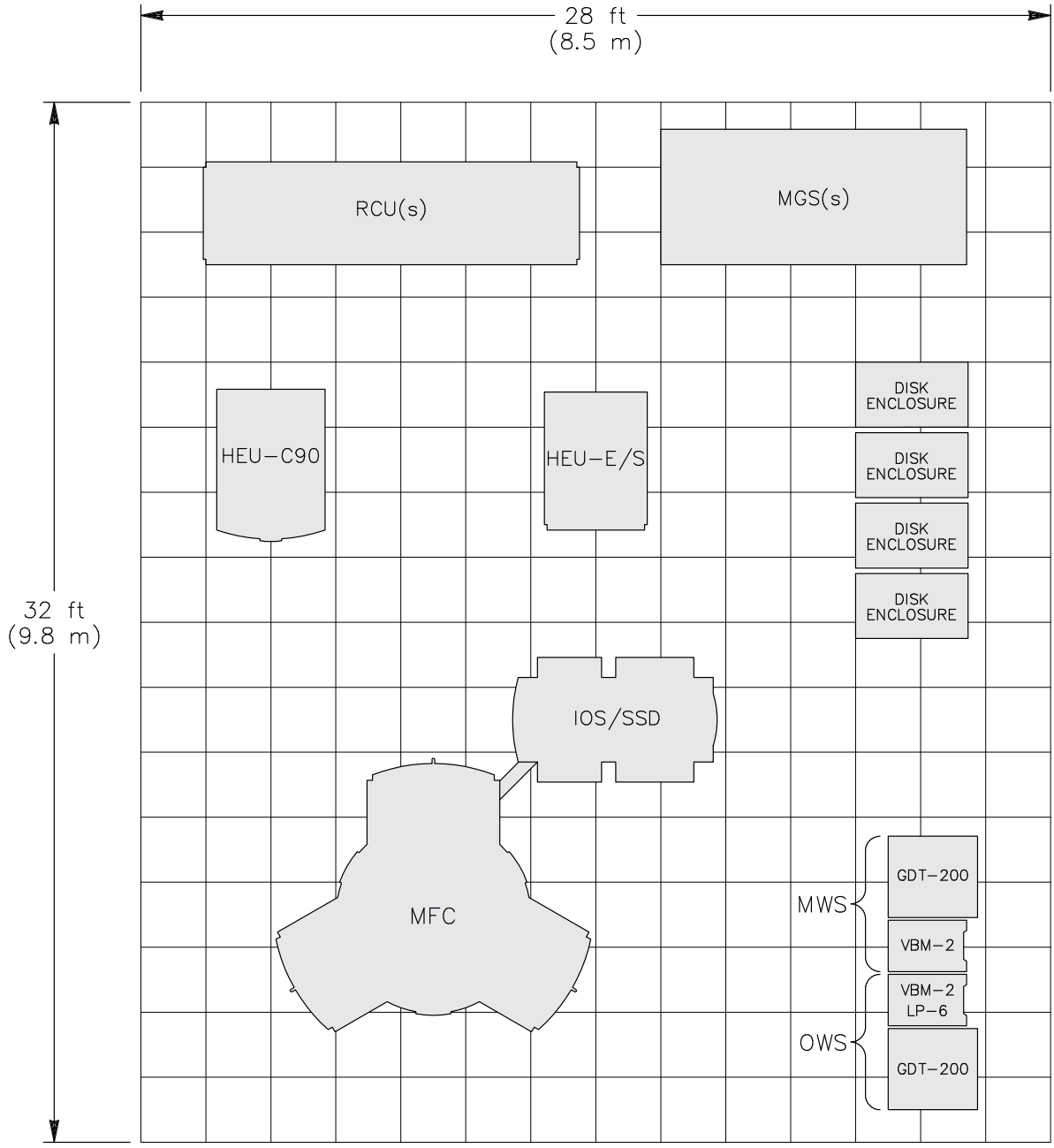


Figure 3-1. CRAY C916 Typical Floor Plan

Equipment Separation Limits

The arrangement of computer equipment within the facility must meet certain placement and separation requirements. You must prepare drawings and documents specifying detailed information about the arrangement and location of the computer equipment. These drawings must be reviewed and approved by Cray Research site planning personnel prior to any site preparation. You should involve the site planning personnel early in the design stage.

The following general criteria should be considered when arranging your computer room:

- Personnel safety
- Maximum system performance
- Satisfactory system installation
- Satisfactory operator and maintenance access

All arrangements must meet signal cable and refrigeration piping length requirements. You should also design the 400-Hz power wiring lengths to minimize voltage drops and reduce installation costs.

Figure 3-2 illustrates the equipment separation limits for the CRAY C916 computer system.

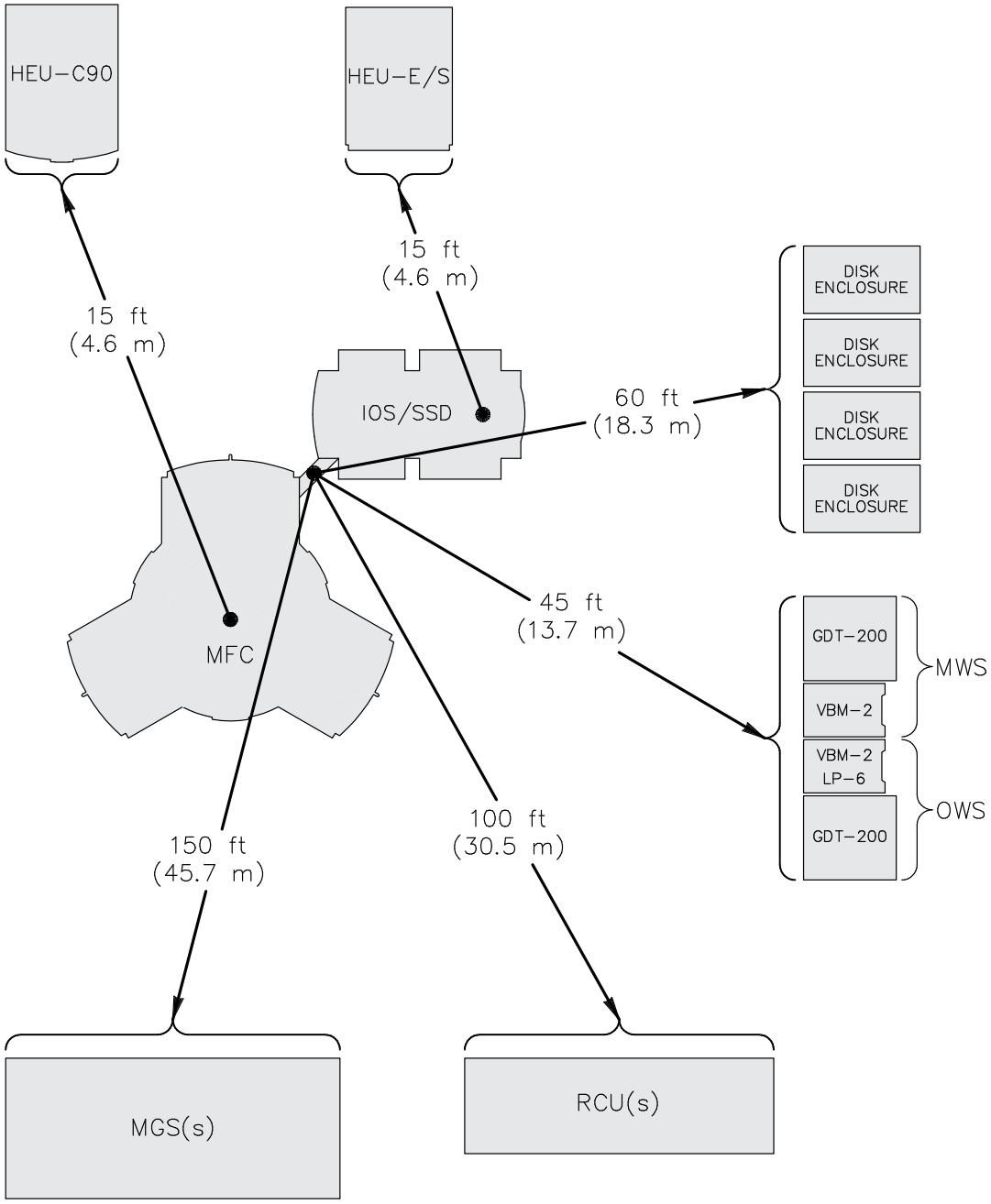


Figure 3-2. CRAY C916 Separation Limits

Specifications

This subsection describes the specifications for the mainframe chassis (MFC), IOS/SSD chassis, and the heat exchanger units (HEU-C90 and HEU-E/S). The information described in this section is useful when designing the computer room, planning the floor layout, and installing the equipment.

Mainframe Chassis

The CRAY C916 mainframe chassis is a dielectric-cooled unit that contains logic modules and power supplies. Table 3-1 provides mainframe chassis specifications. Refer to Figure 3-3 for an illustration of the mainframe chassis.

The mainframe is shipped in four subassemblies: the mainframe wire cage, two power-supply subassemblies, and a power box assembly (refer to Figure 3-4). The power box assembly is shipped approximately 1 week before installation. Refer to Figure 3-5 and Figure 3-6 for illustrations of the mainframe wire cage and power-supply shipping configurations.

Table 3-1. CRAY C916 Mainframe Chassis Specifications

Characteristic	Specification
Height	85.50 in. (217 cm)
Width	116.25 in. (295 cm)
Depth	101.00 in. (257 cm)
Weight	17,392 lbs (7,888 kg)
Floor loading †	1,449 lbs/ft^2 (7,071 kg/m^2)
Access requirements	36.00 in. (91 cm) on all sides except the module end. Module end requires 84.00 in. (213 cm).
Heat dissipation to air	22.58 kBtu/hr (6.62 kW) maximum
Shipping information: Mainframe subassembly Height Width Depth Weight Power-supply subassembly (Two required) Height Width Depth Weight	 76.00 in. (193 cm) 45.00 in. (114 cm) 90.00 in. (229 cm) 6,836 lbs (3,100 kg) 76.00 in. (193 cm) 38.50 in. (98 cm) 75.00 in. (191 cm) 4,854 lbs (2,201 kg) each

† Floor loading values refer to weight distributed directly to the subfloor by Cray Research-supplied mainframe support pedestals.

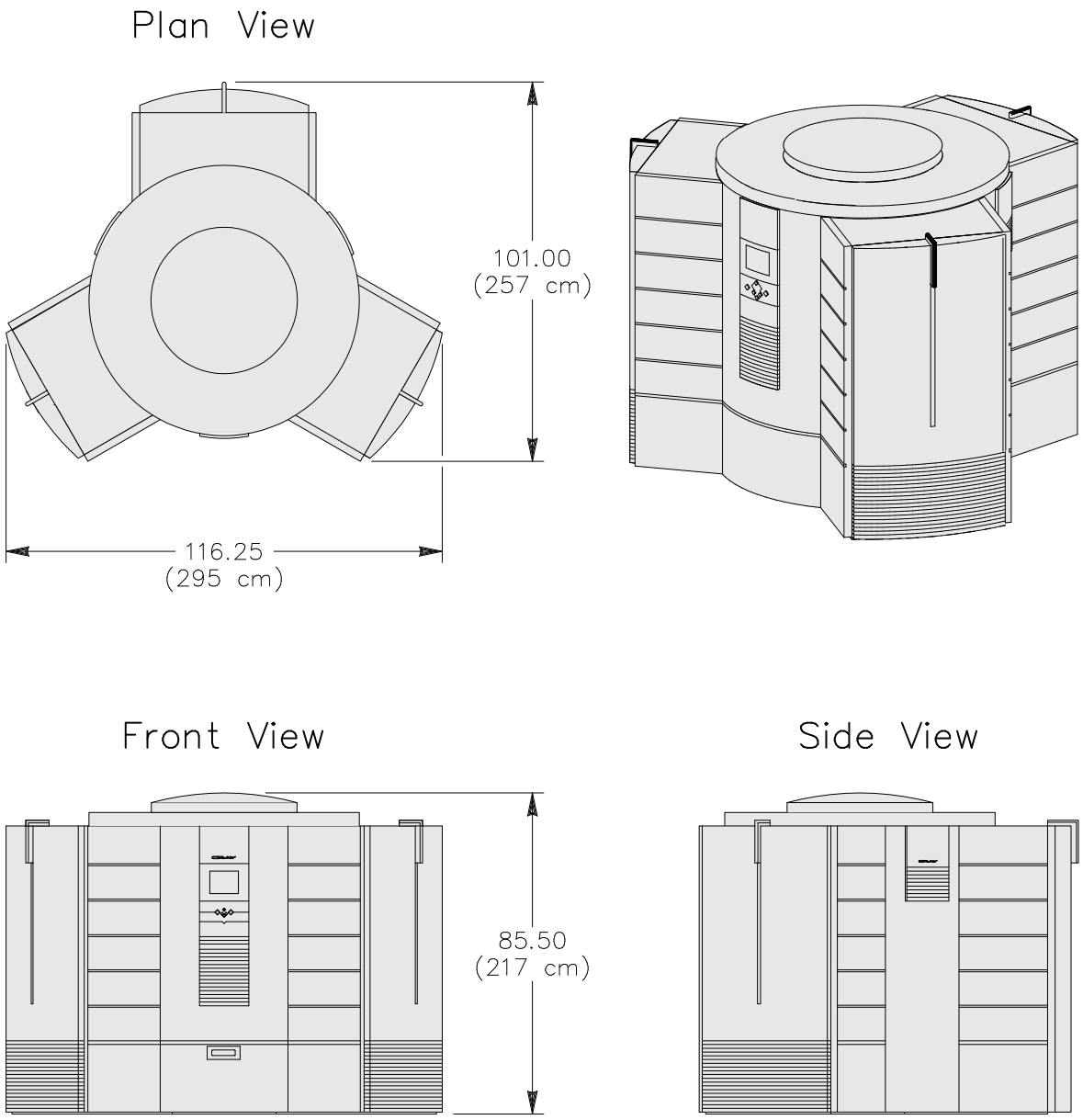


Figure 3-3. CRAY C916 Mainframe Chassis

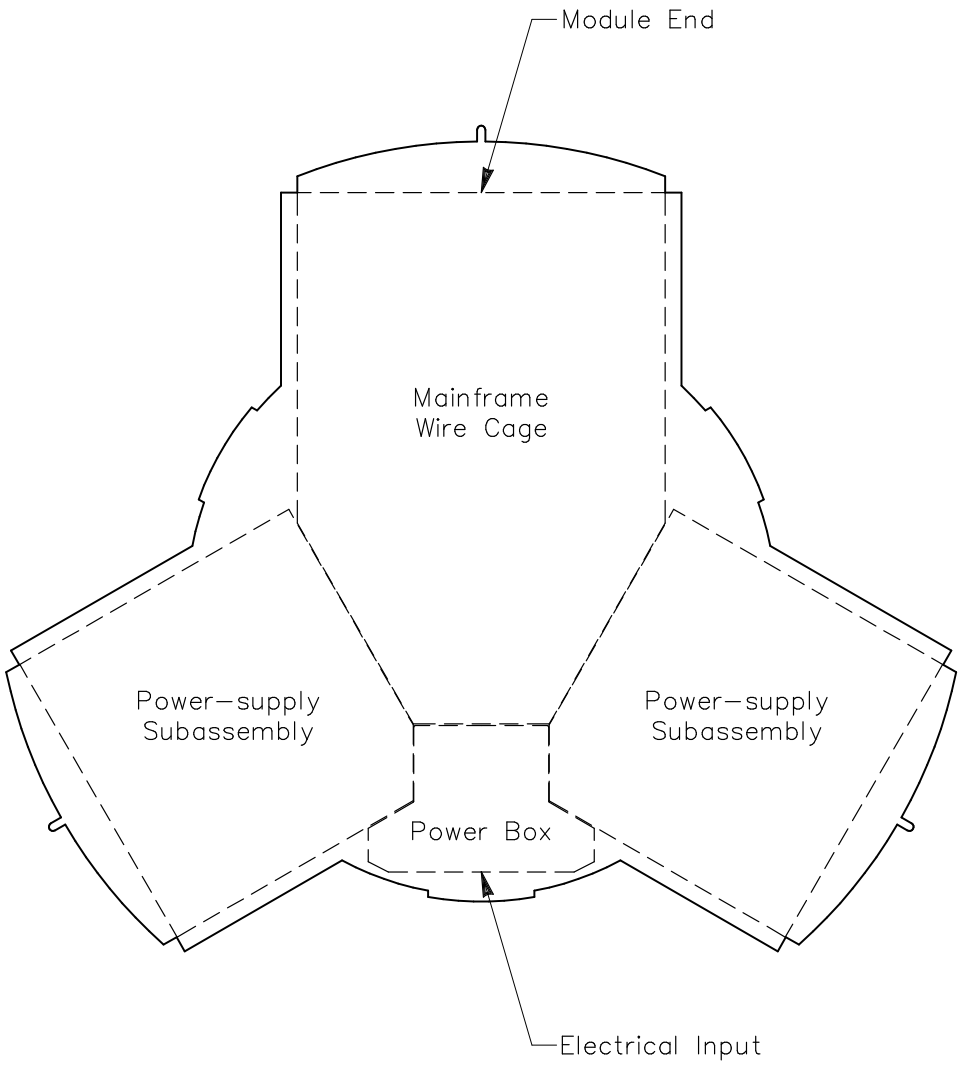


Figure 3-4. CRAY C916 Subassemblies

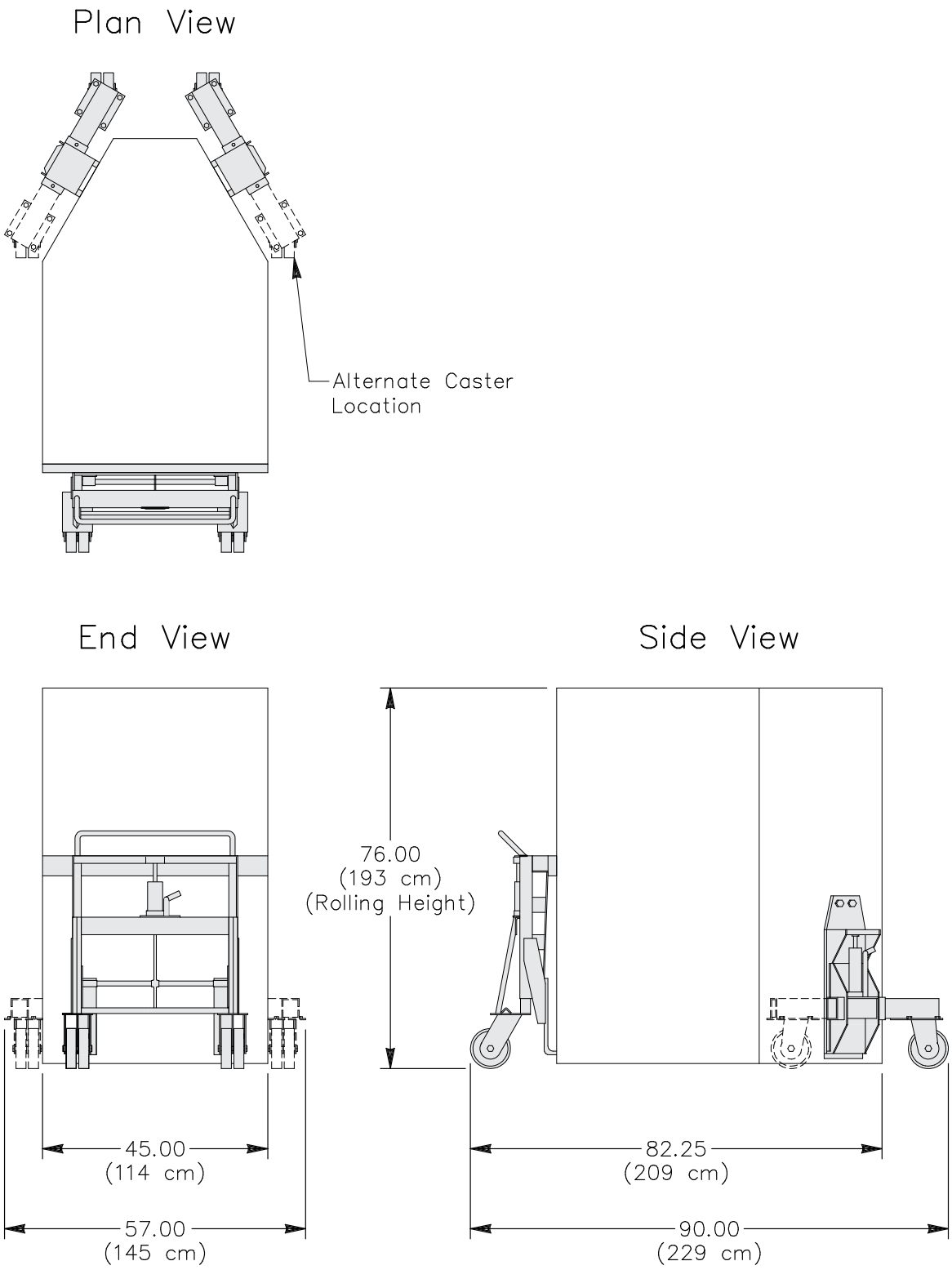


Figure 3-5. CRAY C916 Mainframe Wire Cage Shipping Configuration

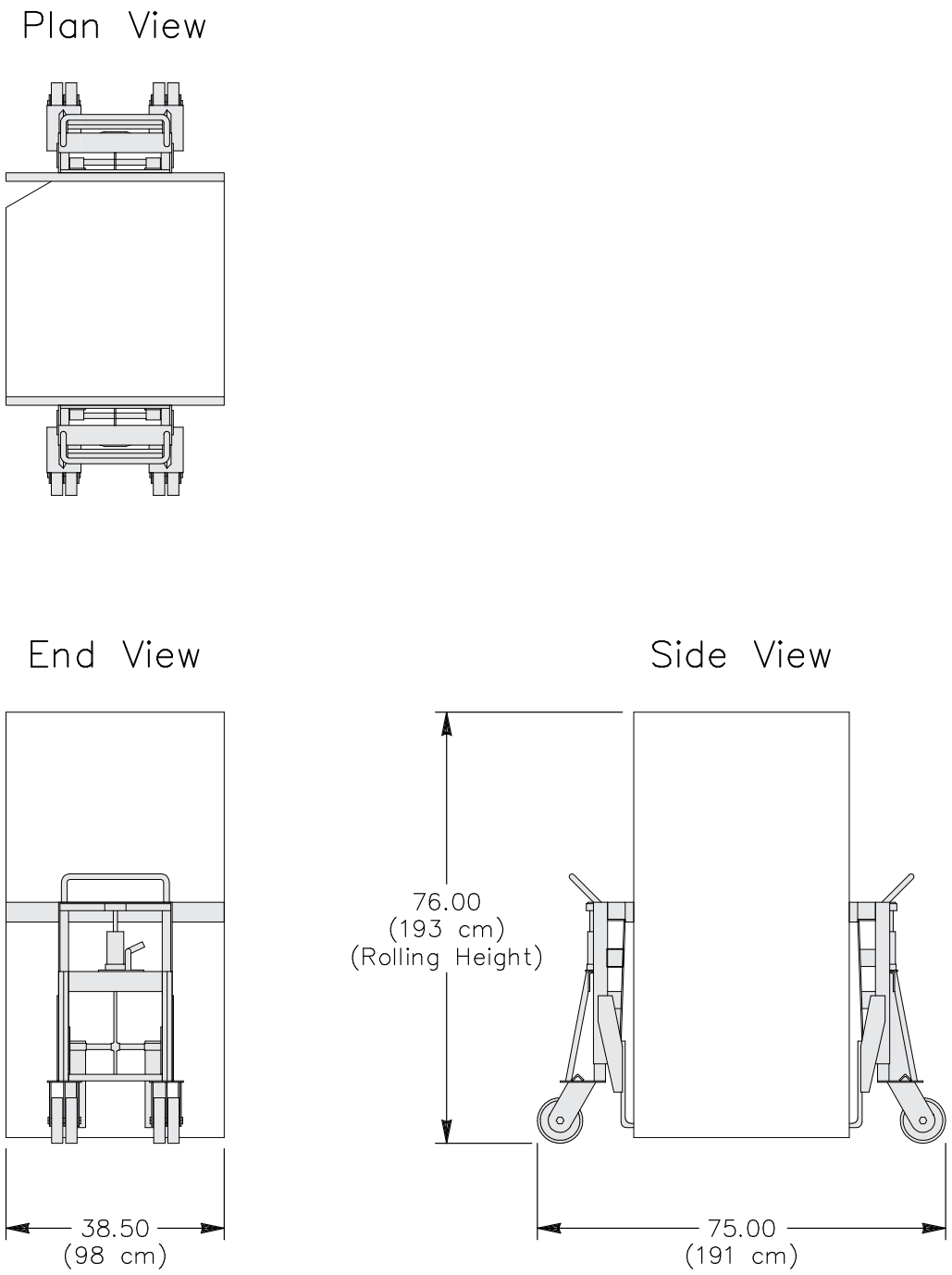


Figure 3-6. CRAY C916 Power-supply Subassembly Shipping Configuration

IOS/SSD Chassis

The IOS/SSD chassis (refer to Figure 3-7) is a dielectric-cooled unit that contains the logic modules and power supplies associated with the IOS and SSD. The SSD portion of this cabinet is optional. All specifications given in this section include the SSD option.

Table 3-2 provides the IOS/SSD chassis specifications. Figure 3-8 illustrates the shipping configuration for the IOS/SSD chassis. The lifts on each end are not part of the equipment and are used only for transporting the IOS/SSD chassis.

Table 3-2. IOS/SSD Chassis Specifications

Characteristic		Specification
Height		76.25 in. (194 cm)
Width		46.00 in. (117 cm)
Depth		75.50 in. (192 cm)
Weight		7,695 lbs (3,490 kg)
Floor loading		520 lbs/ft^2 (2,538 kg/m^2)
Access requirements		36.00 in. (91 cm) on all sides
Heat dissipation to air		8.77 kBtu/hr (2.57 kW) maximum
Shipping size:	Height Width Depth	77.50 in. (197 cm) 40.50 in. (103 cm) 111.00 in. (282 cm)
Shipping weight		8,228 lbs (3,732 kg)

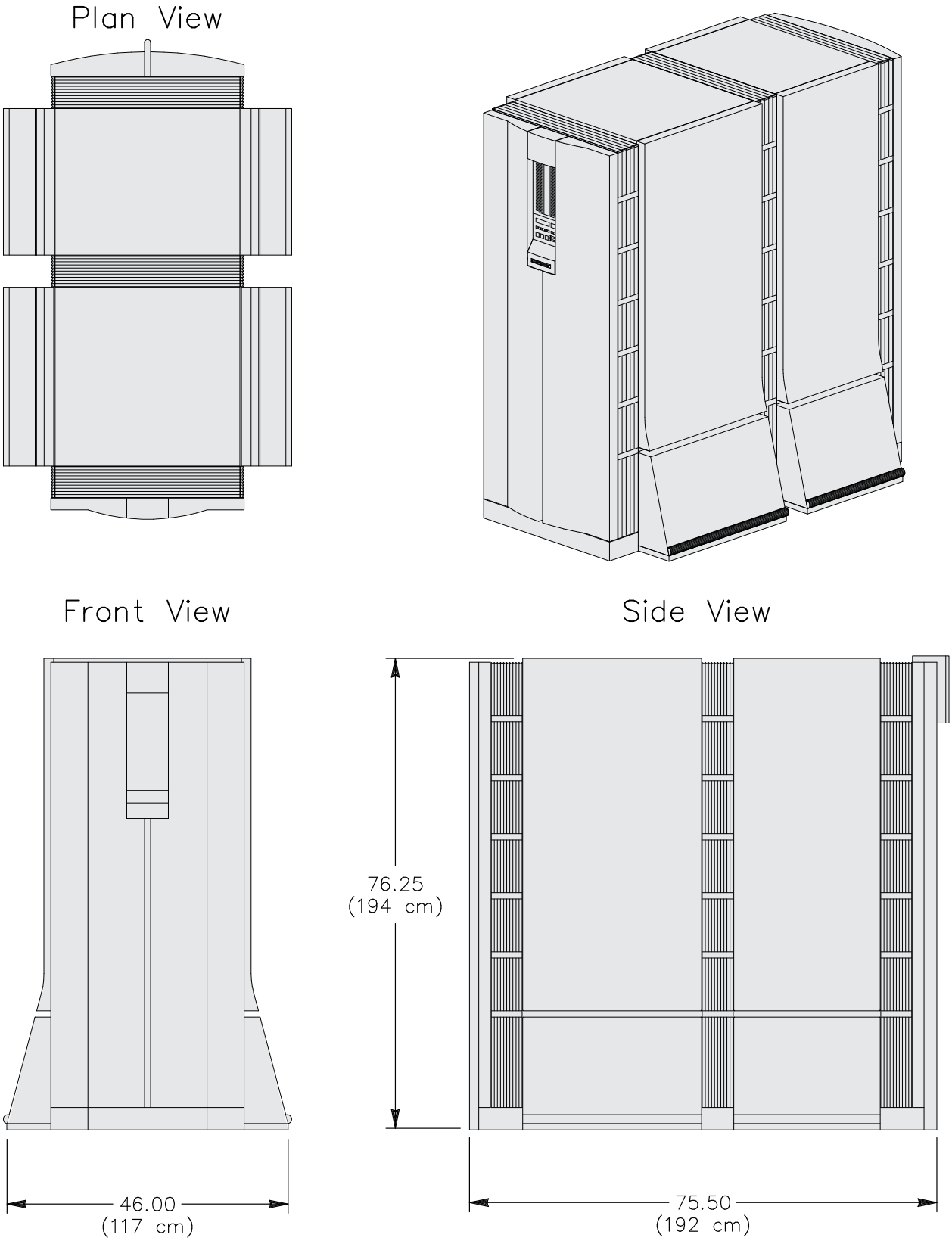


Figure 3-7. IOS/SSD Chassis

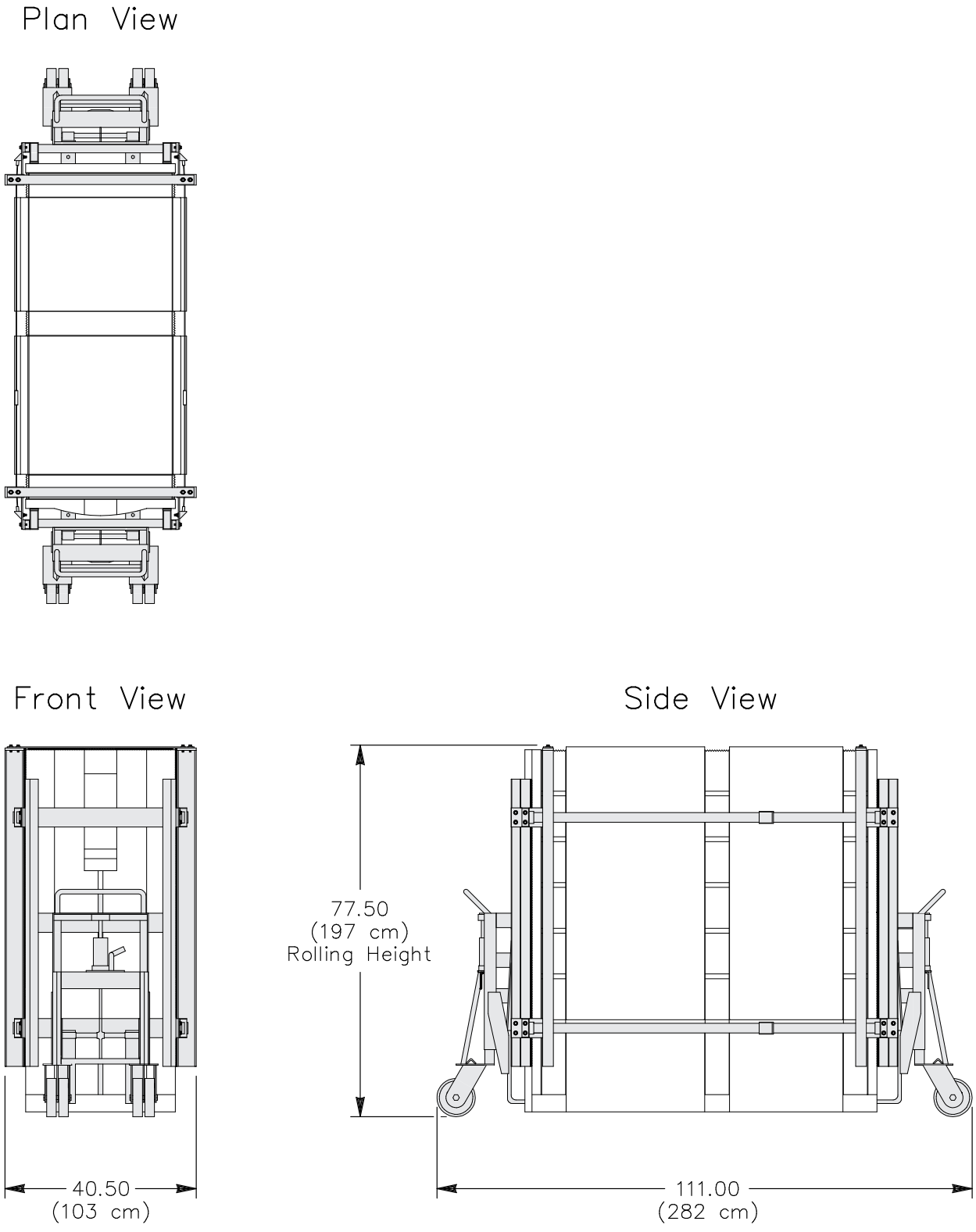


Figure 3-8. IOS/SSD Shipping Configuration

Heat Exchanger Units

The CRAY C916 computer system uses two heat exchanger units to dissipate the heat from the MFC and IOS/SSD electronic components. The following subsections provide specifications for both heat exchanger units.

Heat Exchanger Unit (HEU-C90)

The heat exchanger unit (HEU-C90) transfers the heat generated by the mainframe electronic components to the RCUs. Table 3-3 provides the specifications for the HEU-C90. Refer to Figure 3-9 for an illustration of the HEU-C90.

Table 3-3. HEU-C90 Specifications

Characteristic	Specification
Height	75.75 in. (192 cm)
Width	40.00 in. (102 cm)
Depth	56.00 in. (142 cm)
Weight	2,086 lbs (946 kg)
Floor loading	174 lbs/ft^2 (849 kg/m^2)
Access requirements	40 in. (102 cm) front 36.00 in. (91 cm) sides 18.00 in. (46 cm) back
Heat dissipation to air	3.92 kBtu/hr (1.15 kW)
Shipping size: Height Width Depth	74.75 in. (190 cm) 36.00 in. (91 cm) 82.00 in. (208 cm)
Shipping weight	1,515 lbs (687 kg)

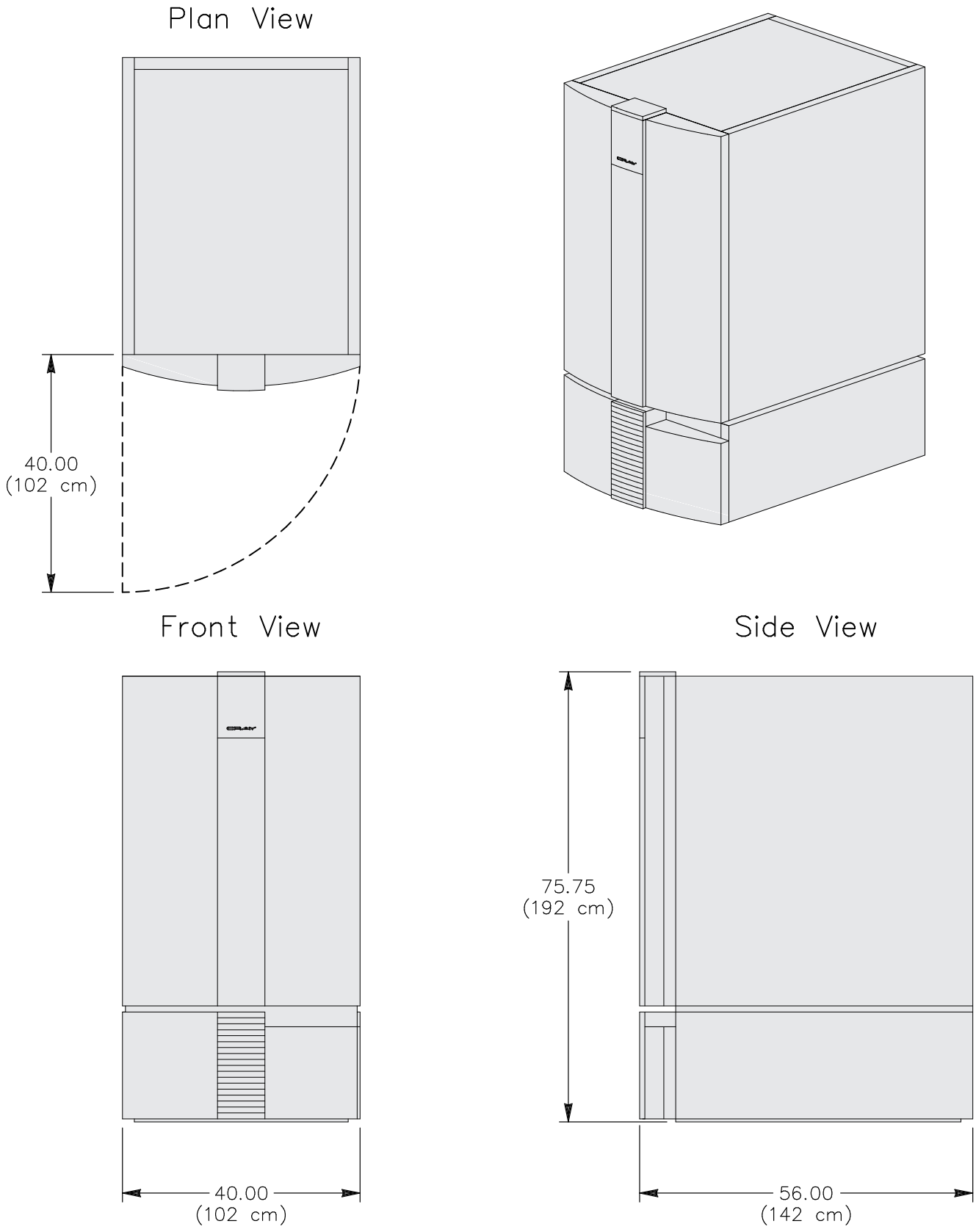


Figure 3-9. Heat Exchanger Unit (HEU-C90)

Heat Exchanger Unit (HEU-E/S)

The heat exchanger unit (HEU-E/S) uses a single pump and heat exchanger to transfer the heat generated by the IOS/SSD components. Table 3-4 provides specifications for the HEU-E/S. Refer to Figure 3-10 for an illustration of the HEU-E/S.

Table 3-4. HEU-E/S Specifications

Characteristic		Specification
Height		62.00 in. (157 cm)
Width		38.00 in. (97 cm)
Depth		51.00 in. (130 cm)
Weight		1,200 lbs (544 kg)
Floor loading		100 lbs/ft^2 (488 kg/m^2)
Access requirements		36.00 in. (91 cm) front and sides 18.00 in. (46 cm) back
Heat dissipation to air		3.92 kBtu/hr (1.15 kW)
Shipping size:	Height Width Depth	63.00 in. (160 cm) 36.00 in. (91 cm) 82.00 in. (208 cm)
Shipping weight		908 lbs (412 kg)

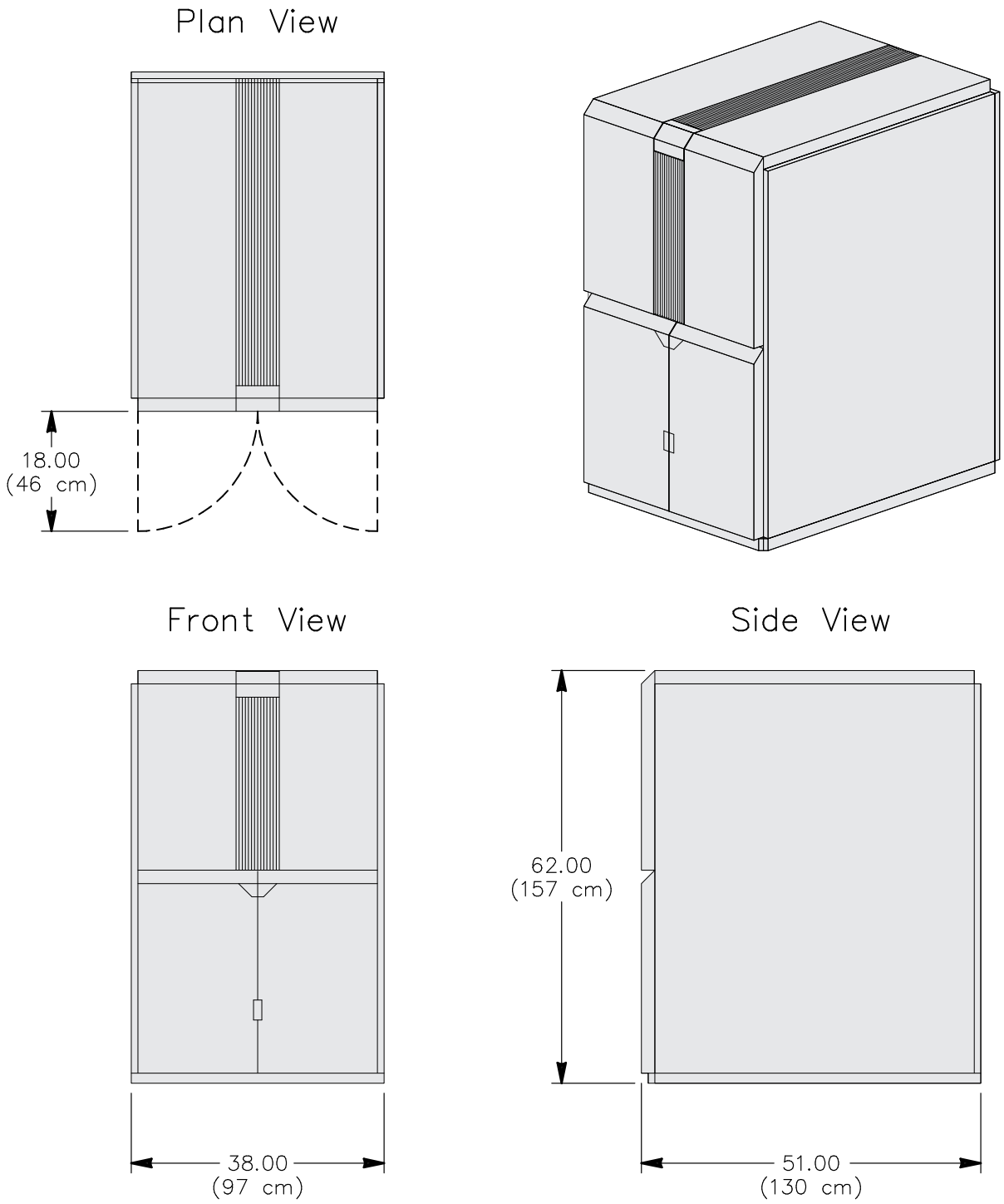


Figure 3-10. Heat Exchanger Unit (HEU-E/S)

Floor Preparation

Prior to system delivery, you must prepare the raised floor for the CRAY C916 computer system installation. You must prepare the floor cutouts and install the additional floor support pedestals and mainframe support pedestals. This subsection provides the information and diagrams necessary to prepare floor cutouts for the MFC, IOS/SSD, HEU-C90, and HEU-E/S.

Floor cutouts provide an opening for data, power, refrigeration, and dielectric-coolant system connections. The floor cutouts must be free of burrs and sharp edges to prevent damage to these system connections.

NOTE: Cray Research provides full-scale templates used to prepare the MFC, IOS/SSD, HEU-C90, and HEU-E/S floor cutouts and to show support pedestal locations.

Mainframe Chassis

You must prepare 14 floor cutouts for the MFC. Refer to Figure 3-11 for the location of these floor cutouts. Cray Research supplies the mainframe support pedestals to accommodate the mainframe chassis floor loading characteristics. These mainframe support pedestals are adjustable to accommodate various floor heights. Refer to Figure 3-12 for the location of the mainframe support pedestals. These support pedestals are preshipped approximately 8 weeks before system arrival.

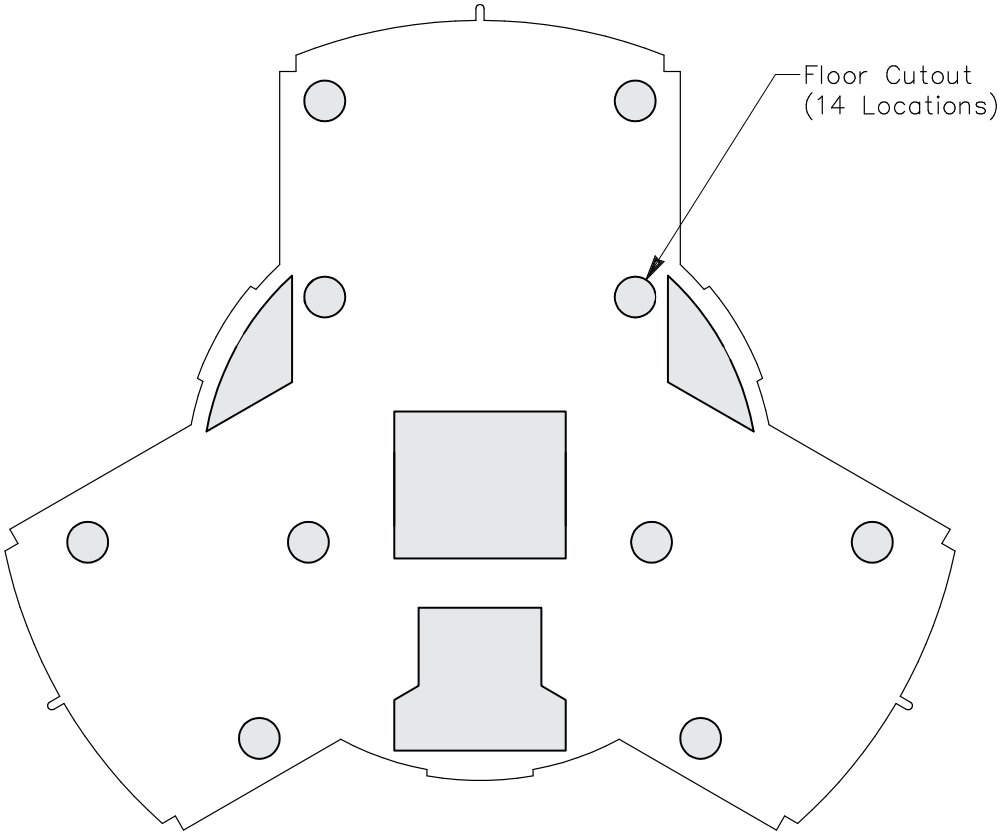


Figure 3-11. CRAY C916 Mainframe Chassis Floor Cutouts

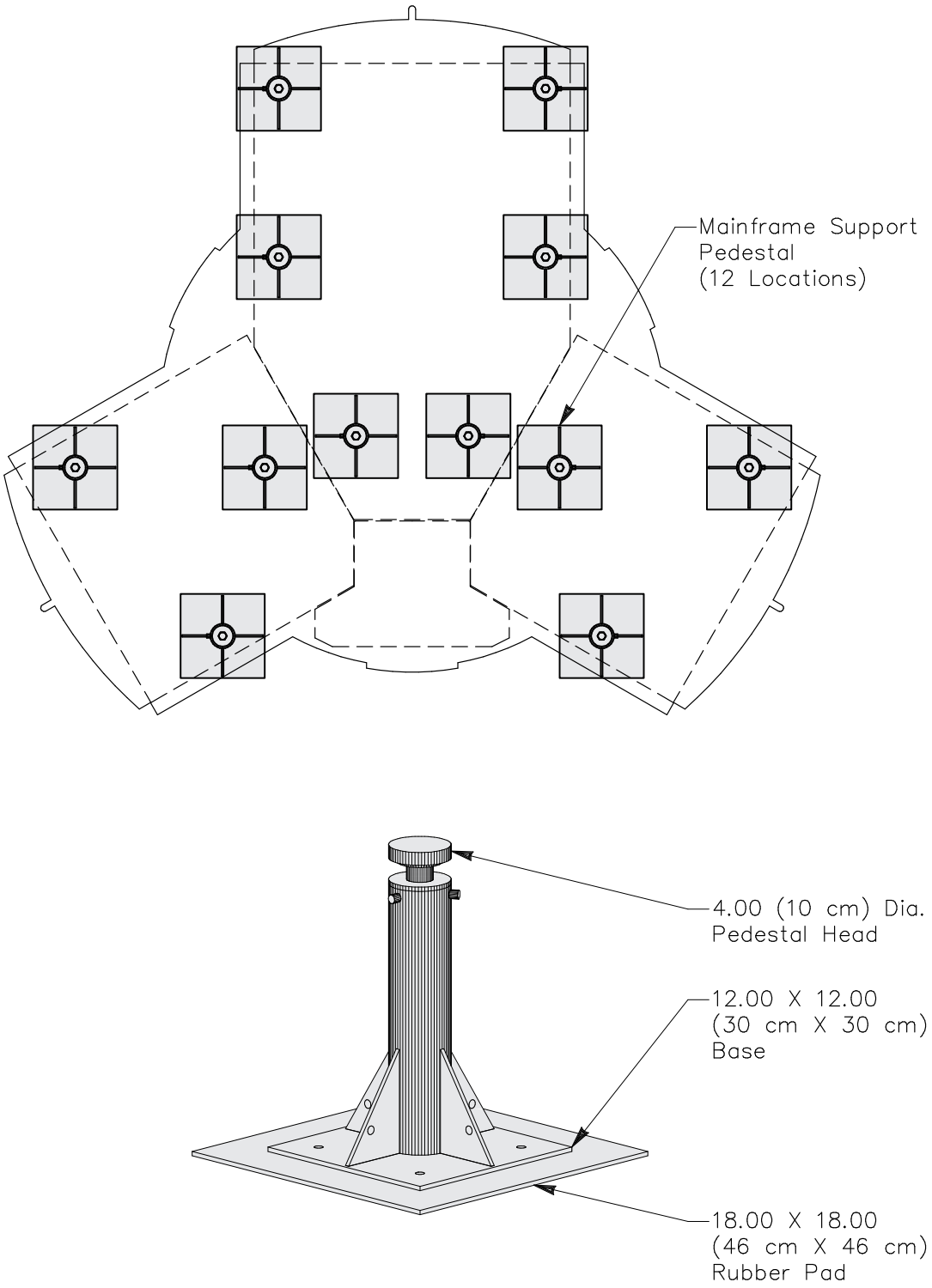


Figure 3-12. CRAY C916 Mainframe Pedestal Locations

IOS/SSD Chassis

You must prepare five floor cutouts for the IOS/SSD chassis. Refer to Figure 3-13 for the location of the floor cutouts for the IOS/SSD chassis.

Additional floor support pedestals are necessary to accommodate the concentrated floor loading characteristics of the computer equipment. You must supply and install the 13 additional floor support pedestals. Some sites might require more floor support pedestals to restore the structural strength of the floor, depending on stringer style and panel size.

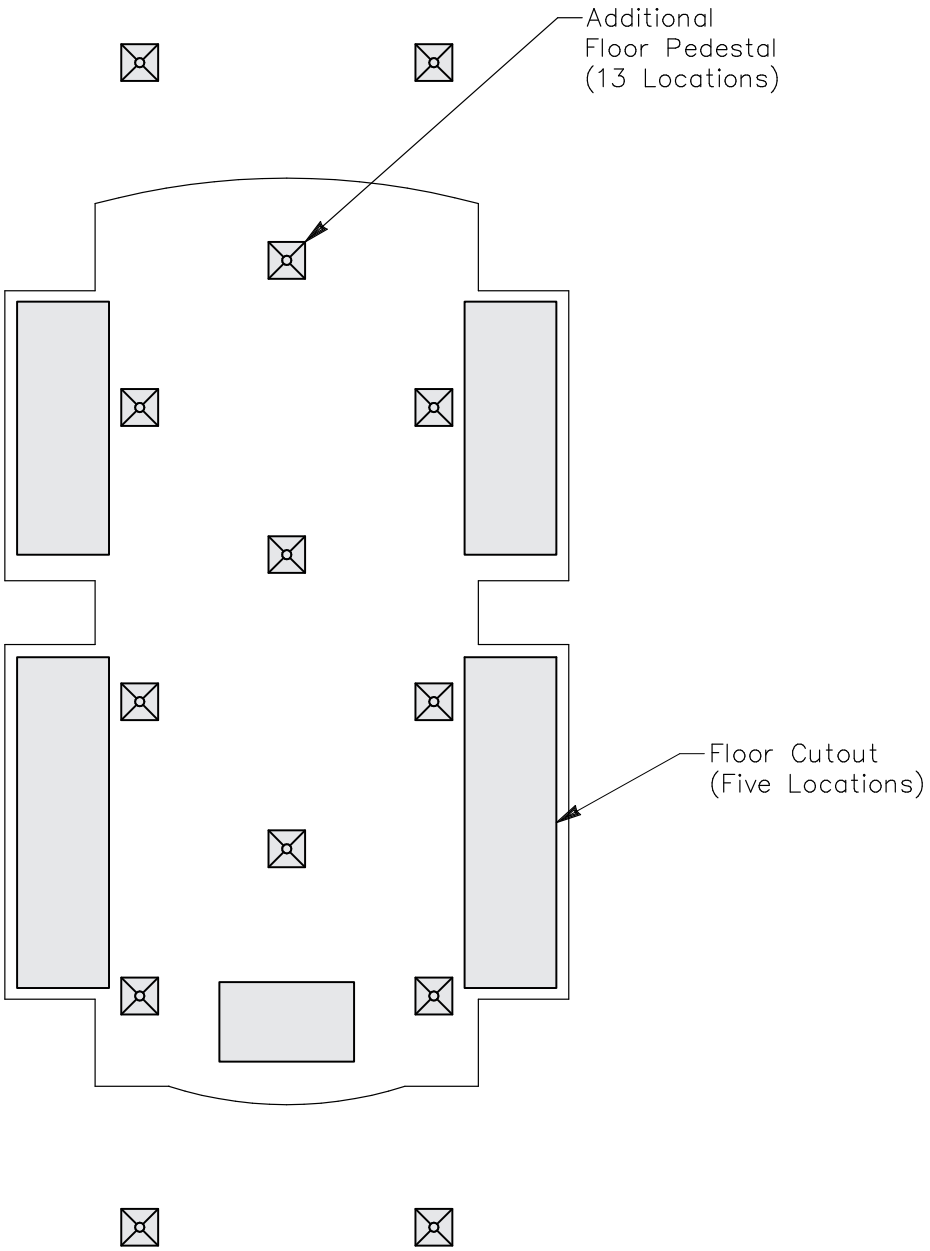


Figure 3-13. IOS/SSD Chassis Floor Cutouts and Additional Floor Pedestals

Heat Exchanger Units

The HEU-C90 requires two floor cutouts for the entrance of refrigeration hoses, dielectric-coolant hoses, and power and control wiring. Refer to Figure 3-14 for an illustration of the floor cutouts for the HEU-C90.

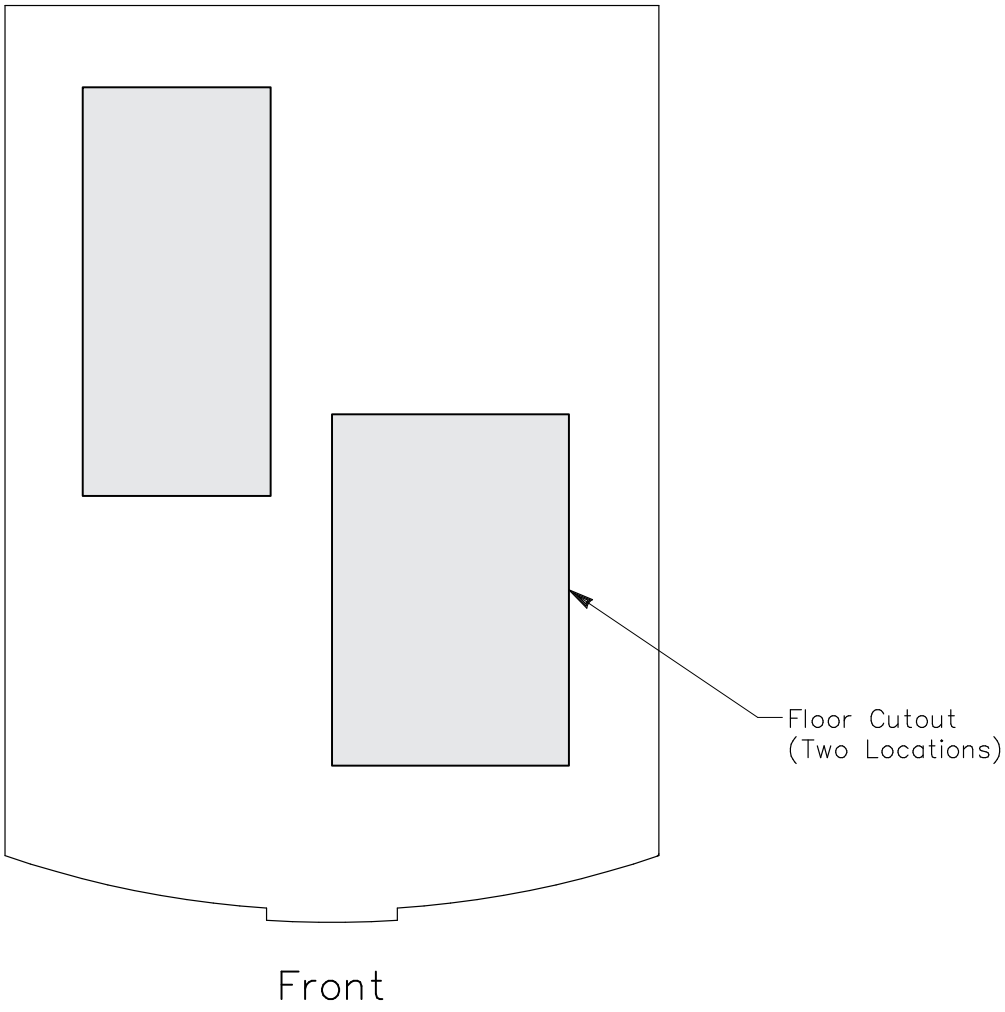


Figure 3-14. HEU-C90 Floor Cutouts

The HEU-E/S also requires two floor cutouts for the entrance of refrigeration hoses, dielectric-coolant hoses, and power and control wiring. Refer to Figure 3-15 for an illustration of the floor cutouts for the HEU-E/S.

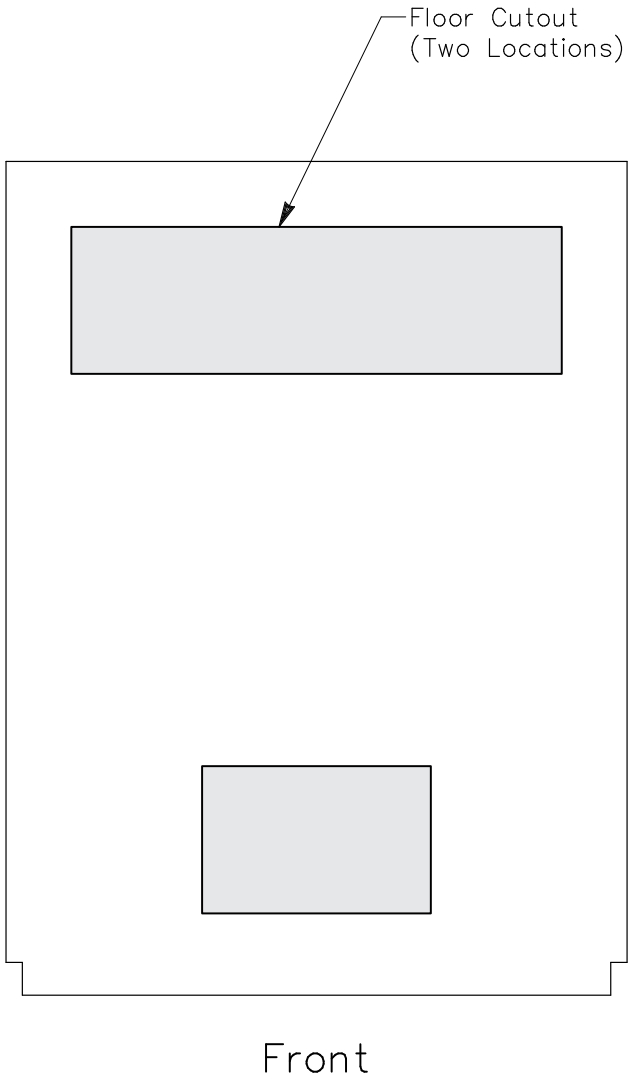


Figure 3-15. HEU-E/S Floor Cutouts

Power Wiring Requirements

You must install all power and control wiring for the following devices: mainframe chassis (MFC), IOS/SSD chassis, and heat exchanger units (HEU-C90 and HEU-E/S). The following subsections provide general information for all circuits and device-specific requirements.

General Requirements

Each device has specific electrical requirements. However, some general information applies to all circuits. Figure 3-16 through Figure 3-19 are illustrations of the power and control wiring for computer systems that have an MGS-6 or MGS-6A and a PDC for both 50- and 60-Hz power sources. (A customer-supplied wall circuit breaker panel may be substituted for the PDC.) Figure 3-20 through Figure 3-23 are illustrations of the power and control wiring for computer systems that have two MGS-4s and a MGPC for both 50- and 60-Hz power sources. The following list provides information additional to the block diagrams.

- Figure 3-16 through Figure 3-23 are guides for your electrical design engineer and must not be used as bid documents or working drawings.
- The equipment arrangements shown in Figure 3-16 through Figure 3-23 are not actual equipment layouts.
- All wiring should be prepared according to applicable local and national codes.
- The maximum 400-Hz voltage drop from the MGSs to the mainframe chassis (MFC) and IOS/SSD chassis should not exceed 2%. Verify that the wire sizes and quantity of conductors meet this requirement.
- All circuit breakers, circuit breaker panels, magnetic contactors, main power disconnect switches, junction boxes, power wiring, raceways, and conduits must be provided and installed by you.
- Conduit or raceways used for 400-Hz power distribution must be aluminum or nonferrous.
- Circuit breakers used for 400-Hz power distribution can be 60-Hz rated, but must be sized for 400-Hz application.
- The minimum suggested control wiring size is #14 AWG (2.5 mm^2).

- Your site preparation design should allow for circuit additions proportionate to system upgrade plans.

- Cray Research recommends the installation of one emergency OFF switch at each computer room exit. All emergency OFF switches should be wired in series and should interrupt power to the computer equipment and to all air-circulating units in the computer room.

- Secure all conduits ending at computer equipment with approved fittings at the equipment wiring entrance.

- Refer to Cray Research-supplied site planning documentation for detailed point-to-point diagrams for all wiring connections to the MFC, HEUs, IOS/SSD chassis, RCU, and MGS.

- Allow a minimum of 36.00 in. (91 cm) of excess wire length above the floor surface to ensure adequate wire length for system connection.

All Cray Research computer equipment must be earth grounded. Refer to the *Equipment Grounding for Cray Research, Inc. Computer Systems*, Site Engineering document number 10658002, for more information about equipment grounding.

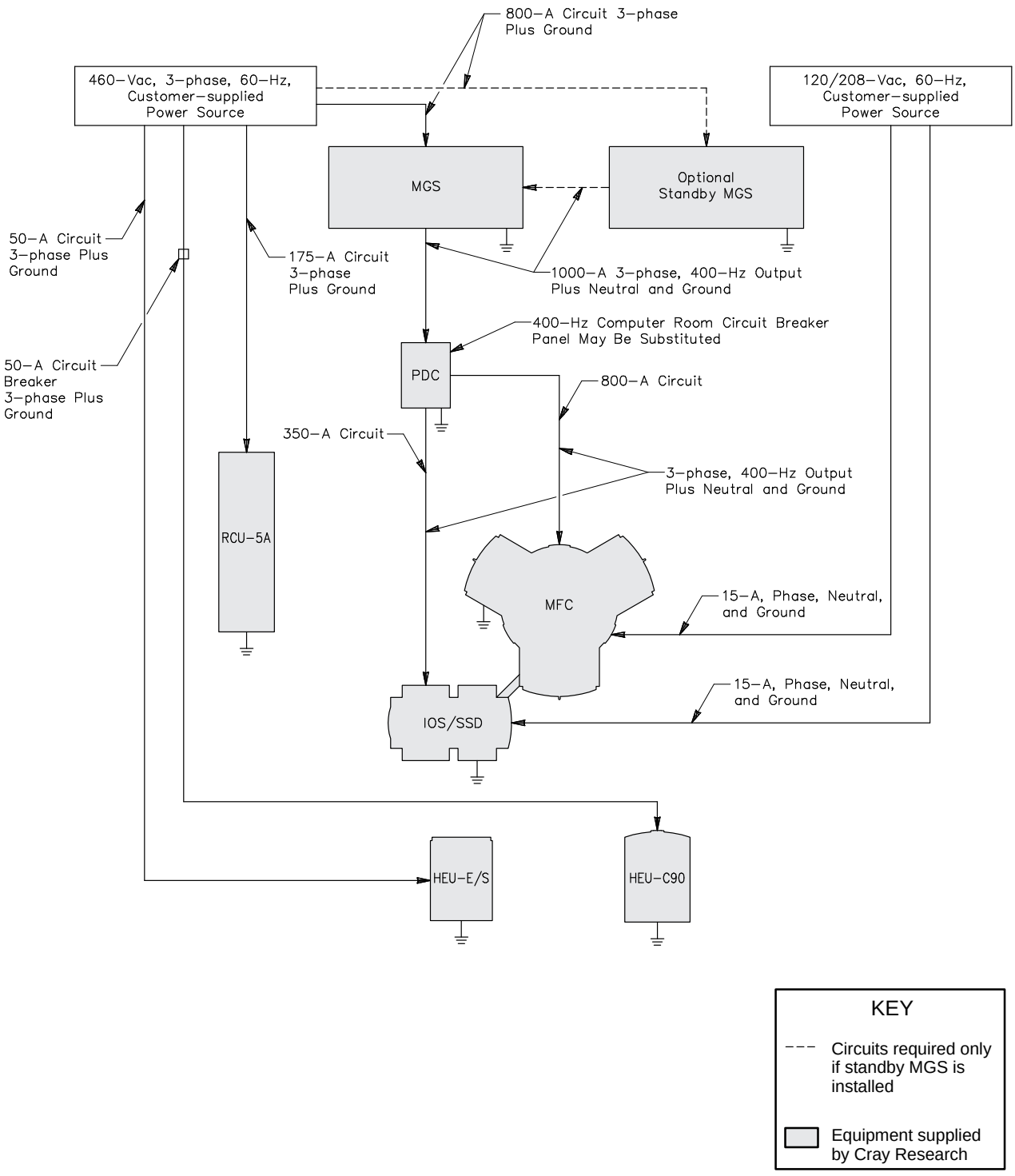


Figure 3-16. CRAY C916 Basic Power Wiring (60 Hz)

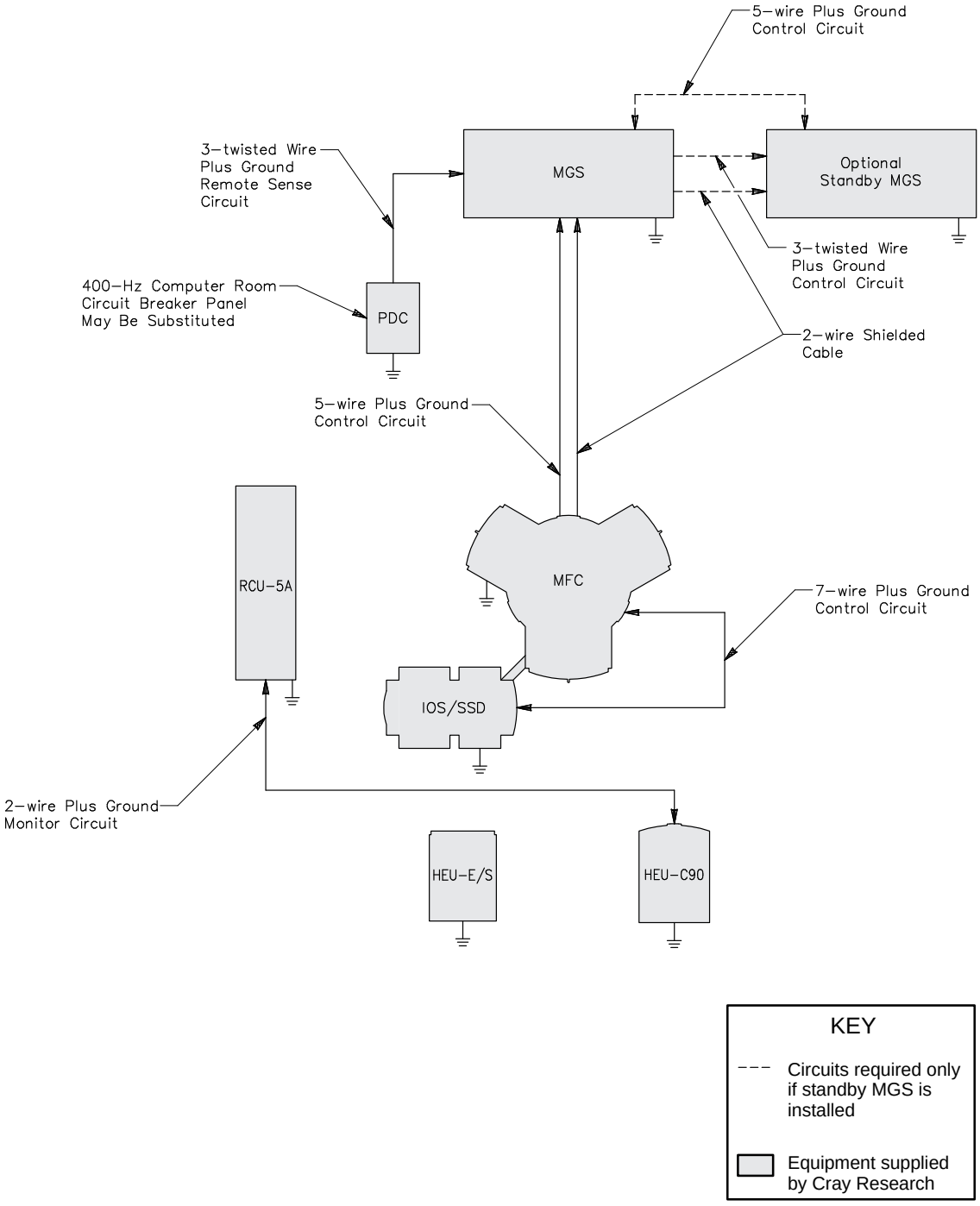


Figure 3-17. CRAY C916 Basic Control Wiring (60 Hz)

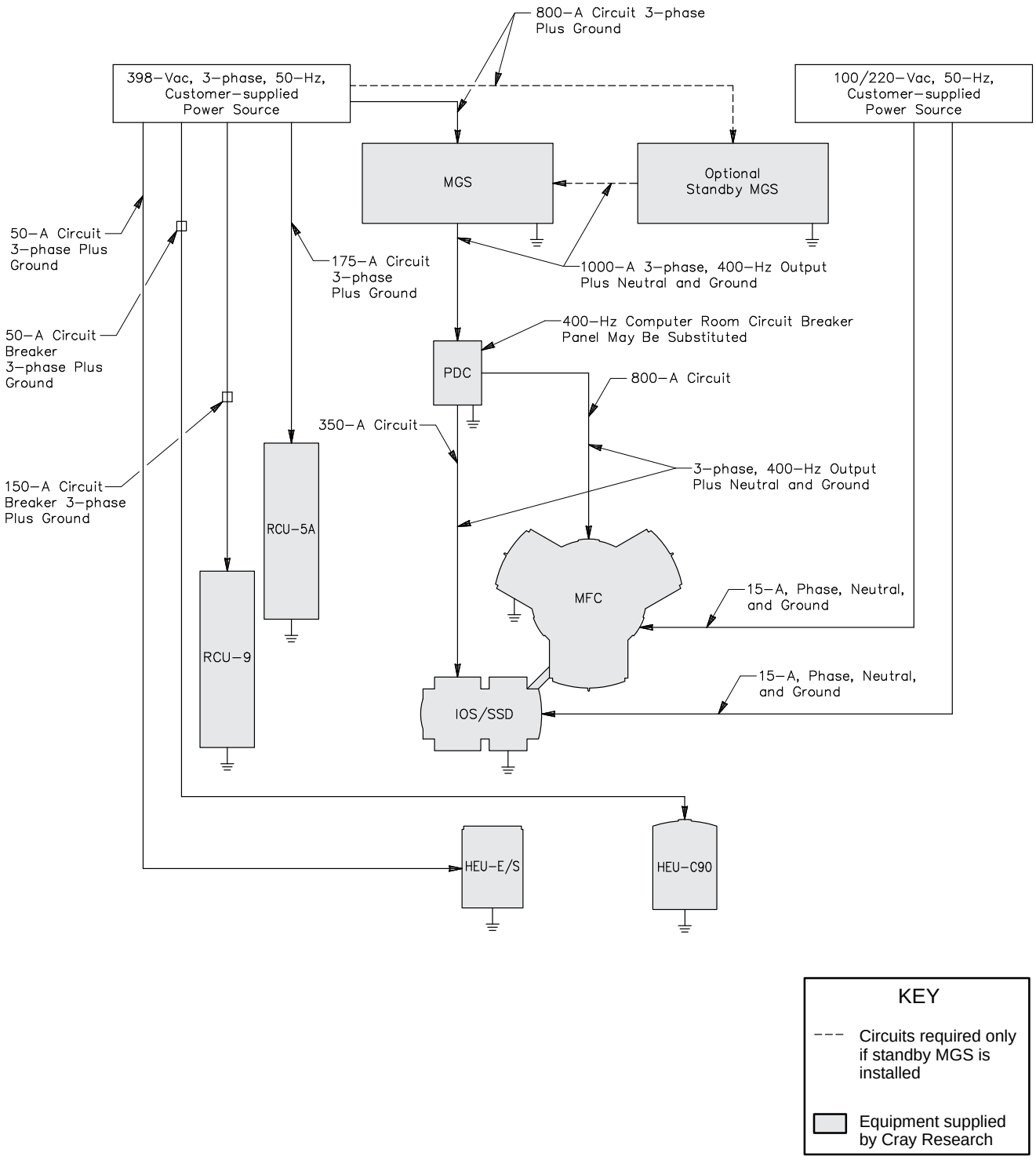


Figure 3-18. CRAY C916 Basic Power Wiring (50 Hz)

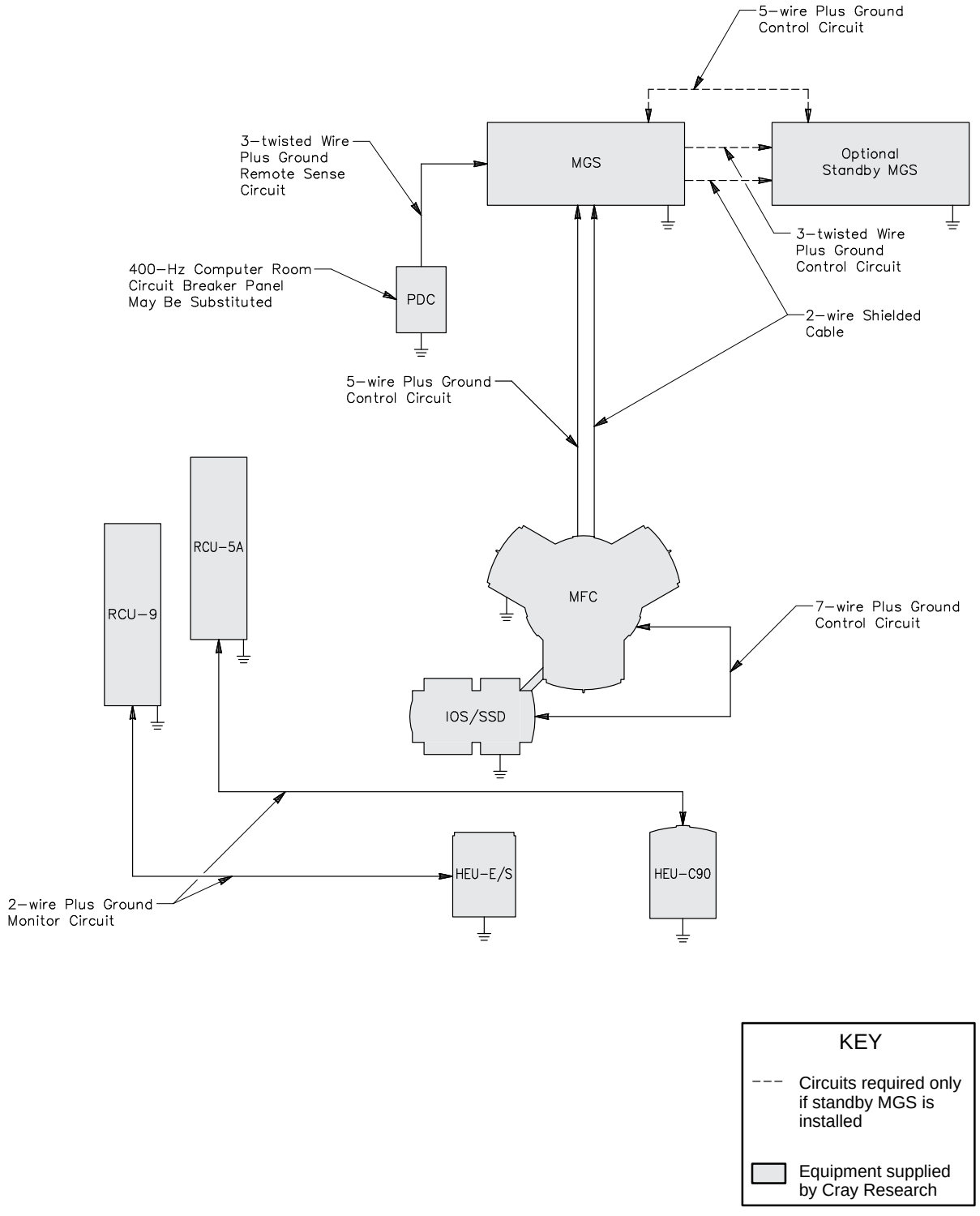


Figure 3-19. CRAY C916 Basic Control Wiring (50 Hz)

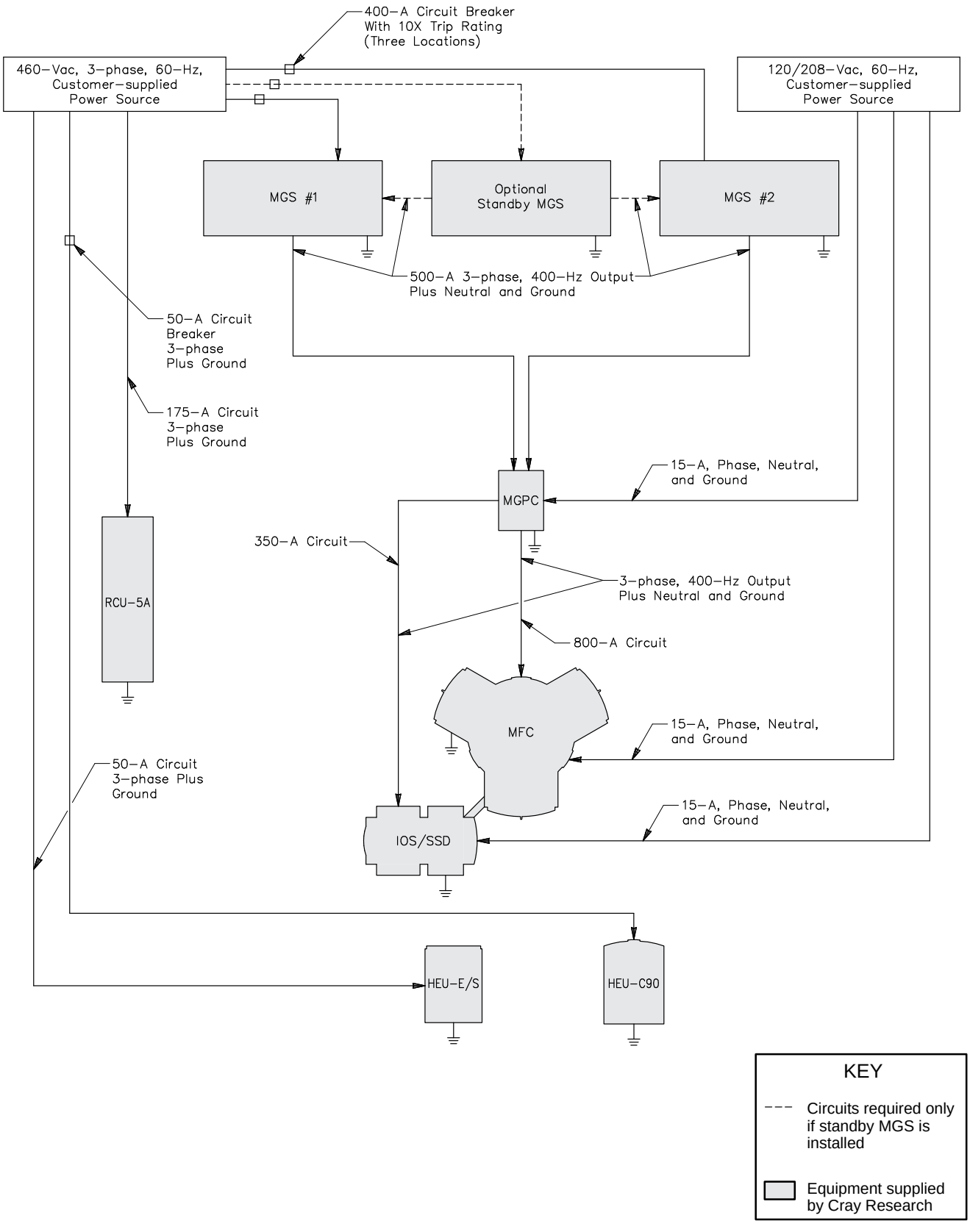


Figure 3-20. CRAY C916 Basic Power Wiring for Systems Configured with an MGPC (60 Hz)

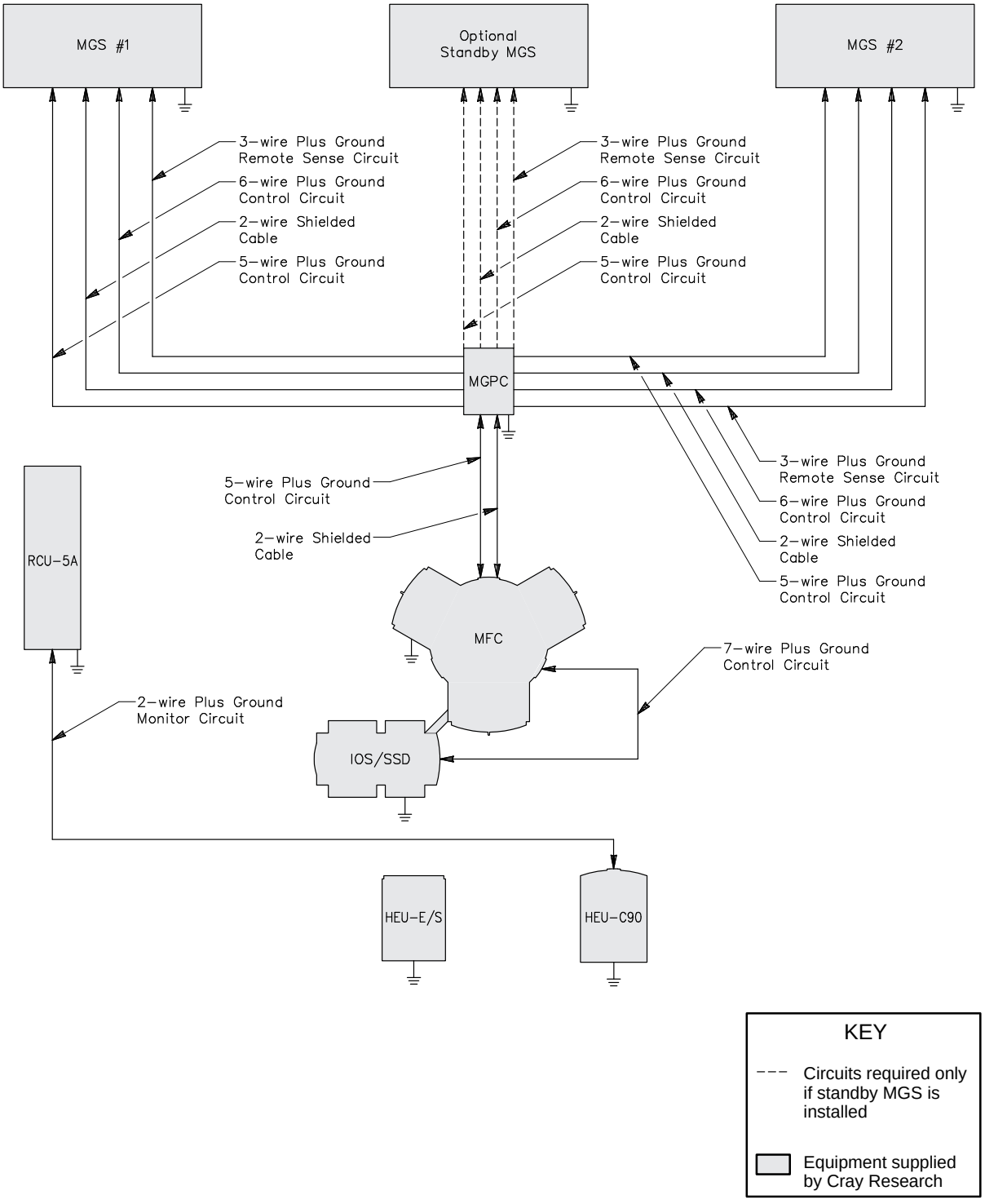


Figure 3-21. CRAY C916 Basic Control Wiring for Systems Configured with an MGPC (60 Hz)

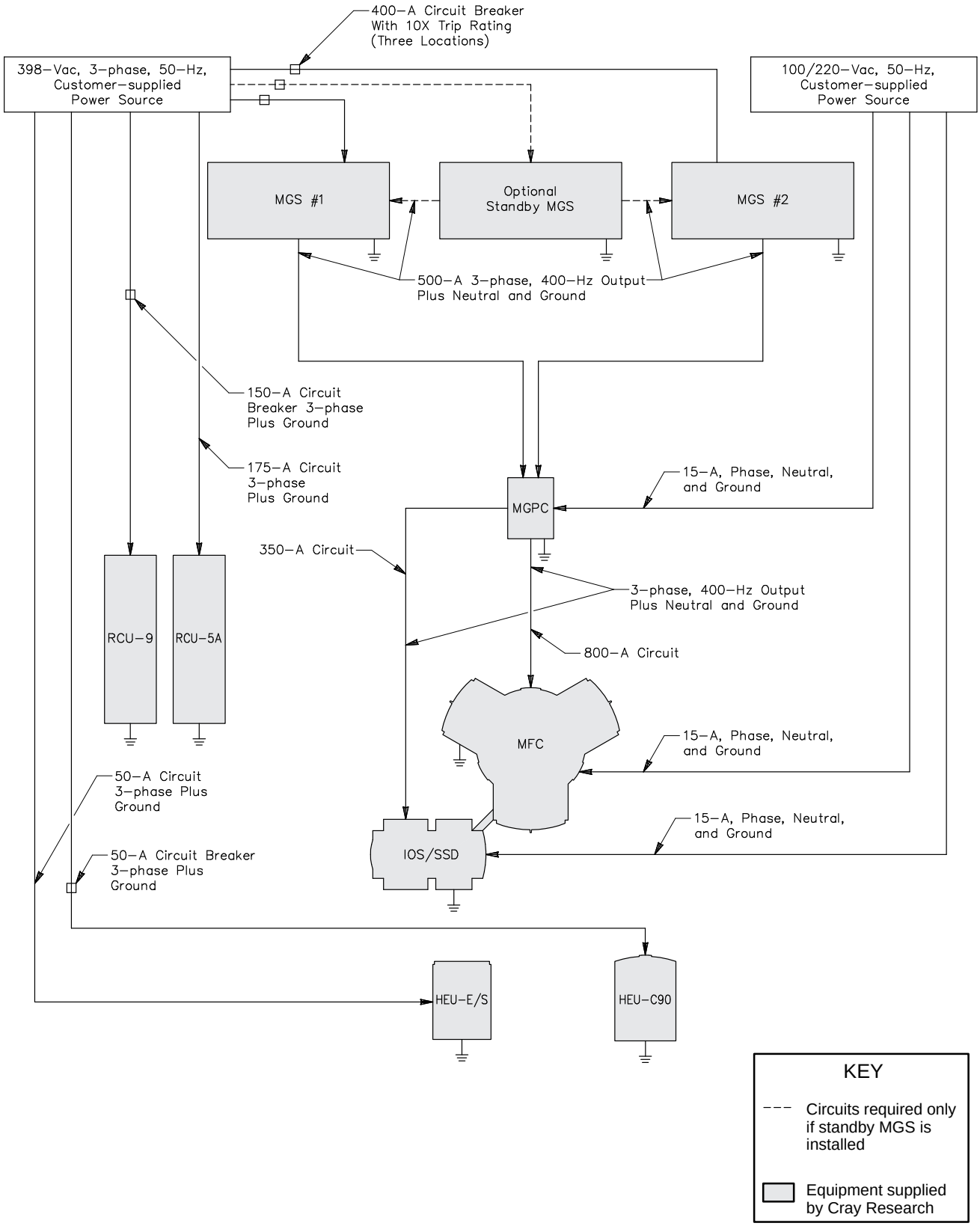


Figure 3-22. CRAY C916 Basic Power Wiring for Systems Configured with an MGPC (50 Hz)

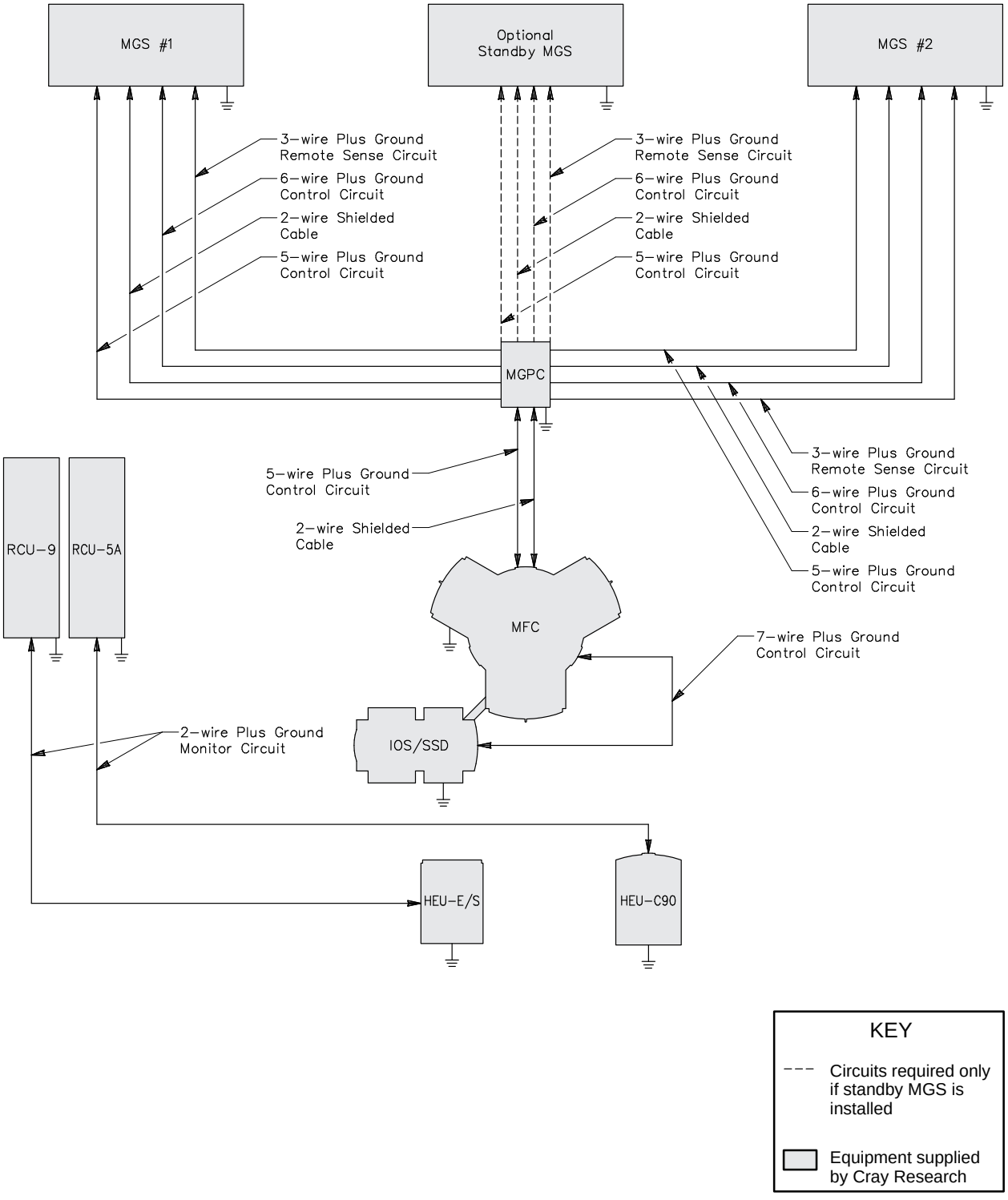


Figure 3-23. CRAY C916 Basic Control Wiring for Systems Configured with an MGPC (50 Hz)

Mainframe Chassis Requirements

You must provide and install the following power and control wiring for the mainframe chassis:

- One 208-Vac, 3-phase (neutral and ground), 400-Hz, 800-A circuit from the computer room circuit breaker panel, MGPC, or PDC to the mainframe chassis.

NOTE: To prevent excessive voltage drops, this circuit requires multiple conductors per phase.

- One 120/220-Vac, 50/60-Hz, single-phase, 15-A circuit to the mainframe chassis for control power
- One 5-wire (plus ground) control circuit from the mainframe chassis to the MGS or MGPC for motor-generator control
- One 2-wire shielded cable (Belden 8720) from the mainframe chassis to the MGS or MGPC for voltage adjustment
- One 7-wire (plus ground) control circuit from the mainframe chassis to the IOS/SSD chassis

IOS/SSD Chassis Requirements

You must supply and install the following power and control wiring for the IOS/SSD chassis:

- One 208-Vac, 3-phase, 400-Hz, 350-A power circuit from the computer room circuit breaker panel, MGPC, or PDC to the IOS/SSD chassis
- One 120/220-Vac, 50/60-Hz, single-phase, 15-A control power circuit to the IOS/SSD chassis

Heat Exchanger Unit (HEU-C90) Requirements

You must supply and install the following power and control wiring for the heat exchanger unit (HEU-C90):

- One of the following incoming 3-phase, 4-wire (including ground wire), 50-A circuits to the HEU-C90:
  - 460 Vac, 60 Hz
  - 398 Vac, 50 Hz

- One 2-wire (plus ground) control circuit from the HEU-C90 to the refrigeration condensing unit (RCU-5A)

Heat Exchanger Unit (HEU-E/S) Requirements

You must supply and install the following power and control wiring for the heat exchanger unit (HEU-E/S):

- One of the following incoming 3-phase, 4-wire (including ground wire), 50-A circuits to the HEU-E/S:
  - 460 Vac, 60 Hz
  - 398 Vac, 50 Hz

- One 2-wire (plus ground) control circuit from the HEU-E/S to the RCU-9 (50-Hz applications only)

Cooling Requirements

The CRAY C916 computer system uses a dielectric-cooling technique that requires special piping and hoses. Dielectric-coolant hoses are required between the heat exchanger unit (HEU-C90) and the mainframe chassis and also between the heat exchanger unit (HEU-E/S) and the IOS/SSD chassis. Refrigeration piping is required between the heat exchanger units (HEU-C90 and HEU-E/S) and the refrigeration condensing units (RCU-5A and RCU-9). Refer to the "Operational Requirements" section of this manual for more information about cooling water requirements.

Dielectric-coolant Hoses

Flexible hoses are required to complete the dielectric-coolant network between the mainframe chassis and the HEU-C90; these hoses are also required between the IOS/SSD chassis and the HEU-E/S. Cray Research supplies and installs all flexible hoses for the dielectric coolant at the time of system installation. Figure 3-24 illustrates the standard arrangement of dielectric-coolant hoses for the CRAY C916 computer system.

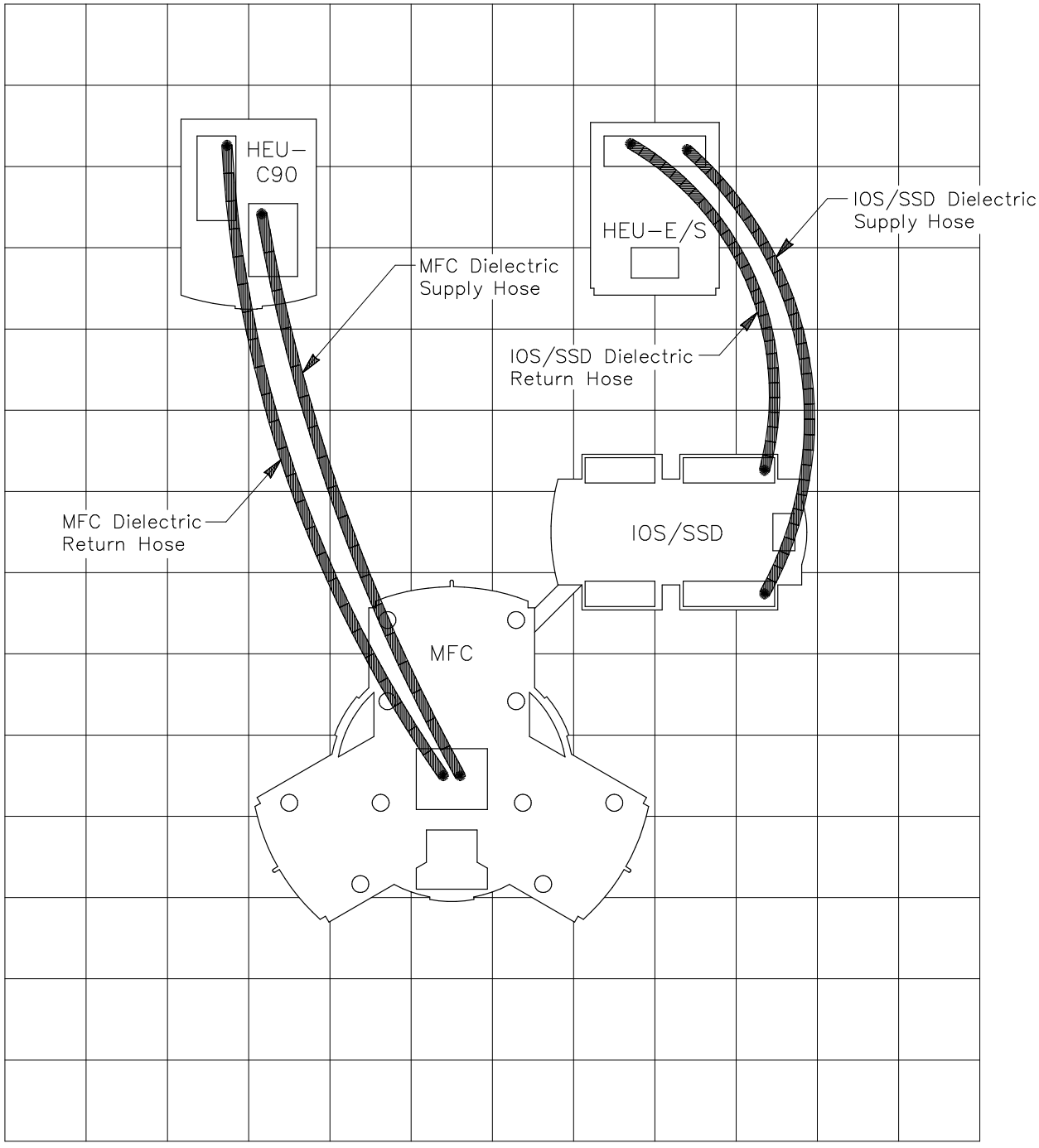


Figure 3-24. CRAY C916 Dielectric-coolant Hoses

Refrigeration Piping

The heat exchanger units are cooled by a refrigerant-cooling technique that uses refrigeration piping to distribute the refrigerant liquid and return the refrigerant vapor to the remote refrigeration condensing units. Your mechanical design engineering staff must prepare working drawings that provide details about planned refrigeration piping.

Approximately 8 weeks prior to the delivery of the computer system, Cray Research will deliver the RCUs and special refrigeration piping component kit to your facility. This kit consists of special manifold assemblies but does not include all refrigeration piping components and materials necessary to prepare the facility.

General Requirements

Figure 3-25 and Figure 3-26 illustrate the refrigeration piping requirements for the heat exchanger units used with the CRAY C916 computer system. You are responsible for installing the special refrigeration components and the RCUs used with your computer system. You must supply and install all piping, couplings, and elbows needed to prepare the facility refrigeration piping for the computer installation. You must also test the refrigeration piping and prepare for final connection before delivery of the computer system.

Cray Research provides *Refrigeration Piping and Component Installation Requirements*, Site Engineering document number 10650228, during the initial site planning meeting. This document describes the required materials, proper installation procedures, leak testing procedures, and evacuation procedures that must be followed by your facility personnel.

At the time of the computer system installation, Cray Research supplies and installs the flexible refrigeration hoses required to complete the refrigeration piping network. In addition, Cray Research installation personnel will charge the refrigeration system, adjust all controls and valves, and apply power to initialize operation of the RCUs. You must supply an adequate amount of Freon R-22 refrigerant to fully charge the system.

The refrigeration piping from the RCUs to the computer equipment must not exceed the total equivalent lineal piping restriction of 100 ft (30.5 m), including directional and elevational changes. Directional changes in pipe routing should be minimal. If directional changes are necessary, the directional changes should be at 45^{o} angles. All refrigeration piping elbows must be the long-radius type.

Changes in pipe routing elevation should also be minimal. When the refrigeration piping must be routed vertically, the vertical rise must not exceed 25 ft (7.6 m). In most instances, an extended vertical rise requires the construction of a double riser within the suction line. In this case, Cray Research site planning personnel provide the preferred design for the double riser.

The following notes provide information additional to Figure 3-25 and Figure 3-26.

- You must supply, route, and install the liquid-line and suction-line piping between the HEUs and the RCUs. These items must conform to Cray Research engineering requirements and must be approved by Cray Research site planning personnel.

- Refrigerant-grade piping components and materials for the refrigeration piping network must be installed in accordance with the requirements illustrated in Figure 3-25, Figure 3-26, and with Cray Research engineering requirements. Any variations of the piping network requirements must be approved by Cray Research site planning personnel.

- Piping support clamps must have a compressible insert between the clamp and the refrigeration piping.

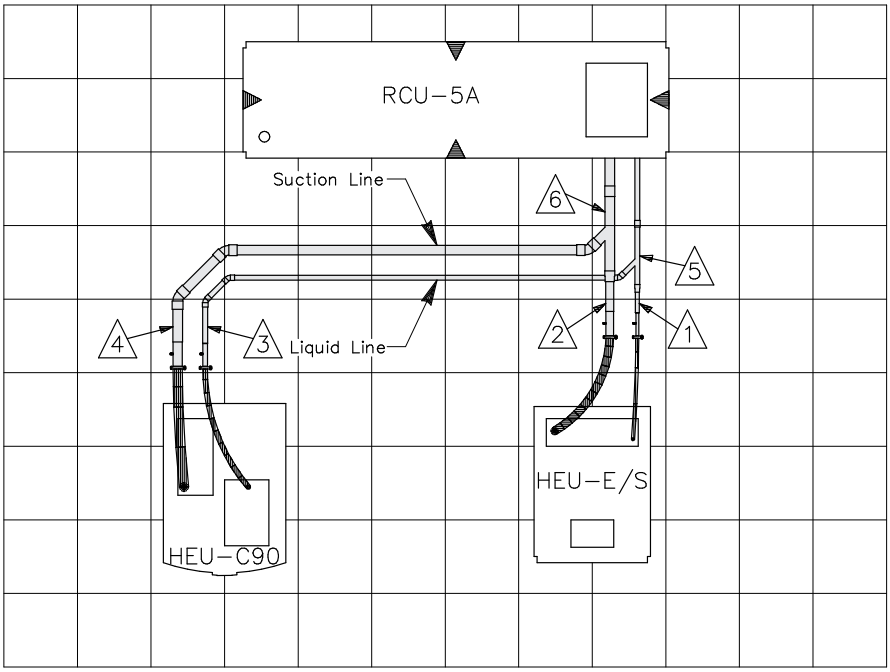
- All refrigeration piping and components must be assembled by you using silver solder and silver soldering techniques according to Cray Research engineering requirements.

- All refrigeration piping and components must be leak tested, evacuated, and prepared for service by you.

- All suction-line piping must be insulated by you after it passes all tests.

Refer to the *Refrigeration Piping and Component Installation Requirements*, Site Engineering document number 10650228, for more information about the installation requirements.

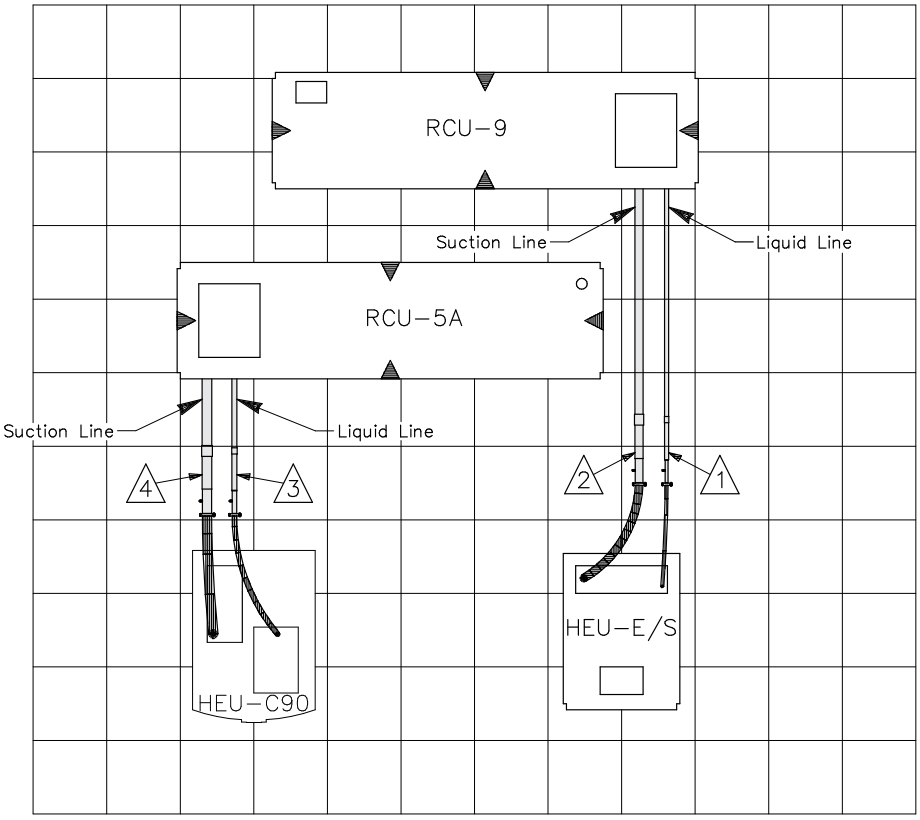
You must supply and install all piping materials, couplings, and elbows needed to interconnect the Cray Research-supplied components. In addition, you must test and prepare the refrigerant and cooling water piping for final connection prior to delivery of the computer system.



NOTES:

1. Liquid Line Flange Assembly, Cray Research part number 12278000
2. Suction Line Flange Assembly, Cray Research part number 12278100
3. Liquid Line Flange Assembly, Cray Research part number 12278200
4. Suction Line Flange Assembly, Cray Research part number 12278300
5. “Y” Fitting, Cray Research part number 12974100
6. “Y” Fitting, Cray Research part number 12974200

Figure 3-25. CRAY C916 Refrigeration Piping for Heat Exchanger Units (60 Hz)



NOTES:

1. Liquid Line Flange Assembly, Cray Research part number 12278000
2. Suction Line Flange Assembly, Cray Research part number 12278100
3. Liquid Line Flange Assembly, Cray Research part number 12278200
4. Suction Line Flange Assembly, Cray Research part number 12278300

Figure 3-26. CRAY C916 Refrigeration Piping for Heat Exchanger Units (50 Hz)

4 CRAY C98 AND CRAY D98 COMPUTER SYSTEMS

Each computer system has slightly different site planning requirements. This section provides detailed site planning information for the CRAY C98 and CRAY D98 computer systems, which includes system configurations, equipment separation limits, specifications, and floor preparation, power wiring, and cooling requirements.

System Configurations

The CRAY C98 and CRAY D98 computer systems consist of a variety of standard and optional equipment. Each computer system has different configurations, depending on customer needs. The following subsections describe the standard equipment and separation limits for a standard CRAY C98 or CRAY D98 computer system.

Standard Equipment

Standard CRAY C98 and CRAY D98 computer systems consist of the following components:

- Mainframe chassis (MFC)
- Heat exchanger unit (HEU-C90)
- Maintenance workstation (MWS)
- Operator workstation (OWS)
- Disk drives and other peripheral equipment
- Motor-generator set (MGS)
- Refrigeration condensing unit (RCU)

The mainframe chassis (MFC) houses various configurations of logic and memory modules. For example, the SSD is optional. If your computer system is not configured with an SSD, the MFC will contain only the mainframe chassis and IOS. This chassis may be upgraded with an SSD.

The CRAY C98 and CRAY D98 computer systems use a heat exchanger unit (HEU-C90) to transfer heat generated by the components in the MFC to the RCU.

Cray Research hardware and software support personnel use the MWS for maintenance and troubleshooting. The OWS is dedicated for your computer operator. Both the MWS and OWS consist of a graphics display terminal (GDT-200), single display table (TBL-3) and a VME-based microcomputer (VBM-2). The MWS and OWS also share a single laser printer (LP-6).

Disk drives and other peripheral equipment are also used with the CRAY C98 and CRAY D98 computer systems. The number of disk drives and other kinds of peripheral equipment depends on individual customer needs. However, a typical CRAY C98 or CRAY D98 computer system disk drive configuration includes disk enclosures (DE-60s and DE-100s) or network disk arrays (ND-12s and ND-14s).

Cray Research offers specially designed front-end interface (FEI) devices that provide a communication link between Cray Research computer systems and other computer systems used in your facility. The two communication mediums used are standard electronic signal wire and fiber-optic cabling. After the type of FEI has been determined, Cray Research will distribute power, cooling, and cabling information.

The CRAY C98 and CRAY D98 computer systems are configured with a single refrigeration condensing unit (RCU-9). This RCU provides cooling for the mainframe.

The CRAY C98 and CRAY D98 computer systems are configured with a single motor-generator set (MGS-4) to provide power to the mainframe. The computer system can also be configured with a standby MGS-4 to provide power in the case of a failure with the normal MGS-4.

Figure 4-1 illustrates a typical computer room floor plan for a CRAY C98 or CRAY D98 computer system. The computer system is configured on a 26 ft x 24 ft (7.9 m x 7.3 m) floor with 24 in. x 24 in. floor panels.

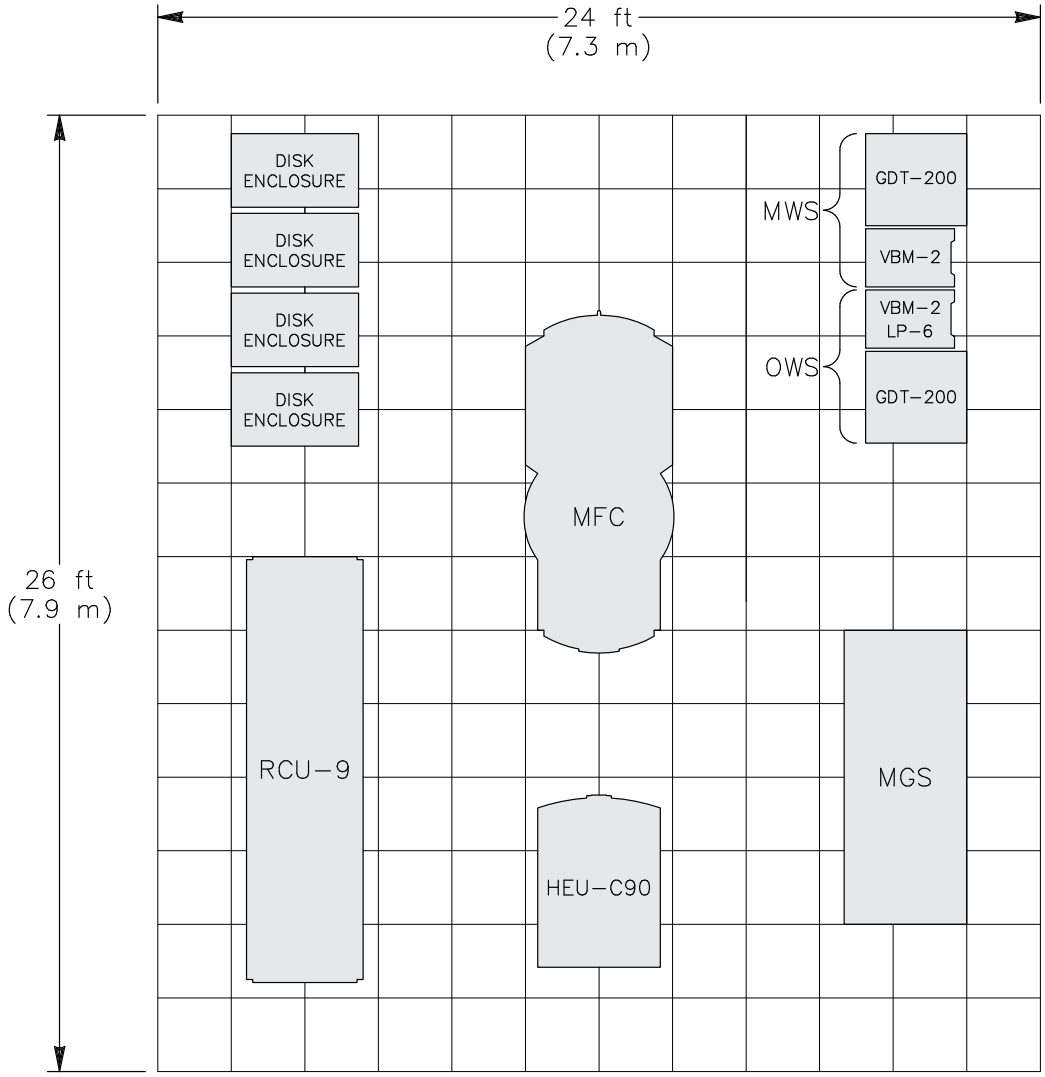


Figure 4-1. CRAY C98 and CRAY D98 Typical Floor Plan

Equipment Separation Limits

The arrangement of computer equipment within the facility must meet certain placement and separation requirements. You must prepare drawings and documents specifying detailed information about the arrangement and location of the computer equipment. These drawings must be reviewed and approved by Cray Research site planning personnel prior to any site preparation. You should involve the site planning personnel early in the design stage.

The following general criteria should be considered when arranging your computer room:

- Personnel safety
- Maximum system performance
- Satisfactory system installation
- Satisfactory operator and maintenance access

All arrangements must meet signal cable and refrigeration piping length restrictions. You should also design the 400-Hz power wiring lengths to minimize voltage drops.

Figure 4-2 illustrates the equipment separation limits for the CRAY C98 and CRAY D98 computer systems.

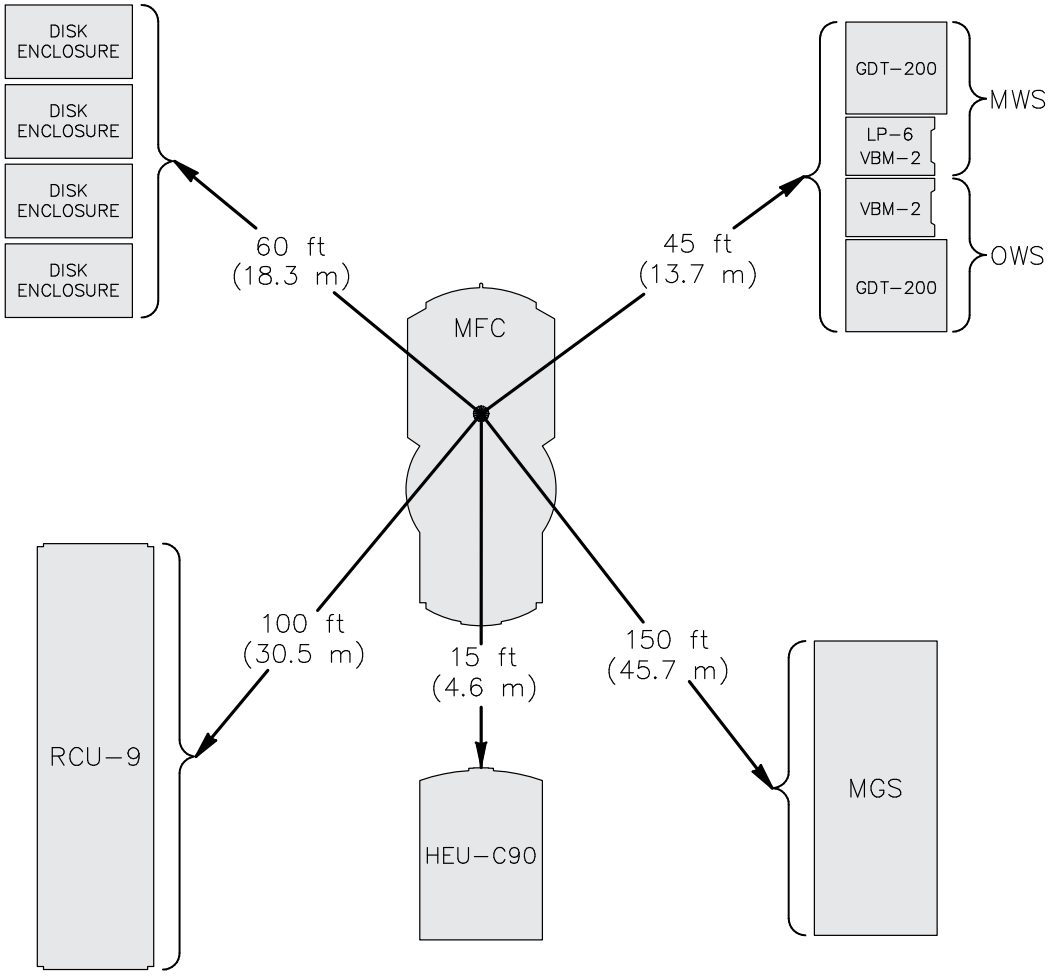


Figure 4-2. CRAY C98 and CRAY D98 Separation Limits

Specifications

This subsection describes the specifications for the mainframe chassis (MFC), the power-supply subassembly, and the heat exchanger unit (HEU-C90). The information in this section is useful when designing the computer room, planning the floor layout, and installing the equipment.

Mainframe Chassis

The CRAY C98 and CRAY D98 mainframe chassis is a dielectric-cooled unit that contains logic modules and power supplies. Table 4-1 provides mainframe chassis specifications for the CRAY C98 and CRAY D98 mainframes. Refer to Figure 4-3 for an illustration of the CRAY C98 and CRAY D98 mainframe chassis.

The mainframe chassis is shipped in two subassemblies: the mainframe subassembly and power-supply subassembly. Refer to Figure 4-4 for an illustration of these subassemblies. Refer to Figure 4-5 for the mainframe subassembly shipping configuration. Refer to Figure 4-6 for the power-supply subassembly shipping configuration.

Table 4-1. CRAY C98 and CRAY D98 Mainframe Chassis Specifications

Characteristic	Specification
Height	85.50 in. (217 cm)
Width	49.00 in. (124 cm)
Depth	112.00 in. (284 cm)
Weight	8,837 lbs (4,008 kg)
Floor loading	368 lbs/ft^2 (1,766 kg/m^2)
Access requirements	36.00 in. (91 cm) on all sides, except module end 60.00 in. (152 cm) on module end
Heat dissipation to air	15.49 kBtu/hr (4.54 kW) maximum
Shipping information: Mainframe subassembly Height Width Depth Weight Power-supply subassembly Height Width Depth Weight	 78.50 in. (199 cm) 113.00 in. (287 cm) 36.00 in. (91 cm) 7,015 lbs (3,181 kg) 78.50 in. (199 cm) 77.00 in. (196 cm) 24.00 in. (61 cm) 2,008 lbs (911 kg)

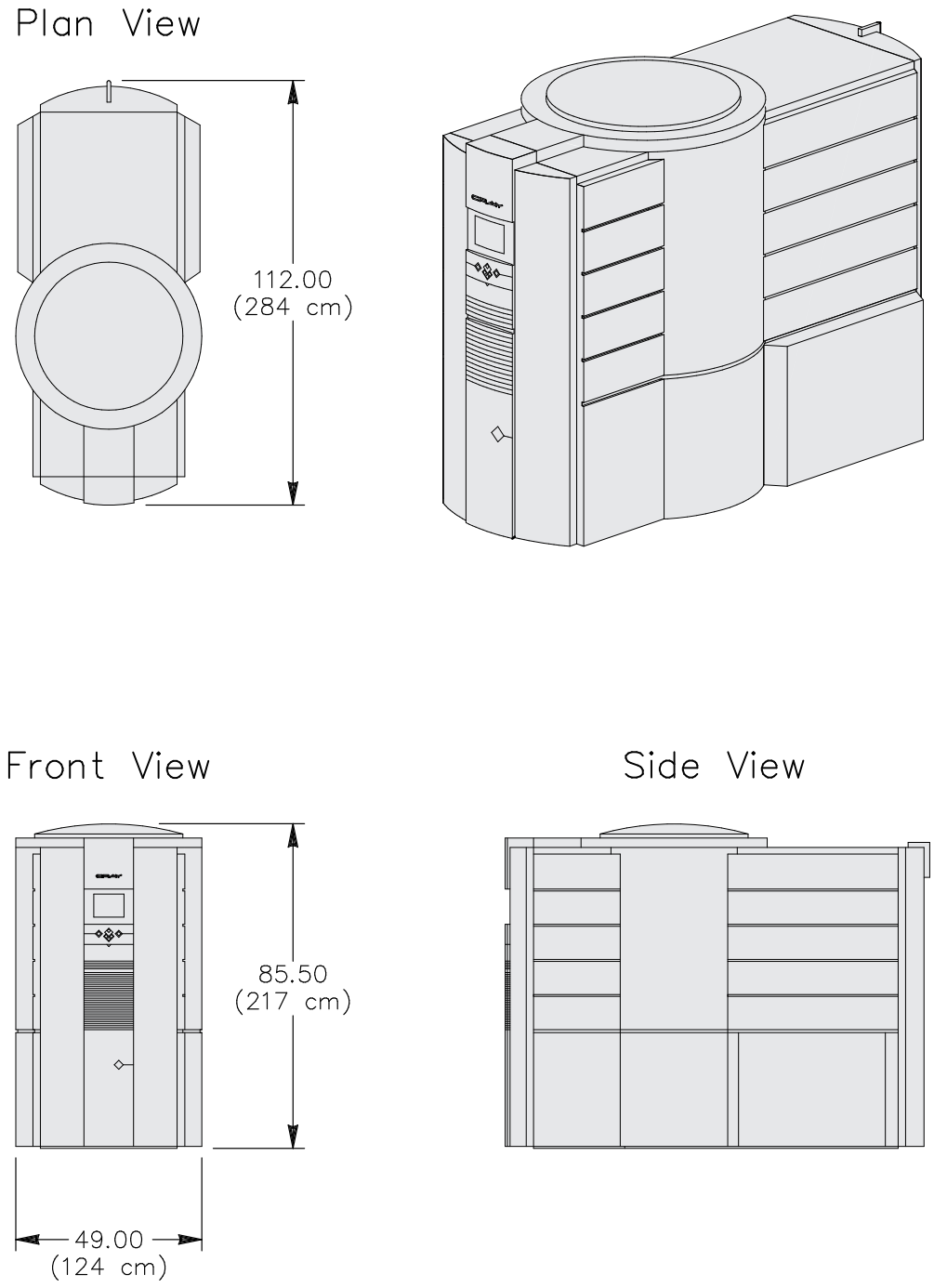


Figure 4-3. CRAY C98 and CRAY D98 Mainframe Chassis

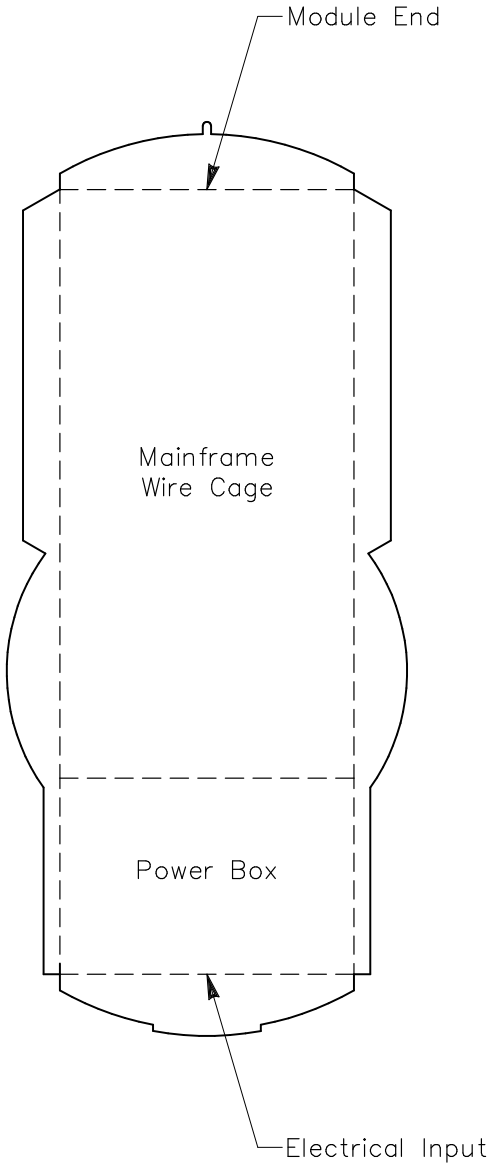


Figure 4-4. CRAY C98 and CRAY D98 Subassemblies

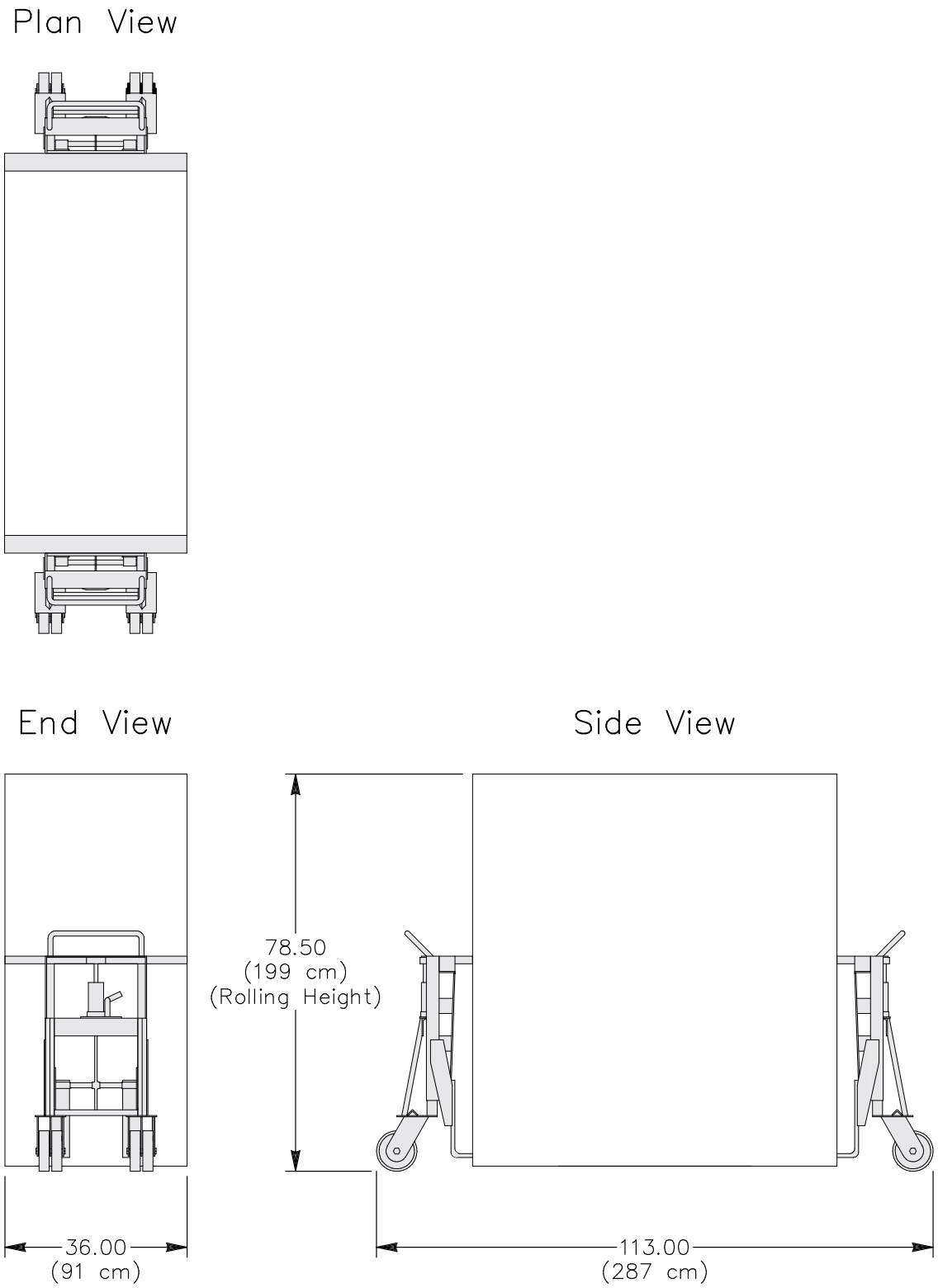


Figure 4-5. CRAY C98 and CRAY D98 Mainframe Subassembly Shipping Configuration

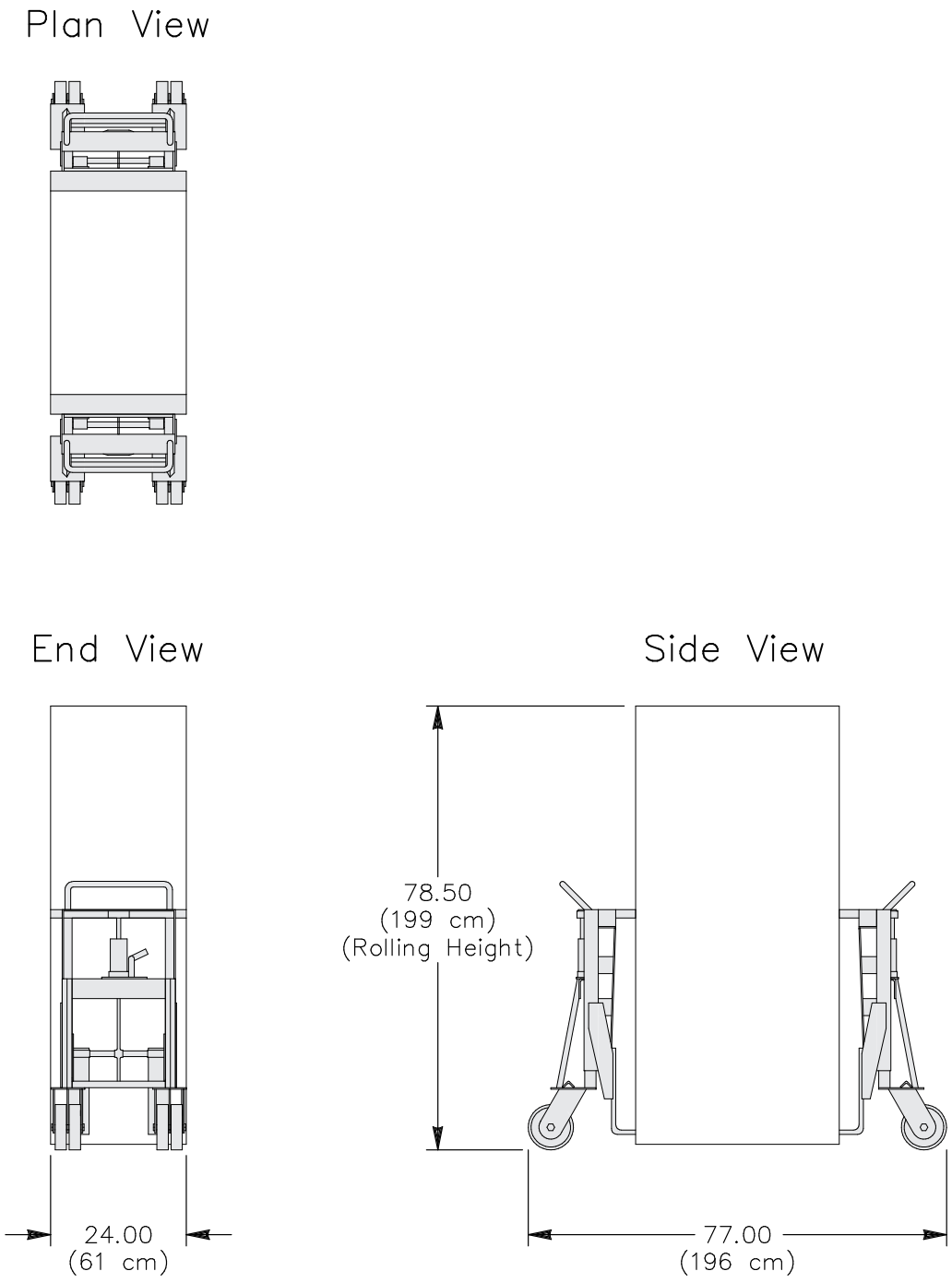


Figure 4-6. CRAY C98 and CRAY D98 Power-supply Subassembly Shipping Configuration

Heat Exchanger Unit (HEU-C90)

The heat exchanger unit (HEU-C90) transfers the heat generated by the mainframe electronic components to the RCU. Table 4-2 provides the specifications for the HEU-C90. Refer to Figure 4-7 for an illustration of the HEU-C90.

Table 4-2. HEU-C90 Specifications

Characteristic		Specification
Height		75.75 in. (192 cm)
Width		40.00 in. (102 cm)
Depth		56.00 in. (142 cm)
Weight		2,086 lbs (946 kg)
Floor loading		174 lbs/ft^2 (849 kg/m^2)
Access requirements		40 in. (102 cm) front 36.00 in. (91 cm) sides 18.00 in. (46 cm) back
Heat dissipation to air		3.92 kBtu/hr (1.15 kW)
Shipping size:	Height Width Depth	74.75 in. (190 cm) 36.00 in. (91 cm) 82.00 in. (208 cm)
Shipping weight		1,515 lbs (687 kg)

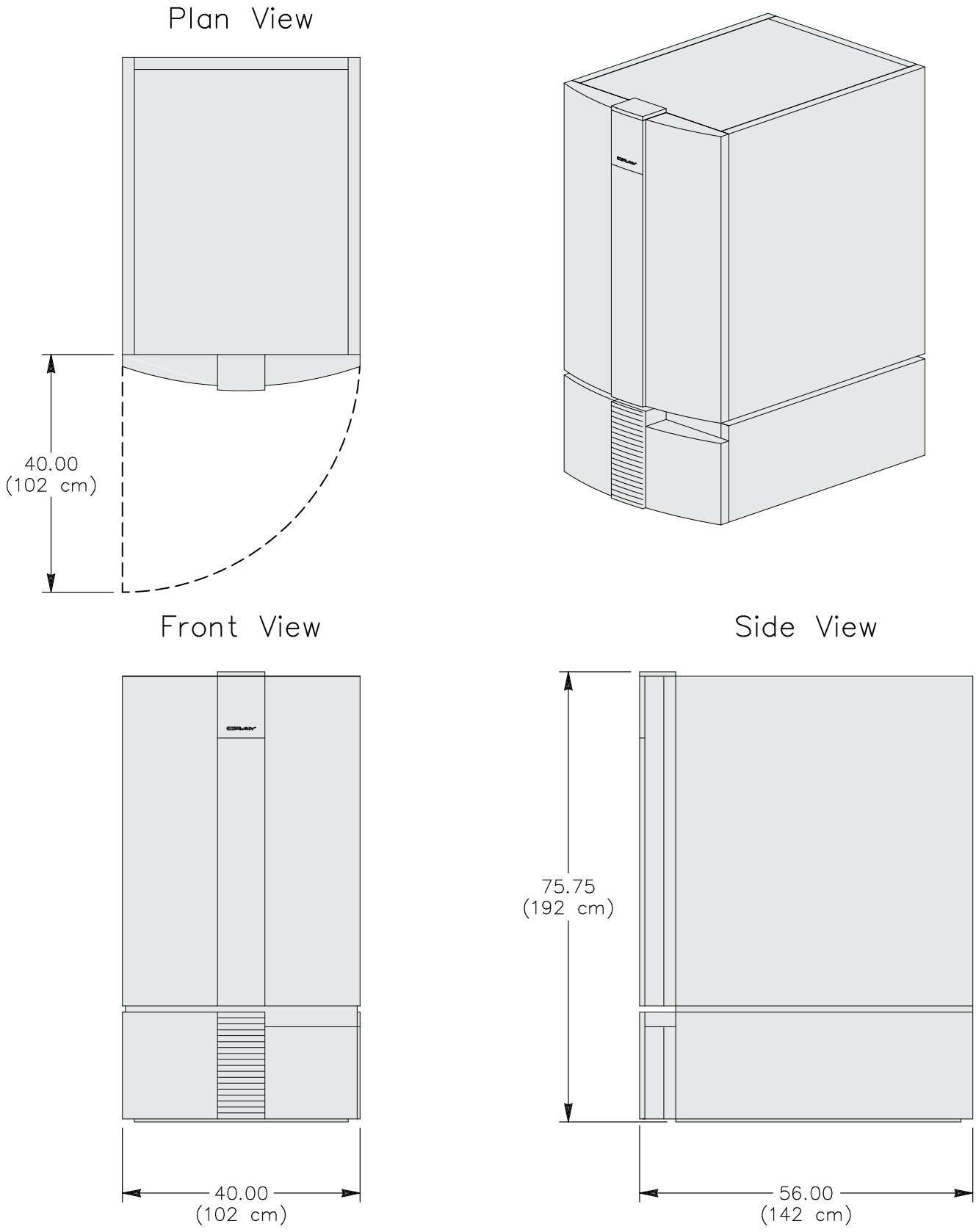


Figure 4-7. Heat Exchanger Unit (HEU-C90)

Floor Preparation

Prior to system delivery, you must prepare the raised floor for the CRAY C98 or CRAY D98 computer system installation. You must prepare the floor cutouts and install the additional floor support pedestals and mainframe support pedestals. This subsection provides the information and diagrams necessary to prepare floor cutouts and floor support pedestals.

Floor cutouts provide an opening for data, power, refrigeration, and dielectric-coolant system connections. The floor cutouts must be free of burrs and sharp edges to prevent damage to these system connections.

NOTE: Cray Research provides full-scale templates used to prepare the MFC and HEU-C90 floor cutouts and to show support pedestal locations.

Mainframe Chassis

You must prepare 10 floor cutouts and install 14 additional floor support pedestals for the MFC. Refer to Figure 4-8 for the location of these floor cutouts.

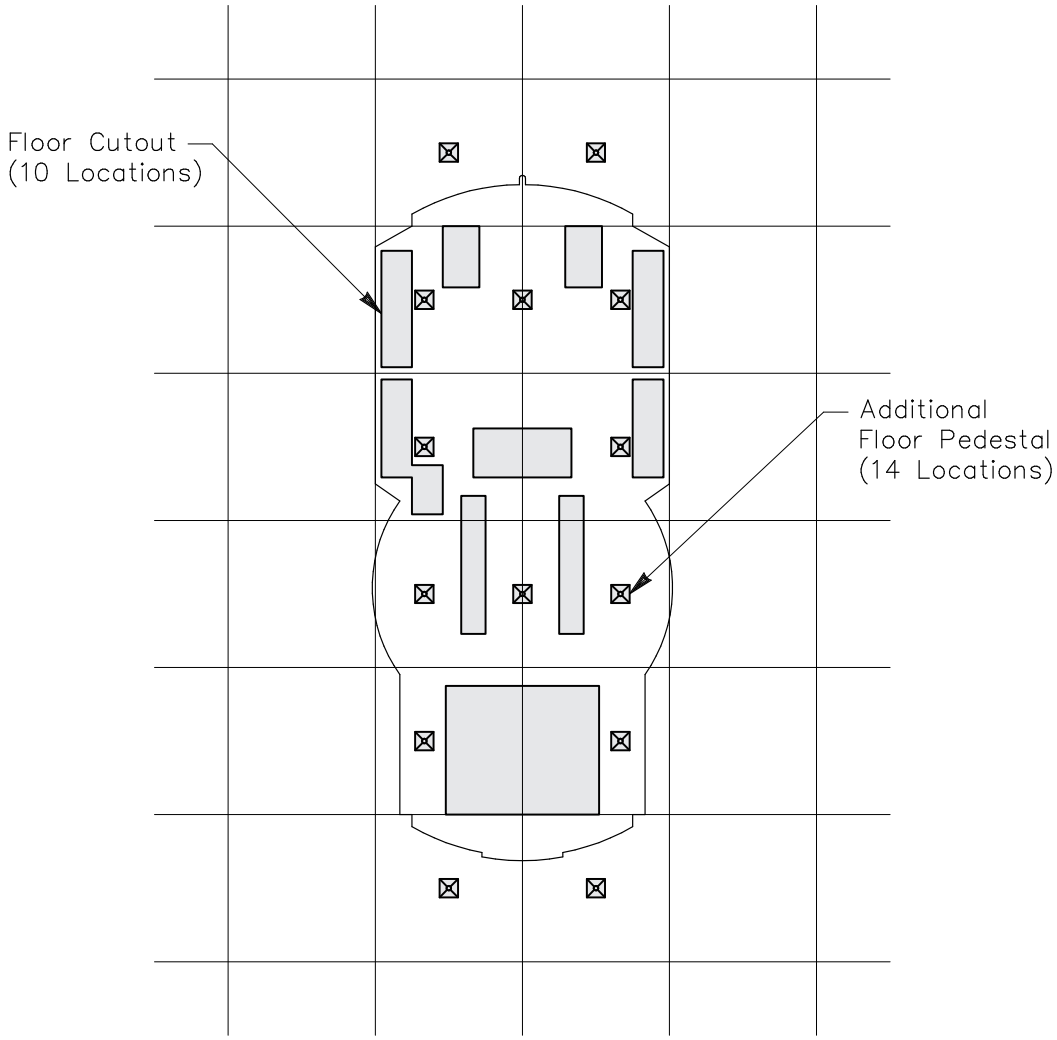


Figure 4-8. CRAY C98 and CRAY D98 Mainframe Chassis Floor Cutouts and Floor Support Pedestals

Heat Exchanger Unit (HEU-C90)

The HEU-C90 requires two floor cutouts for the entrance of refrigeration hoses, dielectric-coolant hoses, and power and control wiring. Refer to Figure 4-9 for an illustration of the floor cutouts for the HEU-C90.

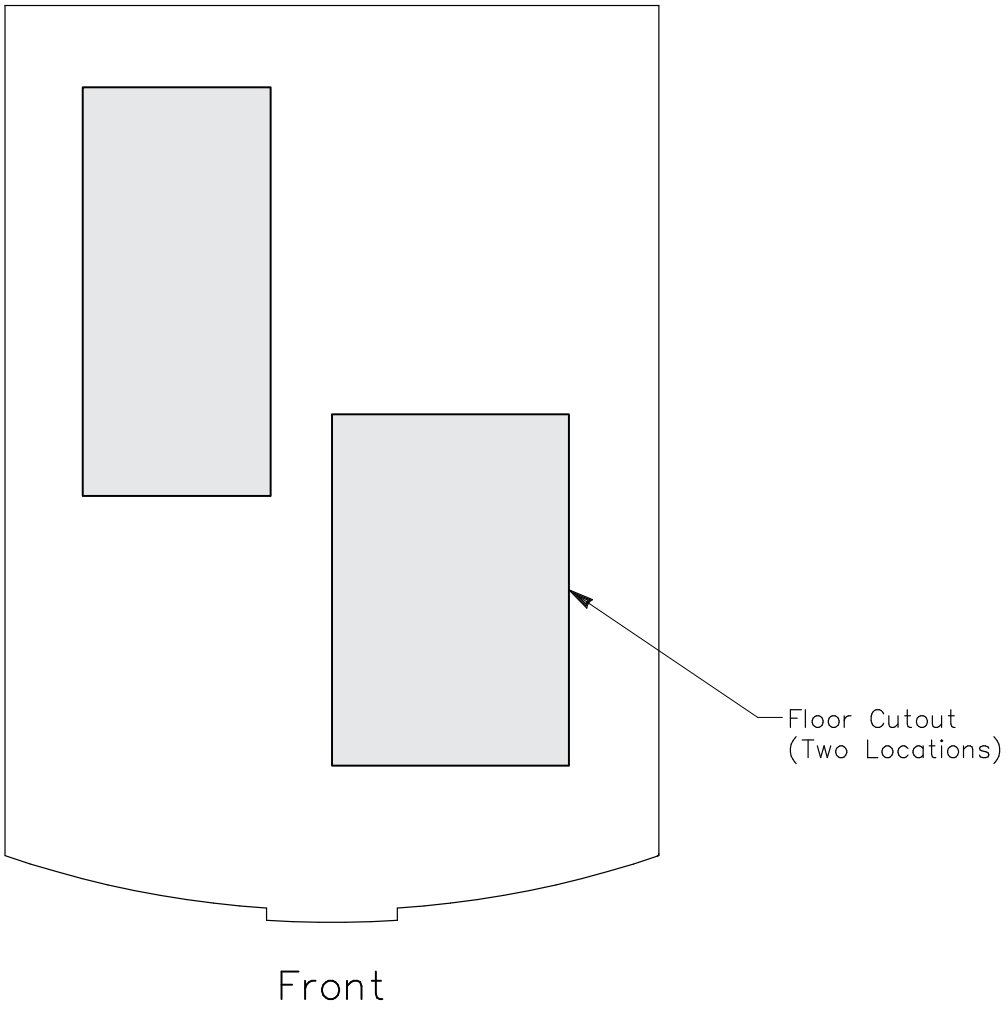


Figure 4-9. HEU-C90 Floor Cutouts

Power Wiring Requirements

You must install all power and control wiring for the mainframe chassis (MFC) and heat exchanger unit (HEU-C90). The following subsections provide general information for all circuits and device-specific requirements.

General Requirements

Each device has specific electrical requirements; however, some general information applies to all circuits. Figure 4-10 illustrates the basic power wiring diagram for the CRAY C98 and CRAY D98 computer systems. Figure 4-11 illustrates the basic control wiring for the CRAY C98 and CRAY D98 computer systems. The following list provides information additional to the block diagrams.

- Figure 4-10 and Figure 4-11 are guides for your electrical design engineer and must not be used as bid documents or working drawings.
- The equipment arrangements shown in Figure 4-10 and Figure 4-11 are not actual equipment layouts.
- All wiring should be prepared according to applicable local and national codes.
- The maximum 400-Hz voltage drop from the MGS to the mainframe chassis (MFC) should not exceed 2%. Verify that the wire sizes and quantity of conductors meet this requirement.
- All circuit breakers, circuit breaker panels, magnetic contactors, main power disconnect switches, junction boxes, power wiring, raceways, and conduits must be provided and installed by you.
- Conduit or raceways used for 400-Hz power distribution must be aluminum or nonferrous.
- Circuit breakers used for 400-Hz power distribution can be 50- or 60-Hz rated, but must be sized for 400-Hz application.
- The minimum suggested control wiring size is #14 AWG (2.5 mm^2).
- Your site preparation design should allow for circuit additions proportionate to system upgrade plans.

- Cray Research recommends the installation of one emergency OFF switch at each computer room exit. All emergency OFF switches should be wired in series and should interrupt power to the computer equipment and to all air-circulating units in the computer room.

- Secure all conduits ending at computer equipment with approved fittings at the equipment wiring entrance.

- Refer to Cray Research-supplied site planning documentation for detailed point-to-point diagrams for all wiring connections to the MFC, HEU, RCU, and MGS.

- Allow a minimum of 36.00 in. (91 cm) of excess wire length above the floor surface to ensure adequate wire length for system connection.

All Cray Research computer equipment must be earth grounded. Refer to the *Equipment Grounding for Cray Research, Inc. Computer Systems*, Site Engineering document number 10658002, for more information about equipment grounding.

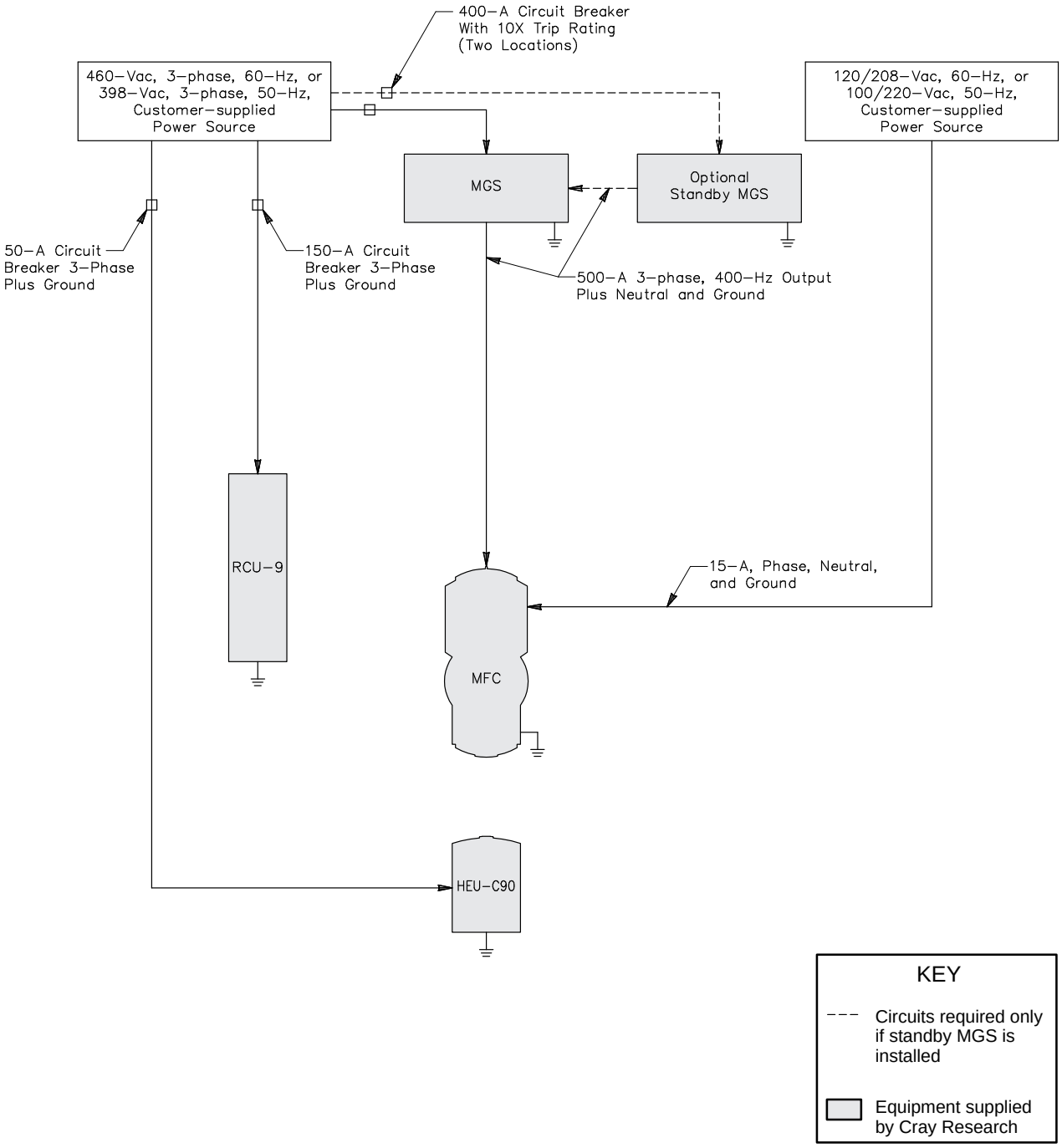


Figure 4-10. CRAY C98 and CRAY D98 Basic Power Wiring

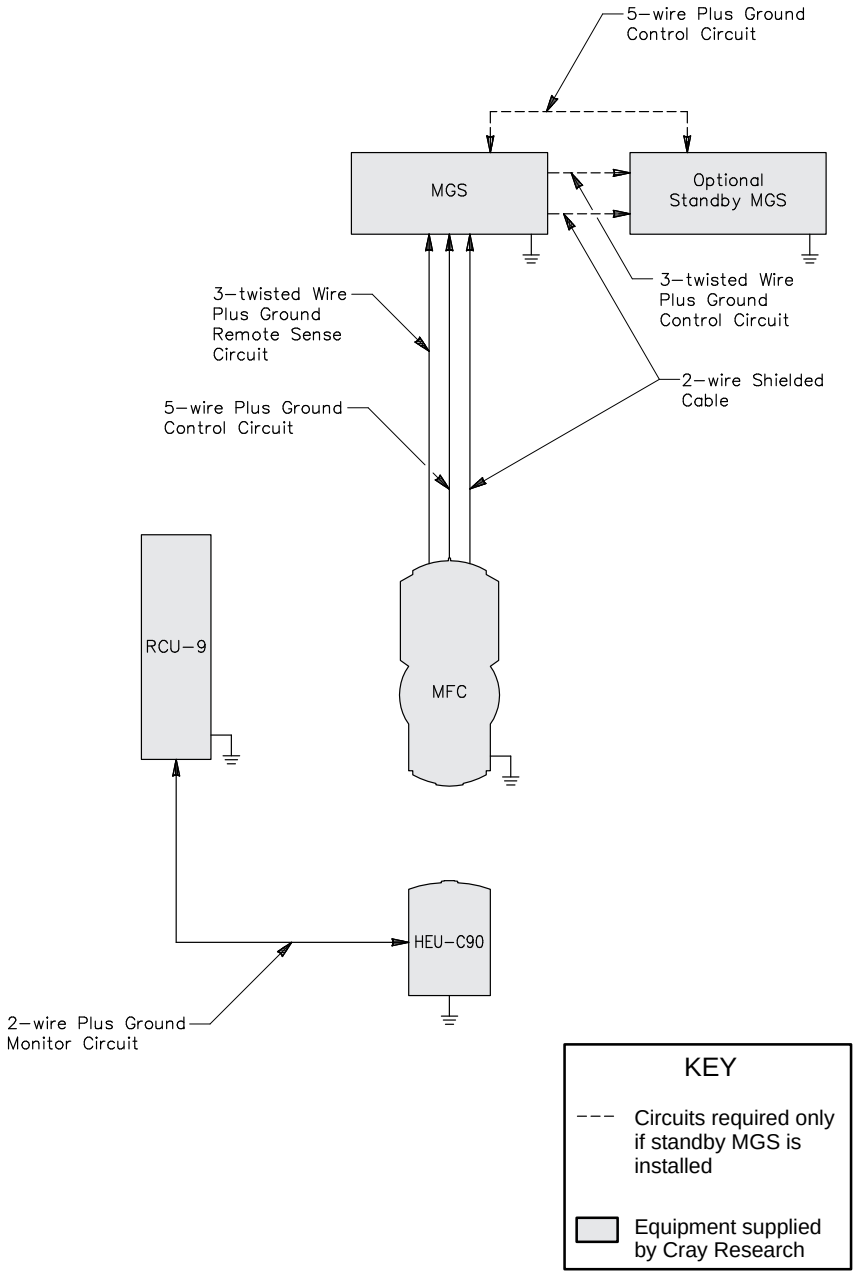


Figure 4-11. CRAY C98 and CRAY D98 Basic Control Wiring

Mainframe Chassis Requirements

You must provide and install the following power and control wiring for the mainframe chassis:

- One 208-Vac, 3-phase (neutral and ground), 400-Hz, 500-A circuit from the MGS to the mainframe chassis

NOTE: To prevent excessive voltage drops, this circuit requires multiple conductors per phase.

- One 120/220-Vac, 50/60-Hz, single-phase, 15-A circuit to the mainframe chassis for control power
- One 5-wire (plus ground) control circuit from the mainframe chassis to the MGS for motor-generator control
- One 2-wire shielded cable (Belden 8720) from the mainframe chassis to the MGS for voltage adjustment
- One 3-twisted wire plus ground circuit to the MGS for remote voltage sensing

Heat Exchanger Unit (HEU-C90) Requirements

You must supply and install the following power and control wiring for the heat exchanger unit (HEU-C90):

- One of the following incoming 3-phase, 4-wire (including ground wire), 50-A circuits to the HEU-C90:
  - 460 Vac, 60 Hz
  - 398 Vac, 50 Hz
- One 2-wire (plus ground) control circuit from the HEU-C90 to the refrigeration condensing unit (RCU-9)

Cooling Requirements

The CRAY C98 and CRAY D98 computer systems use a dielectric-cooling technique that requires special piping and hoses. Dielectric-coolant hoses are required between the heat exchanger unit (HEU-C90) and the mainframe chassis. Refrigeration piping is required between the HEU-C90 and the refrigeration condensing unit (RCU-9). Refer to Section 2, "Operational Requirements," in this manual for more information about cooling water requirements.

Dielectric-coolant Hoses

Flexible hoses are required to complete the dielectric-coolant network between the mainframe chassis and the HEU-C90. Cray Research supplies and installs all flexible hoses for the dielectric coolant during system installation. Figure 4-12 illustrates the standard arrangement of dielectric-coolant hoses for the CRAY C98 and CRAY D98 computer systems.

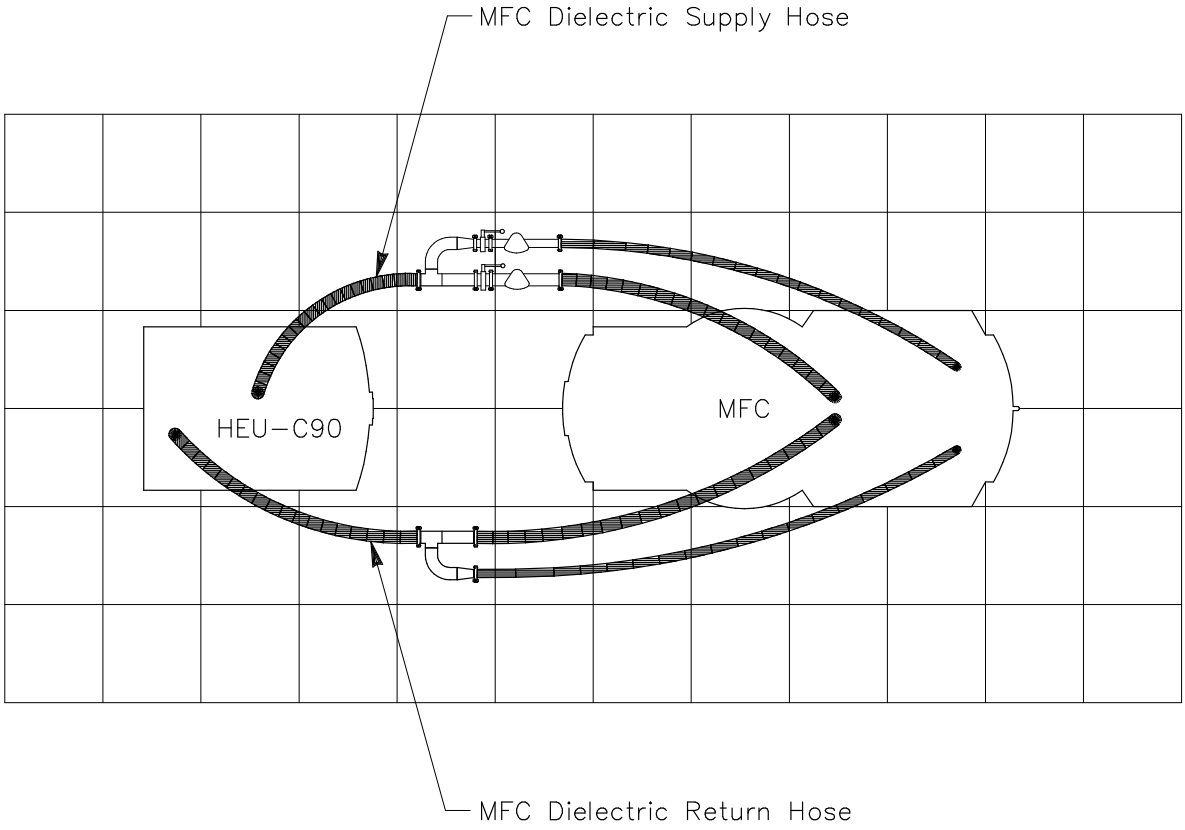


Figure 4-12. CRAY C98 and CRAY D98 Dielectric-coolant Hoses

Refrigeration Piping

The heat exchanger unit is cooled by a refrigerant-cooling technique that uses refrigeration piping to distribute the refrigerant liquid and return the refrigerant vapor to the remote refrigeration condensing units. Your mechanical design engineering staff must prepare working drawings that provide details about planned refrigeration piping.

Approximately 8 weeks prior to the delivery of the computer system, Cray Research will deliver the RCU and special refrigeration piping component kit to your facility. This kit consists of special manifold assemblies but does not include all refrigeration piping components and materials necessary to prepare the facility.

General Requirements

Figure 4-13 illustrates the refrigeration piping requirements for the heat exchanger unit used with the CRAY C98 and CRAY D98 computer systems. You are responsible for installing the special refrigeration components and the RCU used with your computer system. You must supply and install all piping, couplings, and elbows needed to prepare the facility refrigeration piping for the computer installation. You must also test the refrigeration piping and prepare for final connection before delivery of the computer system.

Cray Research provides *Refrigeration Piping and Component Installation Requirements*, Site Engineering document number 10650228, during the initial site planning meeting. This document describes the required materials, proper installation procedures, leak testing procedures, and evacuation procedures that must be followed by your facility personnel.

At the time of the computer system installation, Cray Research supplies and installs the flexible refrigeration hoses required to complete the refrigeration piping network. In addition, Cray Research installation personnel will charge the refrigeration system, adjust all controls and valves, and apply power to initialize operation of the RCU. You must supply an adequate amount of R-22 refrigerant to fully charge the system.

The refrigeration piping from the RCU to the computer equipment must not exceed the total equivalent lineal piping restriction of 100 ft (30.5 m), including directional and elevational changes. Directional changes in pipe routing should be minimal. If directional changes are necessary, the pipes should be routed at 45^{o} angles. All refrigeration piping elbows must be the long-radius type.

Changes in pipe routing elevation should also be minimal. When the refrigeration piping must be routed vertically, the vertical rise must not exceed 25 ft (7.6 m). In most instances, an extended vertical rise requires the construction of a double riser within the suction line. In this case, Cray Research site planning personnel provide the preferred design for the double riser.

The following notes provide information additional to Figure 4-13.

- You must supply, route, and install the liquid-line and suction-line piping between the HEU and the RCU. These items must conform to Cray Research engineering requirements and must be approved by Cray Research site planning personnel.

- Refrigerant-grade piping components and materials for the refrigeration piping network must be installed in accordance with the requirements illustrated in Figure 4-13 and Cray Research engineering requirements. Any variations of the piping network requirements must be approved by Cray Research site planning personnel.

- Piping support clamps must have a compressible insert between the clamp and the refrigeration piping.

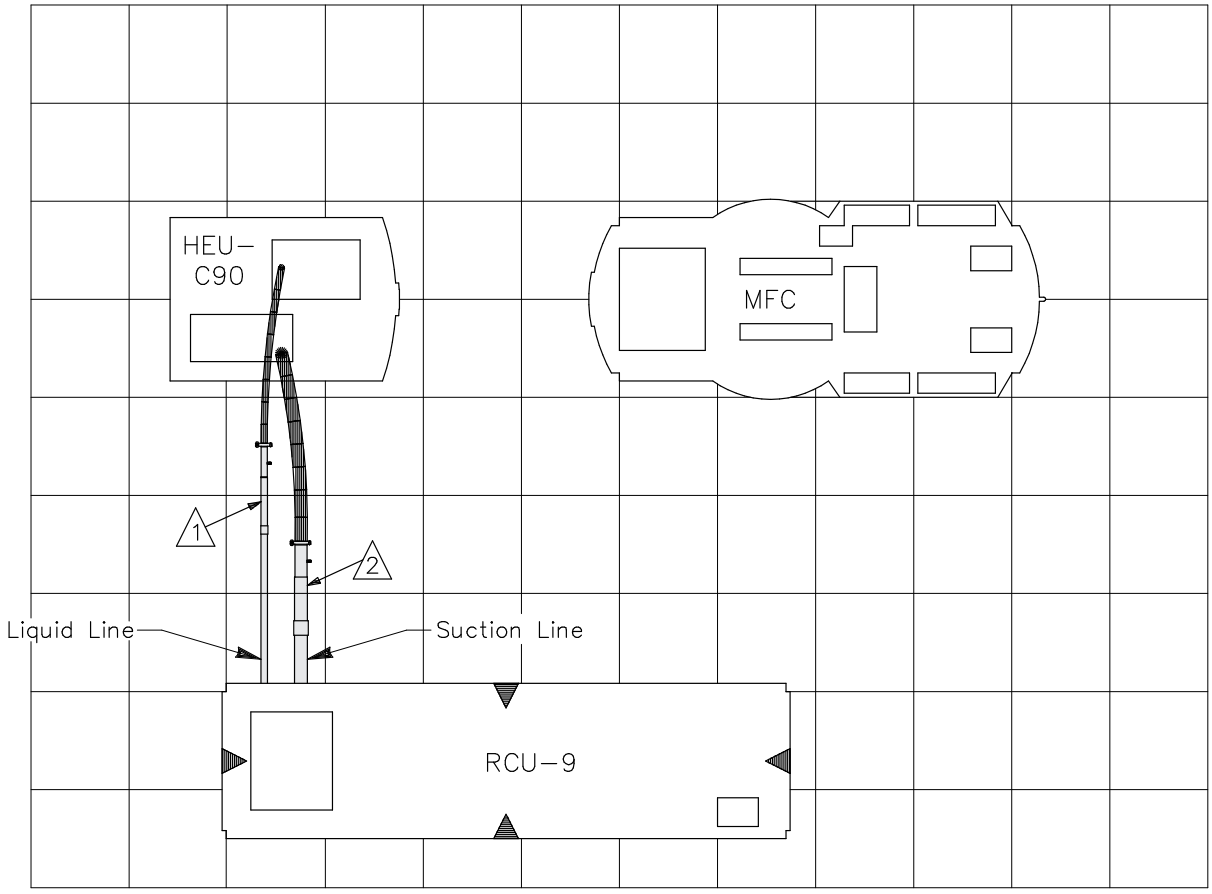
- All refrigeration piping and components must be assembled by you using silver solder and silver soldering techniques according to Cray Research engineering requirements.

- All refrigeration piping and components must be leak tested, evacuated, and prepared for service by you.

- All suction-line piping must be insulated by you after it passes all tests.

Refer to the *Refrigeration Piping and Component Installation Requirements*, Site Engineering document number 10650228, for more information about the installation requirements.

You must supply and install all piping materials, couplings, and elbows needed to interconnect the Cray Research-supplied components. In addition, you must test and prepare the refrigerant and cooling water piping for final connection prior to delivery of the computer system.



NOTES:

1. Liquid Line Flange Assembly, Cray Research part number 12278200
2. Suction Line Flange Assembly, Cray Research part number 12278300

Figure 4-13. CRAY C98 and CRAY D98 Piping Locations for Heat Exchanger Unit

5 CRAY C94 AND CRAY D94 COMPUTER SYSTEMS

Each computer system has slightly different site planning requirements. This section provides detailed site planning information for the CRAY C94 and CRAY D94 computer systems, which includes system configurations, equipment separation limits, specifications, and floor preparation, power wiring, and cooling requirements.

System Configurations

The CRAY C94 and CRAY D94 computer systems consist of a variety of standard and optional equipment. Each computer system has different configurations, depending on customer needs. The following subsections describe the standard equipment and separation limits for standard CRAY C94 and CRAY D94 computer systems.

Standard Equipment

Standard CRAY C94 and CRAY D94 computer systems consist of the following components:

- Mainframe chassis (MFC)
- Heat exchanger unit (HEU-C90)
- Maintenance workstation (MWS)
- Operator workstation (OWS)
- Disk drives and other peripheral equipment
- Motor-generator set (MGS)
- Refrigeration condensing unit (RCU)

The mainframe chassis (MFC) houses various configurations of logic modules. For example, the SSD is optional. If your computer system is not configured with an SSD, the MFC will contain only the mainframe chassis and IOS. This chassis may be upgraded with an SSD.

The CRAY C94 and CRAY D94 computer systems use a heat exchanger unit (HEU-C90), which is connected to the MFC. The HEU transfers heat generated by the components in the MFC to the RCU.

Cray Research hardware and software support personnel use the MWS for maintenance and troubleshooting. The OWS is dedicated for your computer operator. Both the MWS and OWS consist of a graphics display terminal (GDT-200), single display table (TBL-3) and a VME-based microcomputer (VBM-2). The MWS and OWS also share a single laser printer (LP-6).

Disk drives and other peripheral equipment are also used with the CRAY C94 or CRAY D94 computer system. The number of disk drives and other kinds of peripheral equipment depends on individual customer needs. However, a typical CRAY C94 or CRAY D94 computer system disk drive configuration includes disk enclosures (DE-60s and DE-100s) or network disk arrays (ND-12s or ND-14s).

Cray Research offers specially designed front-end interface (FEI) devices that provide a communication link between Cray Research computer systems and other computer systems used in your facility. The two communication mediums used are standard electronic signal wire and fiber-optic cabling. Cray Research will identify the type of FEI configured with your computer system in documentation distributed during the initial site planning meeting.

The CRAY C94 and CRAY D94 computer systems are configured with a single refrigeration condensing unit (RCU-9). This RCU provides cooling for the mainframe.

The CRAY C94 and CRAY D94 computer systems are configured with a single motor-generator set (MGS-4) to provide power to the mainframe. The computer system can also be configured with a standby MGS-4 to provide power in the case the normal MGS-4 fails.

Figure 5-1 illustrates a typical computer room floor plan for a CRAY C94 and CRAY D94 computer systems. The computer system is configured on a 24 ft x 26 ft (7.3 m x 7.9 m) floor with 24 in. x 24 in. floor panels.

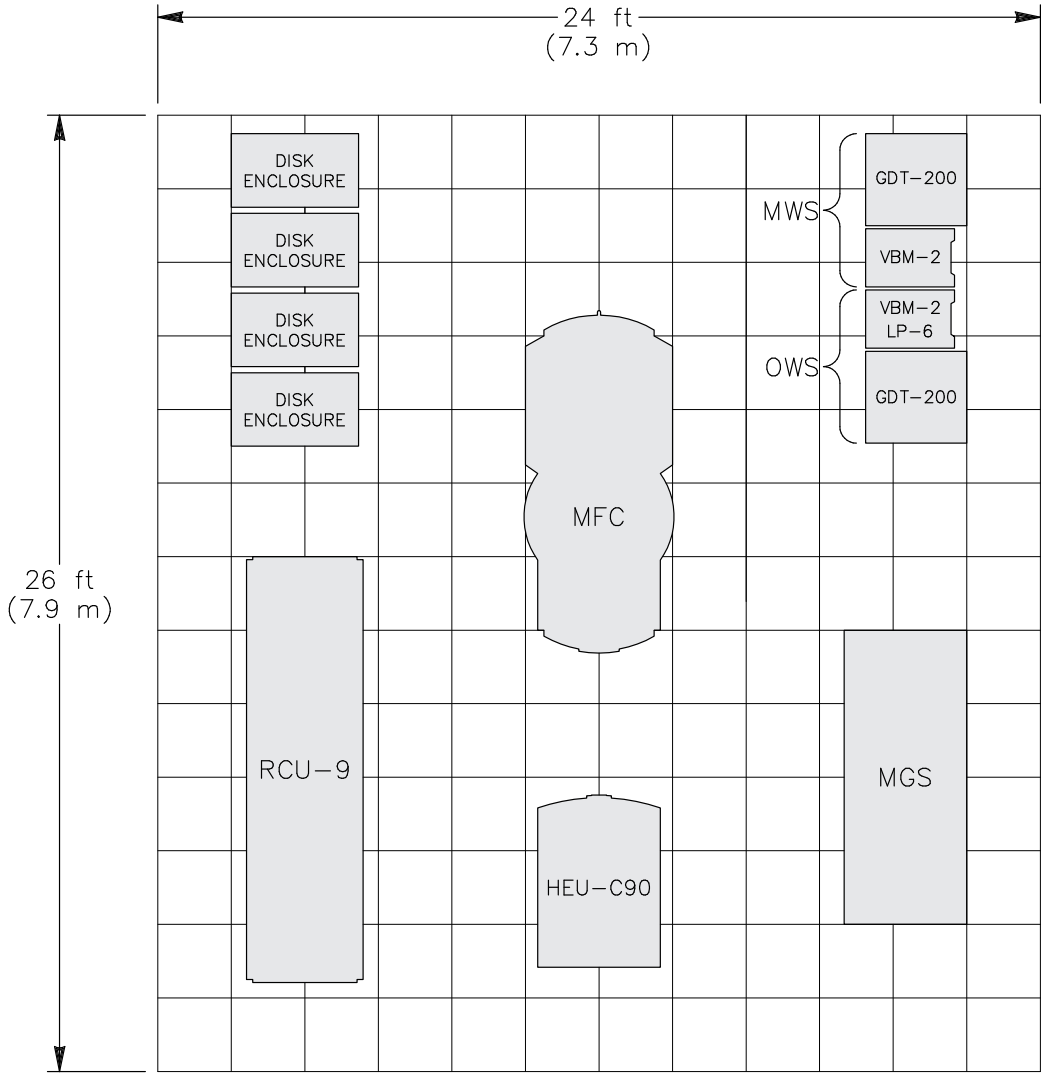


Figure 5-1. CRAY C94 and CRAY D94 Typical Floor Plan

Equipment Separation Limits

The arrangement of computer equipment within the facility must meet certain placement and separation requirements. You must prepare drawings and documents specifying detailed information about the arrangement and location of the computer equipment. These drawings must be reviewed and approved by Cray Research site planning personnel prior to any site preparation. You should involve the site planning personnel early in the design stage.

The following general criteria should be considered when arranging your computer room:

- Personnel safety
- Maximum system performance
- Satisfactory system installation
- Satisfactory operator and maintenance access

All arrangements must comply with signal cable and refrigeration piping length restrictions. You should also design the 400-Hz power wiring lengths to minimize voltage drops.

Figure 5-2 illustrates the equipment separation limits for the CRAY C94 and CRAY D94 computer systems.

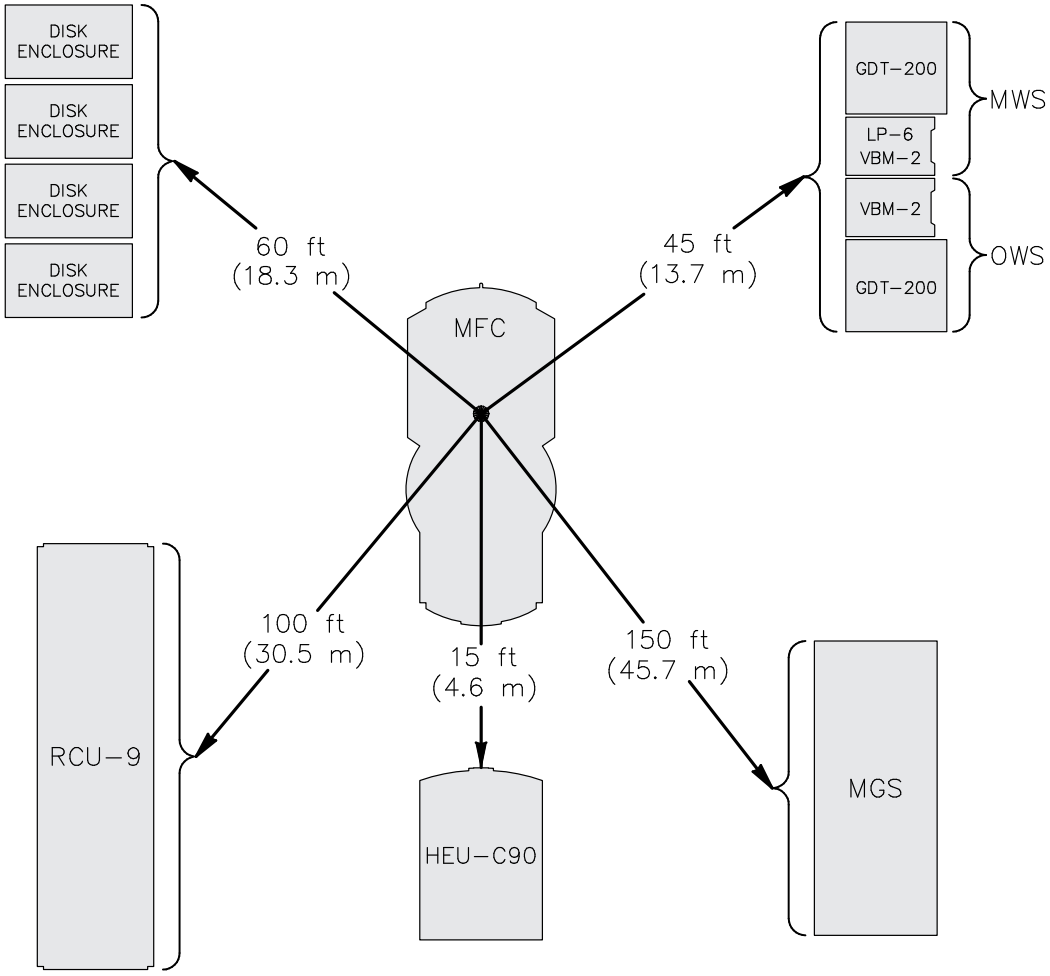


Figure 5-2. CRAY C94 and CRAY D94 Separation Limits

Specifications

This subsection describes the specifications for the mainframe chassis (MFC) and the heat exchanger unit (HEU-C90). The information in this section is useful when designing the computer room, planning the floor layout, and installing the equipment.

Mainframe Chassis

The CRAY C94 and CRAY D94 mainframe chassis is a dielectric-cooled unit that contains logic modules and power supplies. Table 5-1 provides mainframe chassis specifications for the CRAY C94 and CRAY D94 mainframes. Refer to Figure 5-3 for an illustration of the mainframe chassis.

The mainframe chassis is shipped in two subassemblies: the mainframe subassembly and the power supply subassembly. Refer to Figure 5-4 for an illustration of these subassemblies. Refer to Figure 5-5 for the mainframe subassembly shipping configuration. Refer to Figure 5-6 for the power-supply subassembly shipping configuration.

Table 5-1. CRAY C94 and CRAY D94 Mainframe Chassis Specifications

Characteristic	Specification
Height	85.50 in. (217 cm)
Width	49.00 in. (124 cm)
Depth	112.00 in. (284 cm)
Weight	7,997 lbs (3,627 kg)
Floor loading	333 lbs^2/ft^2 (1,625 kg/m^2)
Access requirements	36.00 in. (91 cm) on all sides, except module end 60.00 in. (152 cm) on module end
Heat dissipation to air	10.03 kBtu/hr (2.94 kW)
Shipping information: Mainframe subassembly Height Width Depth Weight Power-supply subassembly Height Width Depth Weight	 78.50 in. (199 cm) 113.00 in. (287 cm) 36.00 in. (91 cm) 6,175 lbs (2,800 kg) 78.50 in. (199 cm) 77.00 in. (196 cm) 24.00 in. (61 cm) 2,008 lbs (911 kg)

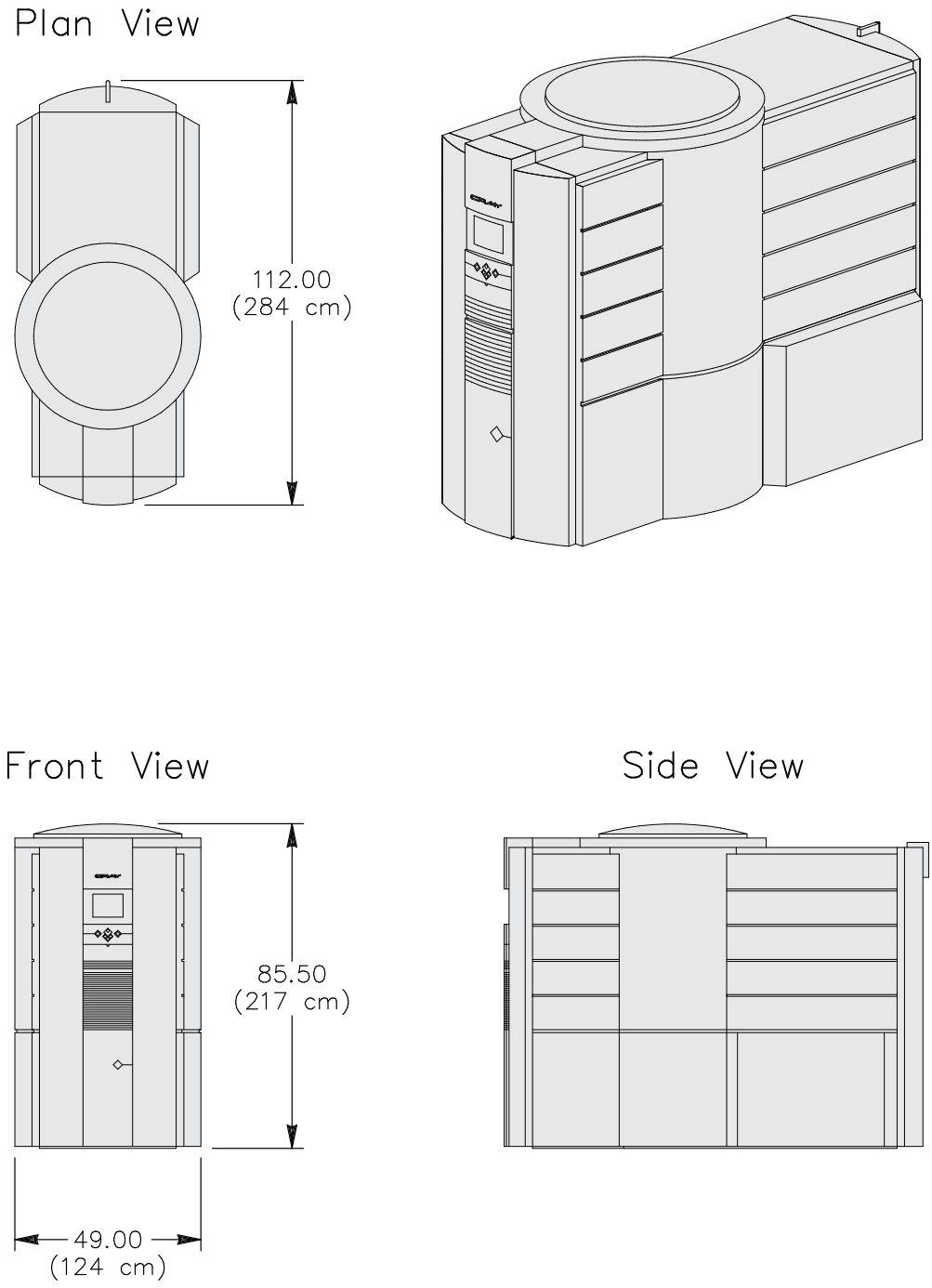


Figure 5-3. CRAY C94 and CRAY D94 Mainframe Chassis

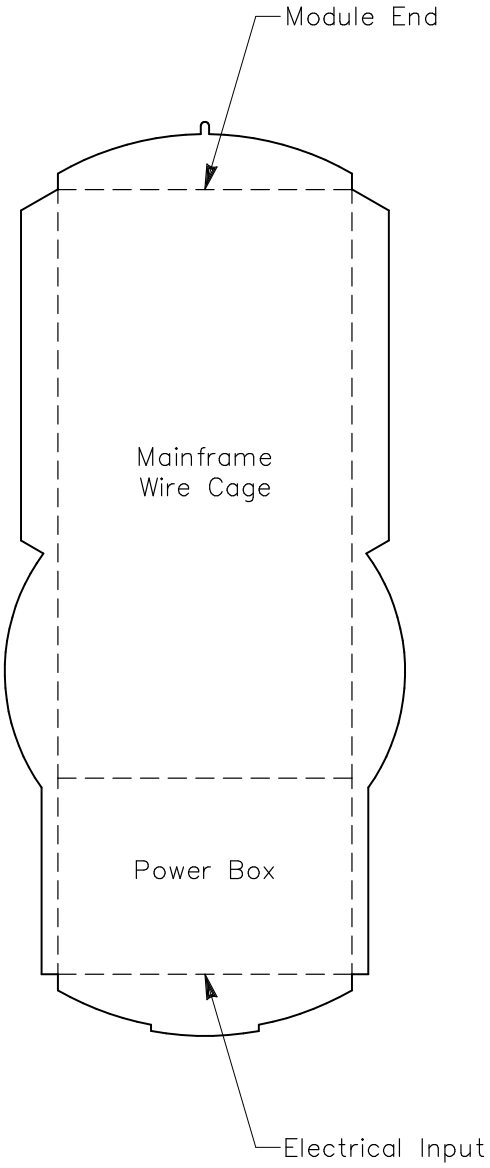


Figure 5-4. CRAY C94 and CRAY D94 Subassemblies

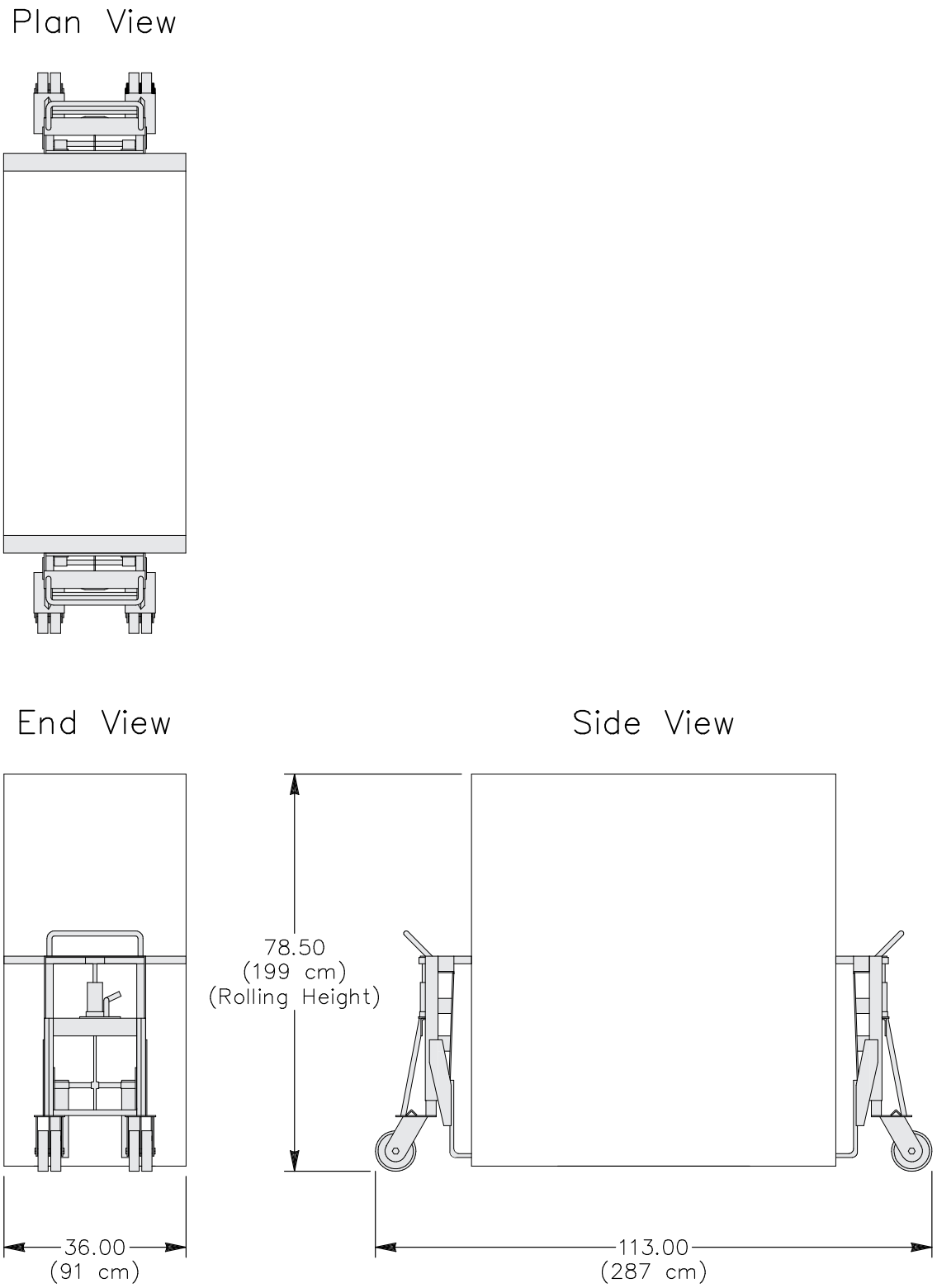


Figure 5-5. CRAY C94 and CRAY D94 Mainframe Subassembly Shipping Configuration

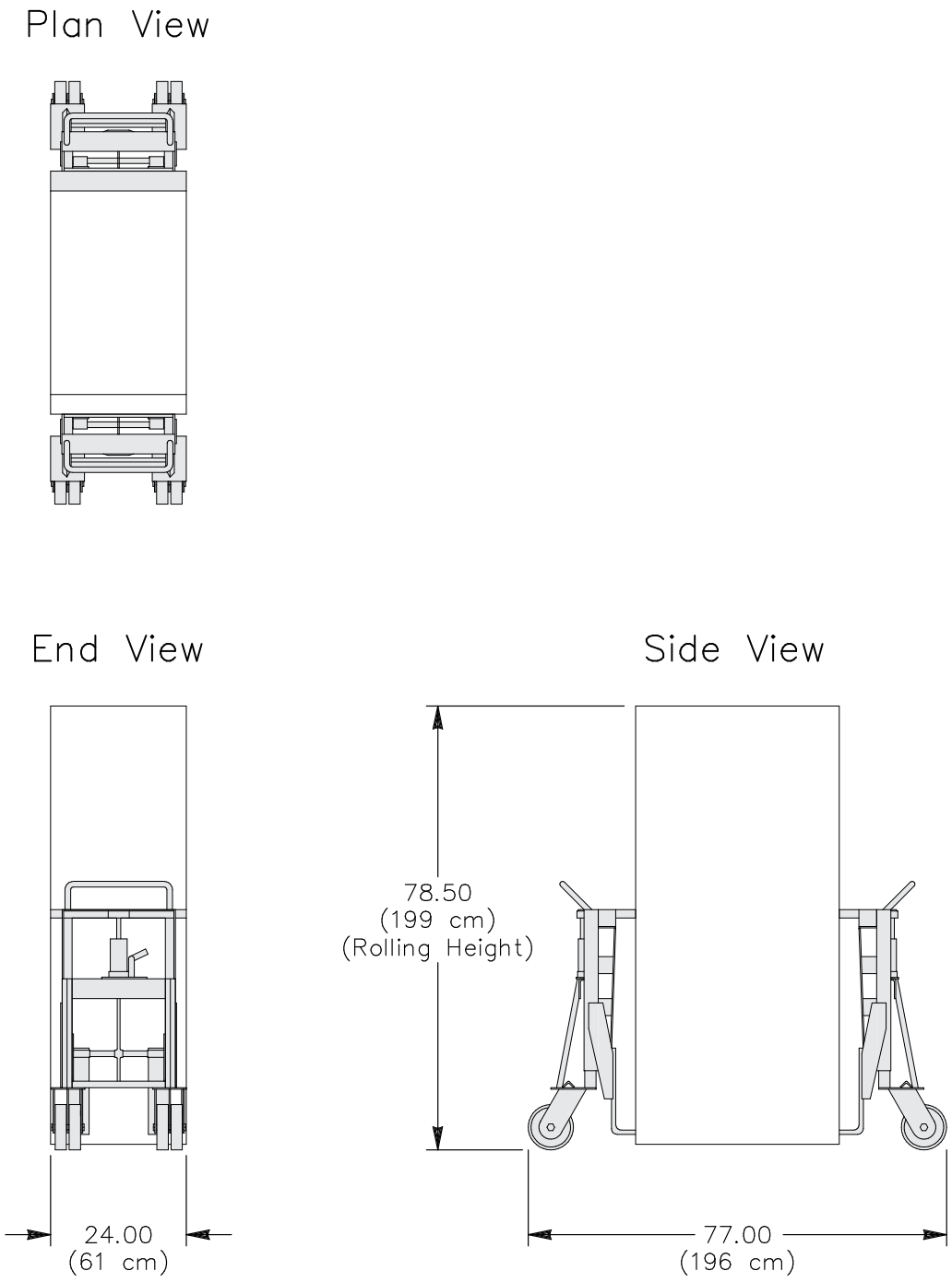


Figure 5-6. CRAY C94 and CRAY D94 Power-supply Subassembly Shipping Configuration

Heat Exchanger Unit (HEU-C90)

The heat exchanger unit (HEU-C90) transfers the heat generated by the mainframe electronic components to the RCU. Table 5-2 provides the specifications for the HEU-C90. Refer to Figure 5-7 for an illustration of the HEU-C90.

Table 5-2. HEU-C90 Specifications

Characteristic		Specification
Height		75.75 in. (192 cm)
Width		40.00 in. (102 cm)
Depth		56.00 in. (142 cm)
Weight		2,086 lbs (946 kg)
Floor loading		174 lbs/ft^2 (849 kg/m^2)
Access requirements		40 in. (102 cm) front 36.00 in. (91 cm) sides 18.00 in. (46 cm) back
Heat dissipation to air		3.92 kBtu/hr (1.15 kW)
Shipping size:	Height Width Depth	74.75 in. (190 cm) 36.00 in. (91 cm) 82.00 in. (208 cm)
Shipping weight		1,515 lbs (687 kg)

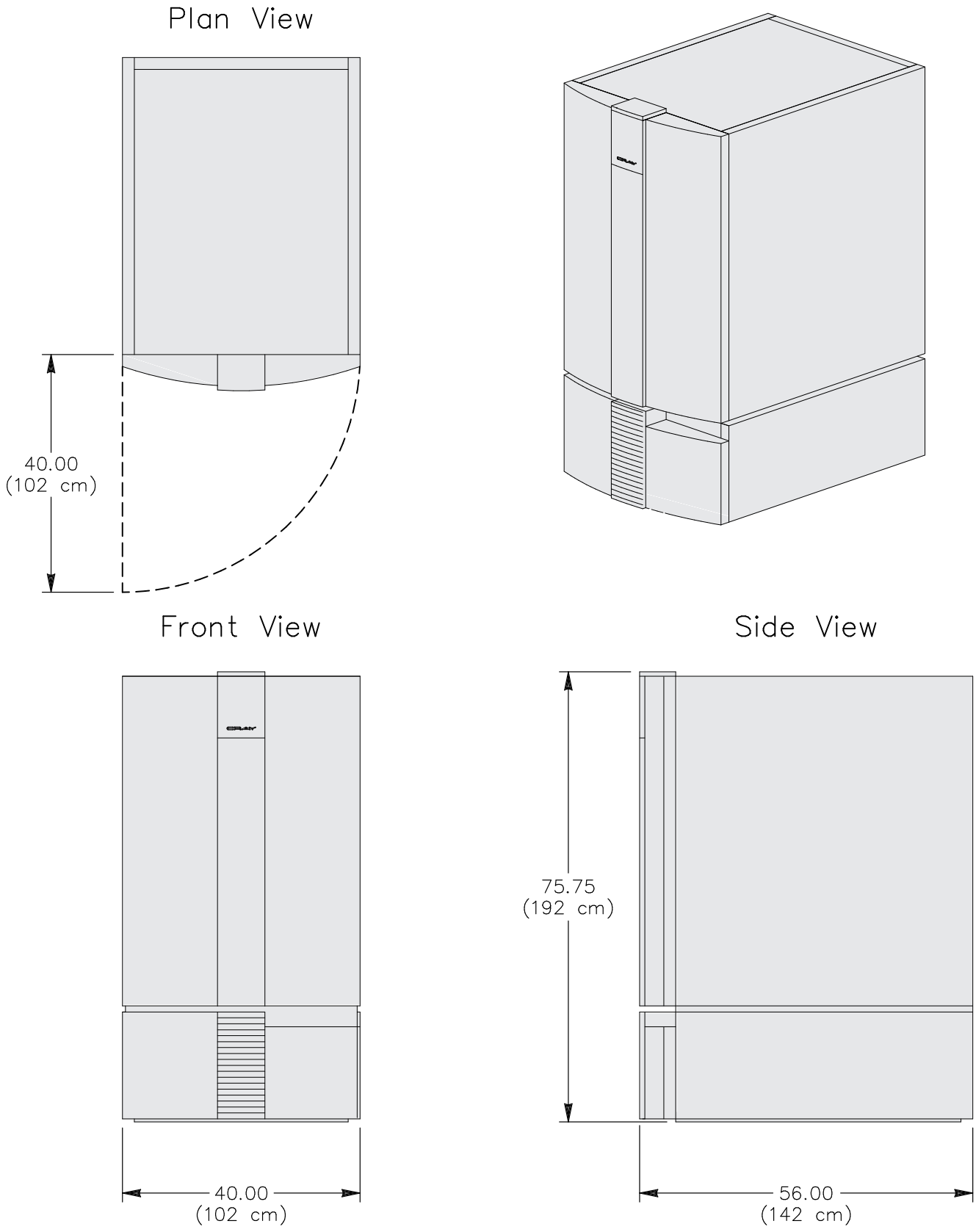


Figure 5-7. Heat Exchanger Unit (HEU-C90)

Floor Preparation

Prior to system delivery, you must prepare the raised floor for the CRAY C94 and CRAY D94 computer system installations. You must prepare the floor cutouts and install the additional floor support pedestals. This subsection provides the information and diagrams necessary to prepare floor cutouts and additional floor support pedestals.

Floor cutouts provide an opening for data, power, refrigeration, and dielectric-coolant system connections. The floor cutouts must be free of burrs and sharp edges to prevent damage to these system connections.

NOTE: Cray Research provides full-scale templates used to prepare the MFC and HEU-C90 floor cutouts and to show support pedestal locations.

Mainframe Chassis

You must prepare 10 floor cutouts and install 14 additional floor support pedestals for the MFC. Refer to Figure 5-8 for the location of these floor cutouts and additional floor support pedestals.

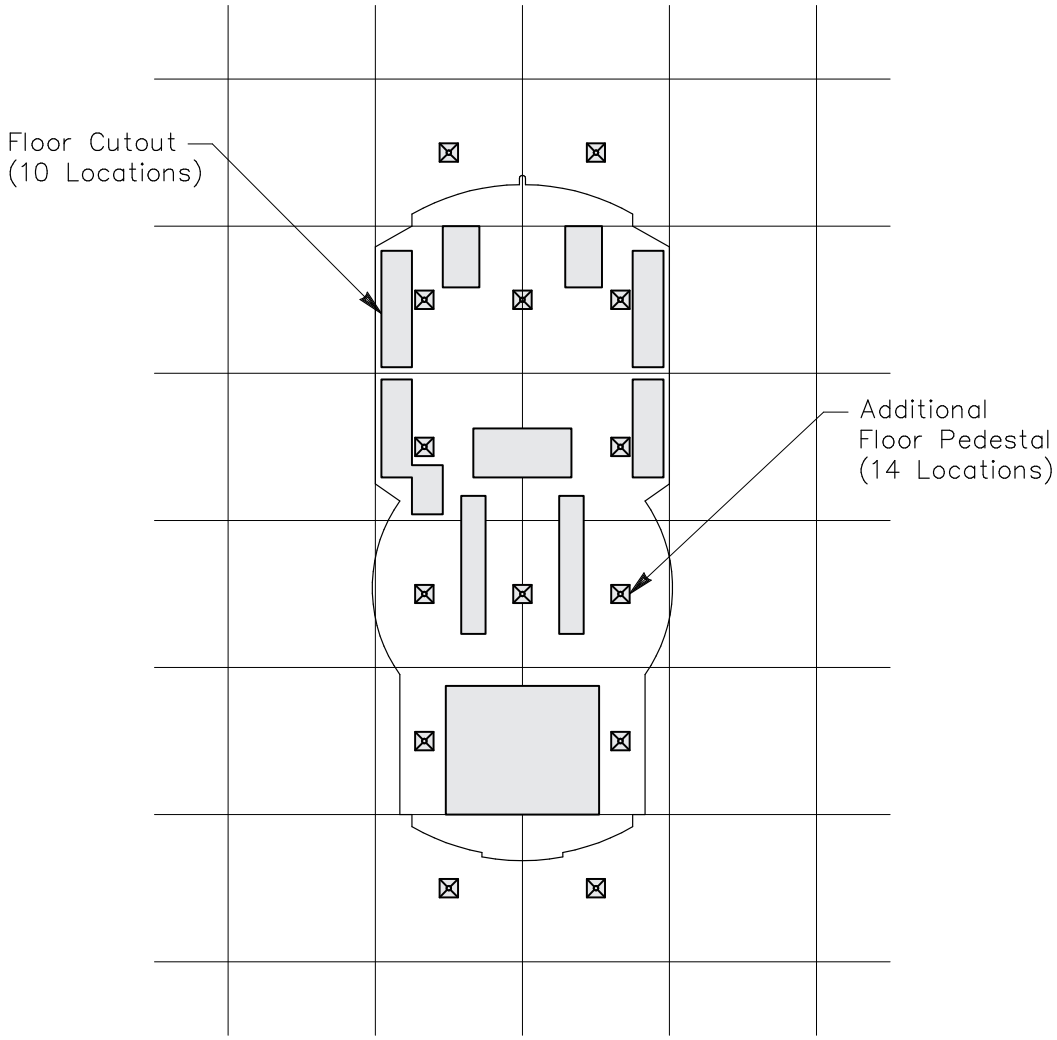


Figure 5-8. CRAY C94 and CRAY D94 Mainframe Chassis Floor Cutouts and Floor Support Pedestals

Heat Exchanger Unit (HEU-C90)

The HEU-C90 requires two floor cutouts for the entrance of refrigeration hoses, dielectric-coolant hoses, and power and control wiring. Refer to Figure 5-9 for an illustration of the floor cutouts for the HEU-C90.

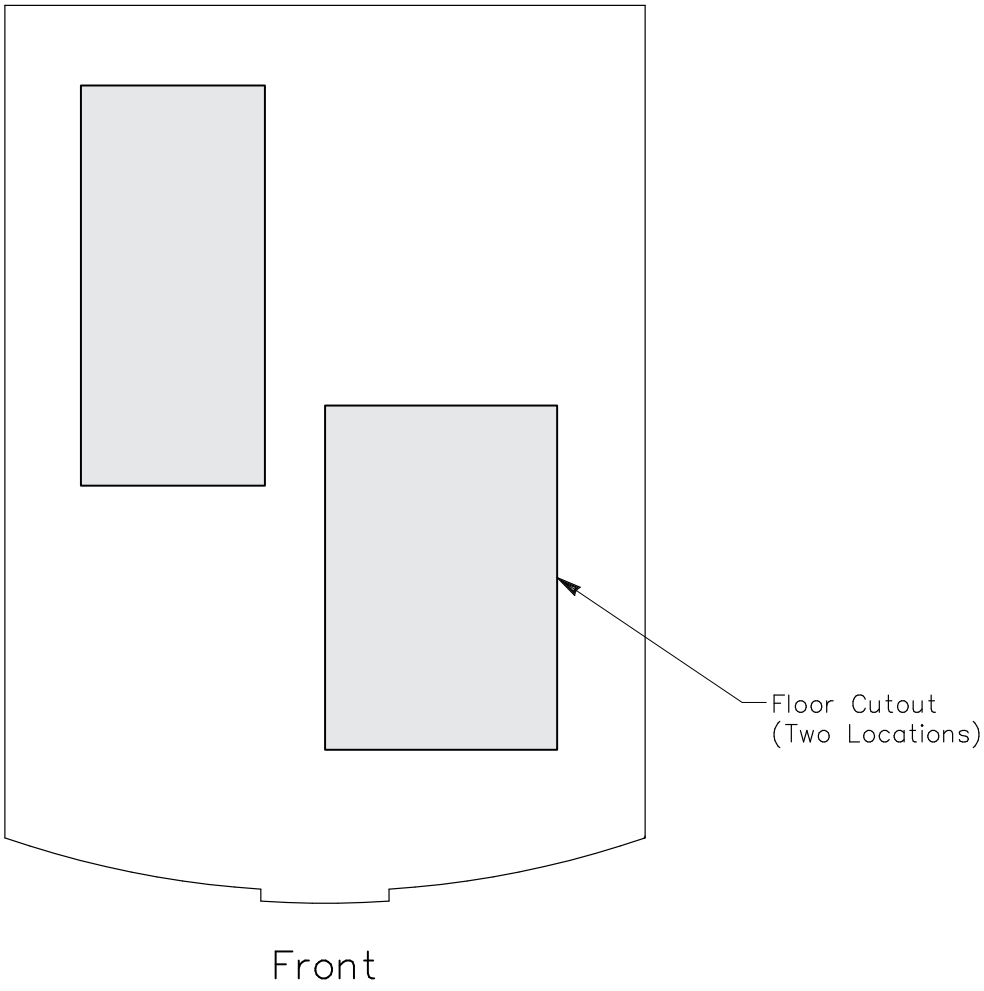


Figure 5-9. HEU-C90 Floor Cutouts

Power Wiring Requirements

You must install all power and control wiring for the mainframe chassis (MFC) and heat exchanger unit (HEU-C90). The following subsections provide general information for all circuits and device-specific requirements.

General Requirements

Each device has specific electrical requirements; however, some general information applies to all circuits. Figure 5-10 illustrates the basic power wiring diagram for the CRAY C94 and CRAY D94 computer systems. Figure 5-11 illustrates the basic control wiring for the CRAY C94 and CRAY D94 computer systems. The following list provides information additional to the block diagrams:

- Figure 5-10 and Figure 5-11 are guides for your electrical design engineer and must not be used as bid documents or working drawings.
- The equipment arrangements shown in Figure 5-10 and Figure 5-11 are not actual equipment layouts.
- All wiring should be prepared according to applicable local and national codes.
- The maximum 400-Hz voltage drop from the MGSs to the mainframe chassis (MFC) should not exceed 2%. Verify that the wire sizes and quantity of conductors meet this requirement.
- All circuit breakers, circuit breaker panels, magnetic contactors, main power disconnect switches, junction boxes, power wiring, raceways, and conduits must be provided and installed by you.
- Conduit or raceways used for 400-Hz power distribution must be aluminum or nonferrous.
- Circuit breakers used for 400-Hz power distribution can be 50- or 60-Hz rated, but must be sized for 400-Hz application.
- The minimum suggested control wiring size is #14 AWG (2.5 mm^2).
- Your site preparation design should allow for circuit additions proportionate to system upgrade plans.

- Cray Research recommends the installation of one emergency OFF switch at each computer room exit. All emergency OFF switches should be wired in series and should interrupt power to the computer equipment and to all air-circulating units in the computer room.

- Secure all conduits ending at computer equipment with approved fittings at the equipment wiring entrance.

- Refer to Cray Research-supplied site planning documentation for detailed point-to-point diagrams for all wiring connections to the MFC, HEU, RCU, and MGS.

- Allow a minimum of 36.00 in. (91 cm) of excess wire length above the floor surface to ensure adequate wire length for system connection.

All Cray Research computer equipment must be earth grounded. Refer to the *Equipment Grounding for Cray Research, Inc. Computer Systems*, Site Engineering document number 10658002, for more information about equipment grounding.

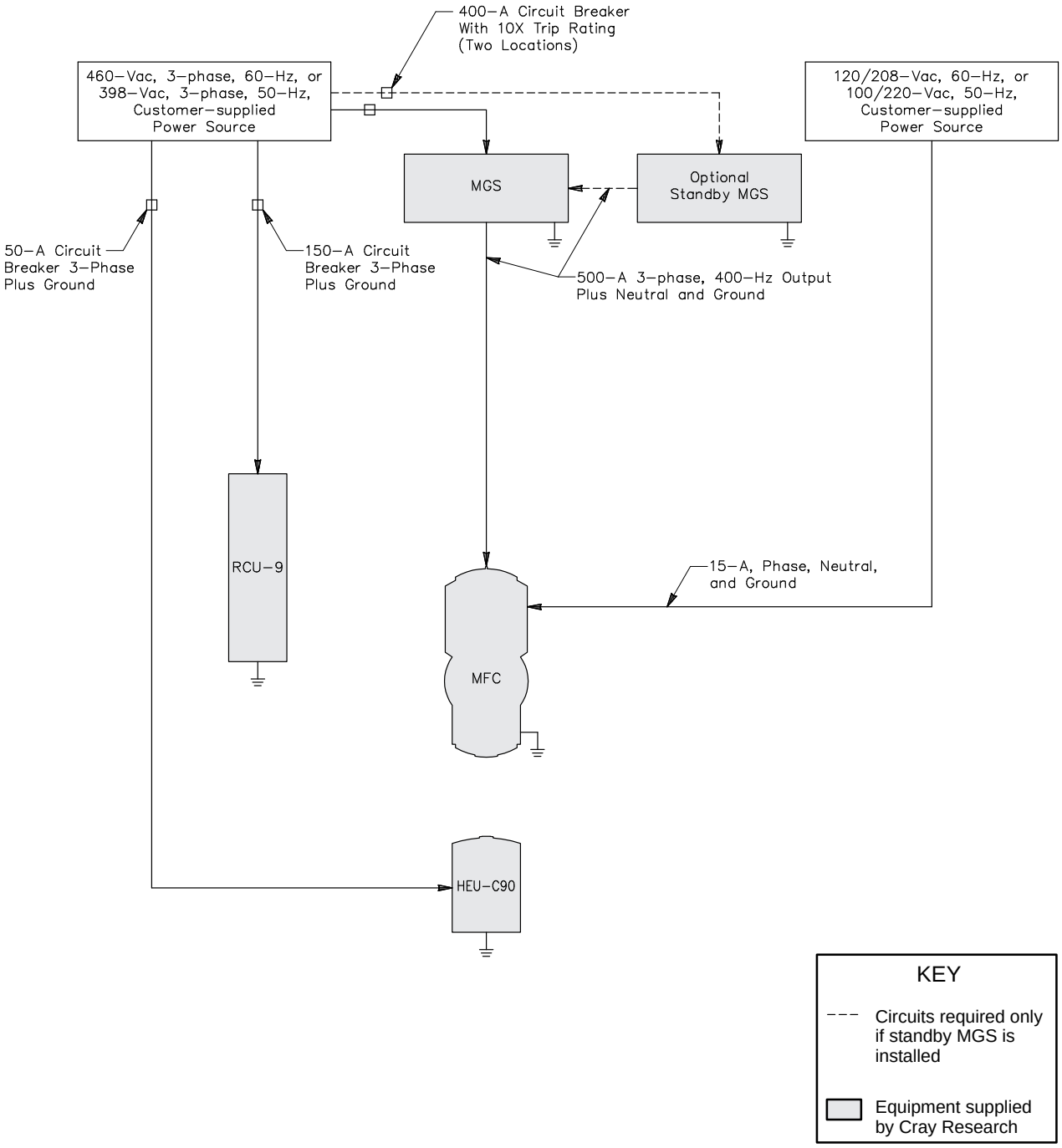


Figure 5-10. CRAY C94 and CRAY D94 Basic Power Wiring

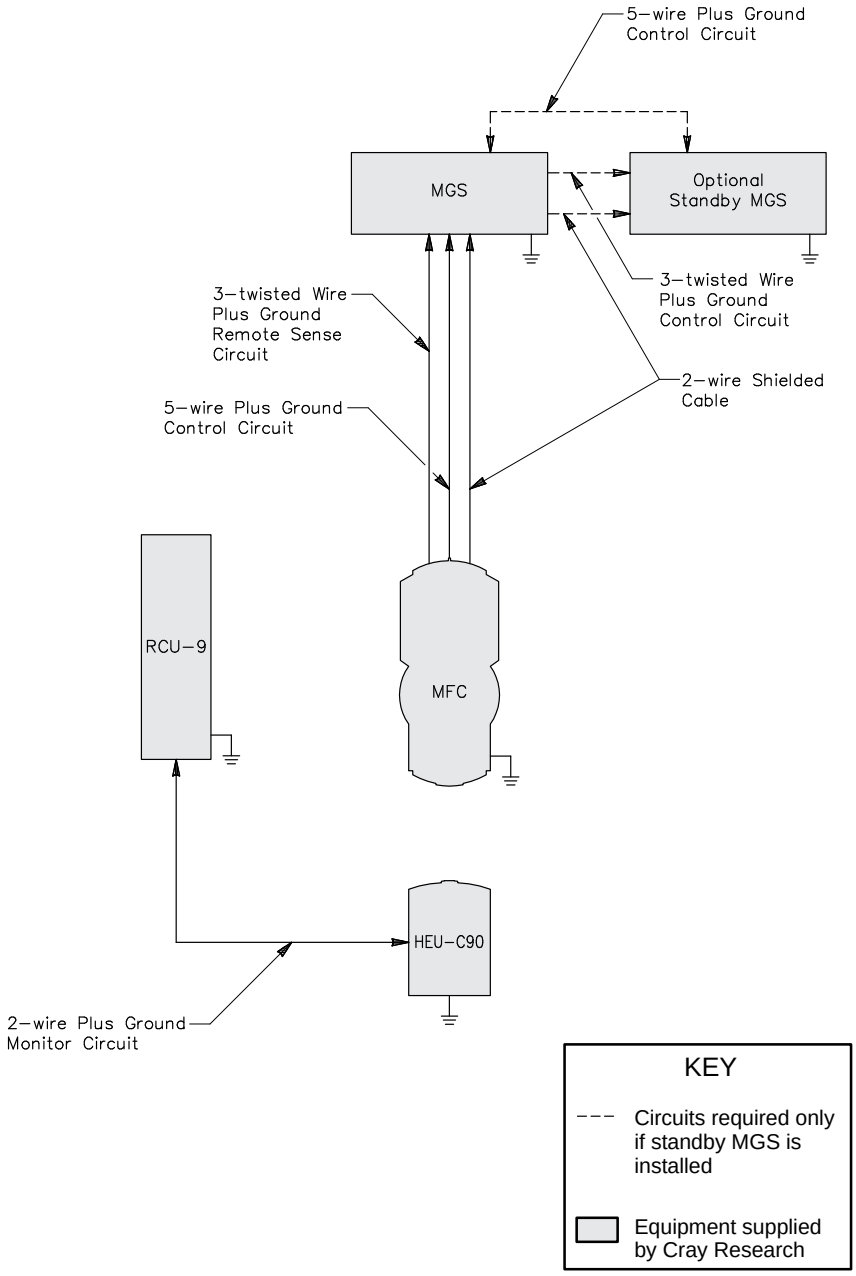


Figure 5-11. CRAY C94 and CRAY D94 Basic Control Wiring

Mainframe Chassis Requirements

You must provide and install the following power and control wiring for the mainframe chassis:

- One 208-Vac, 3-phase (neutral and ground), 400-Hz, 500-A circuit from the MGS to the mainframe chassis.

NOTE: To prevent excessive voltage drops, this circuit requires multiple conductors per phase.

- One 120/220-Vac, 50/60-Hz, single-phase, 15-A circuit to the mainframe chassis for control power
- One 5-wire (plus ground) control circuit from the mainframe chassis to the MGS for motor-generator control
- One 2-wire shielded cable (Belden 8720) from the mainframe chassis to the MGS for voltage adjustment
- One 3-twisted wire plus ground circuit to the MGS for remote voltage sensing

Heat Exchanger Unit (HEU-C90) Requirements

You must supply and install the following power and control wiring for the heat exchanger unit (HEU-C90):

- One of the following incoming 3-phase, 4-wire (including ground wire), 50-A circuits to the HEU-C90:
  - 460 Vac, 60 Hz
  - 398 Vac, 50 Hz
- One 2-wire (plus ground) control circuit from the HEU-C90 to the refrigeration condensing unit (RCU-9)

Cooling Requirements

The CRAY C94 and CRAY D94 computer system uses a dielectric-cooling technique that requires special piping and hoses. Dielectric-coolant hoses are required between the heat exchanger unit (HEU-C90) and the mainframe chassis. Refrigeration piping is required between the heat exchanger unit (HEU-C90) and the refrigeration condensing unit (RCU-9). Refer to Section 2, "Operational Requirements," in this manual for more information about cooling water requirements.

Dielectric-coolant Hoses

Flexible hoses are required to complete the dielectric-coolant network between the mainframe chassis and the HEU-C90. Cray Research supplies and installs all flexible hoses for the dielectric coolant during system installation. Figure 5-12 illustrates the standard arrangement of dielectric-coolant hoses for the CRAY C94 and CRAY D94 computer systems.

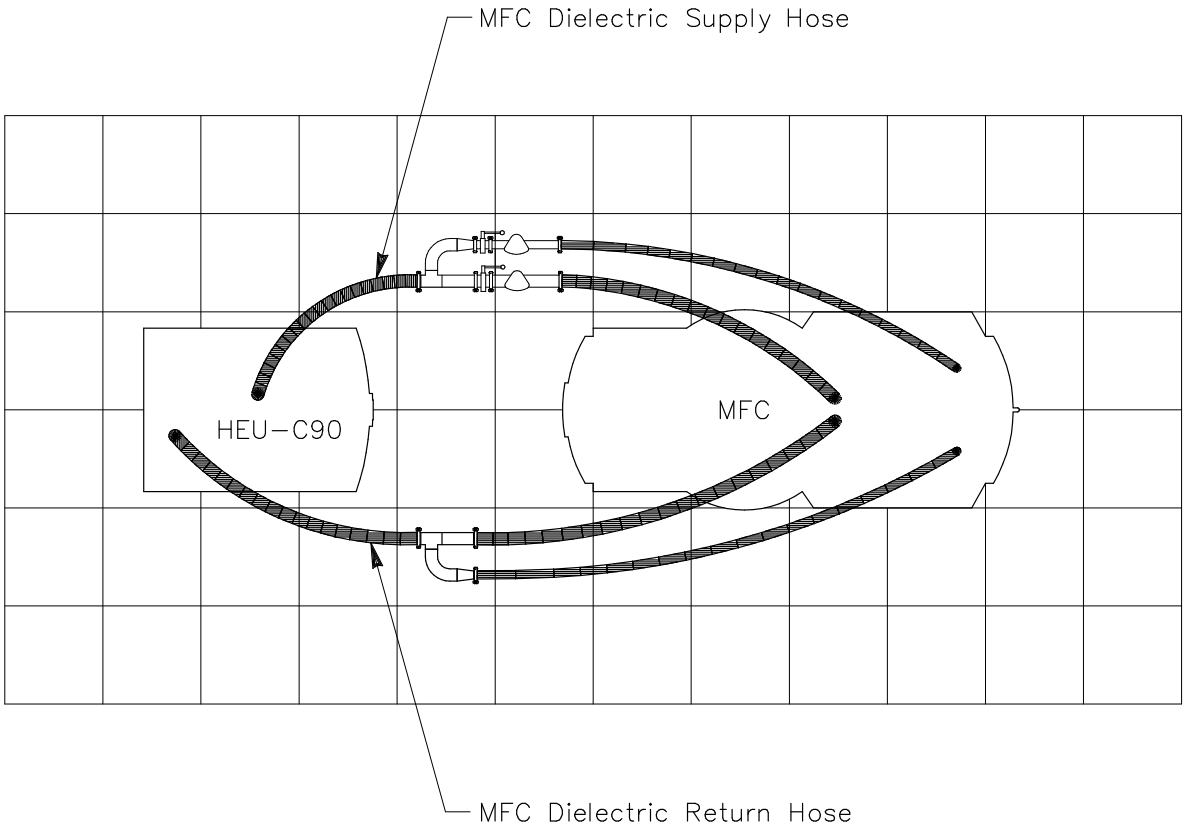


Figure 5-12. CRAY C94 and CRAY D94 Dielectric-coolant Hoses

Refrigeration Piping

The heat exchanger unit is cooled by a refrigerant-cooling technique that uses refrigeration piping to distribute the refrigerant liquid and return the refrigerant vapor to the remote refrigeration condensing unit. Your mechanical design engineering staff must prepare working drawings that provide details about planned refrigeration piping.

Approximately 8 weeks prior to the delivery of the computer system, Cray Research will deliver the RCU and special refrigeration piping component kit to your facility. This kit consists of special manifold assemblies but does not include all refrigeration piping components and materials necessary to prepare the facility.

General Requirements

Figure 5-13 illustrates the refrigeration piping requirements for the heat exchanger units used with the CRAY C94 and CRAY D94 computer systems. You are responsible for installing the special refrigeration components and the RCU used with your computer system. You must supply and install all piping, couplings, and elbows needed to prepare the facility refrigeration piping for the computer installation. You must also test the refrigeration piping and prepare for final connection before delivery of the computer system.

Cray Research provides *Refrigeration Piping and Component Installation Requirements*, Site Engineering document number 10650228, during the initial site planning meeting. This document describes the required materials, proper installation procedures, leak testing procedures, and evacuation procedures that must be followed by your facility personnel.

At the time of the computer system installation, Cray Research supplies and installs the flexible refrigeration hoses required to complete the refrigeration piping network. In addition, Cray Research installation personnel will charge the refrigeration system, adjust all controls and valves, and apply power to initialize operation of the RCU. You must supply an adequate amount of R-22 refrigerant to fully charge the system.

The refrigeration piping from the RCU to the computer equipment must not exceed the total equivalent lineal piping restriction of 100 ft (30.5 m), including directional and elevational changes. Directional changes in pipe routing should be minimal. If directional changes are necessary, the pipes should be routed at 45^{o} angles. All refrigeration piping elbows must be the long-radius type.

Changes in pipe routing elevation should also be minimal. When the refrigeration piping must be routed vertically, the vertical rise must not exceed 25 ft (7.6 m). In most instances, an extended vertical rise requires the construction of a double riser within the suction line. In this case, Cray Research site planning personnel provide the preferred design for the double riser.

The following notes provide information additional to Figure 5-13:

- You must supply, route, and install the liquid-line and suction-line piping between the HEU and the RCU. These items must conform to Cray Research engineering requirements and must be approved by Cray Research site planning personnel.

- Refrigerant-grade piping components and materials for the refrigeration piping network must be installed in accordance with the requirements illustrated in Figure 5-13 and Cray Research engineering requirements. Any variations of the piping network requirements must be approved by Cray Research site planning personnel.

- Piping support clamps must have a compressible insert between the clamp and the refrigeration piping.

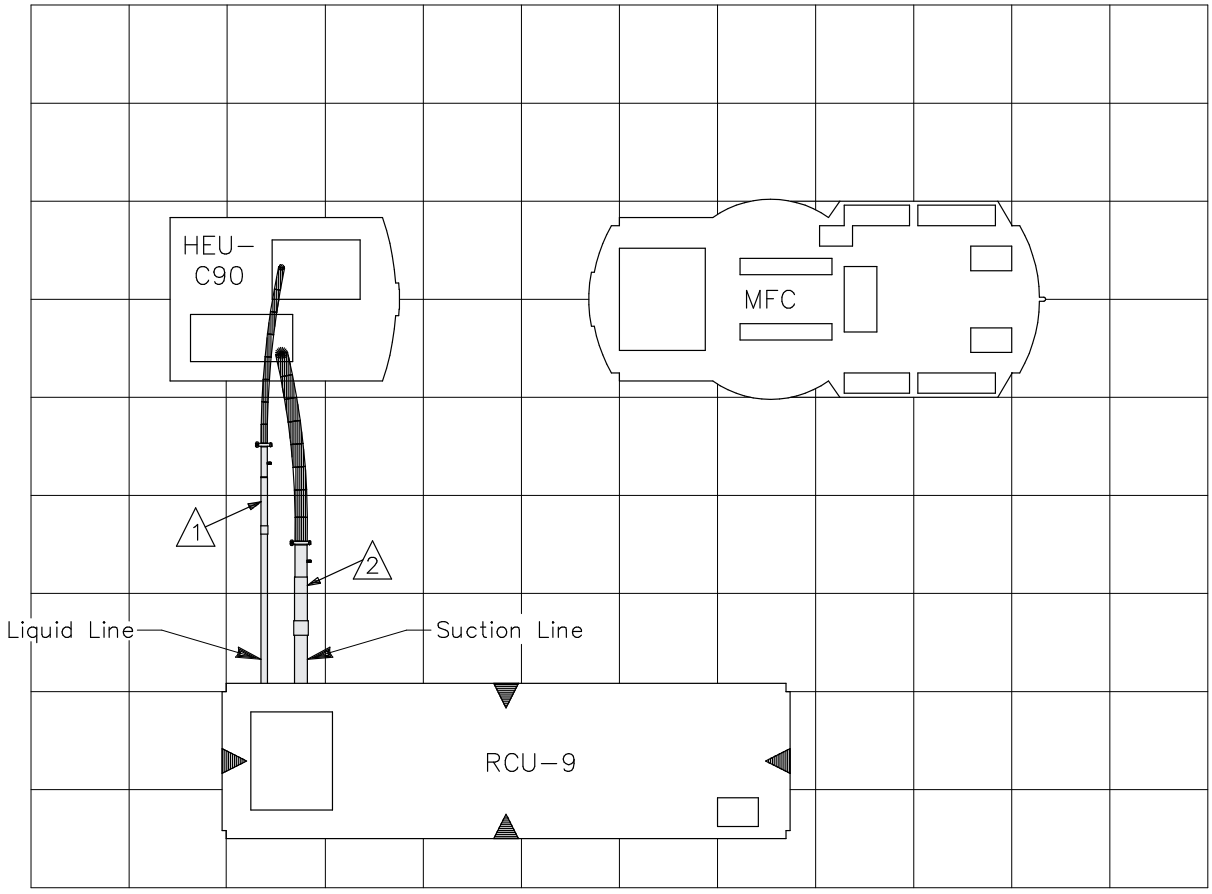
- All refrigeration piping and components must be assembled by you using silver solder and silver soldering techniques according to Cray Research engineering requirements.

- All refrigeration piping and components must be leak tested, evacuated, and prepared for service by you.

- All suction-line piping must be insulated by you after it passes all tests.

Refer to the *Refrigeration Piping and Component Installation Requirements*, Site Engineering document number 10650228, for more information about the installation requirements.

You must supply and install all piping materials, couplings, and elbows needed to interconnect the Cray Research-supplied components. In addition, you must test and prepare the refrigerant and cooling water piping for final connection prior to delivery of the computer system.



NOTES:

1. Liquid Line Flange Assembly, Cray Research part number 12278200
2. Suction Line Flange Assembly, Cray Research part number 12278300

Figure 5-13. CRAY C94 and CRAY D94 Piping Locations for Heat Exchanger Unit

6 PERIPHERAL EQUIPMENT

The peripheral equipment for the CRAY C916, CRAY C98, CRAY D98, CRAY C94, or CRAY D94 computer system includes the following devices:

- Disk enclosure (DE-60)
- Disk enclosure (DE-100)
- Removable disk cabinet (RDE-6)
- Network disk array enclosure
- Network disk personal computer (ND-PC)
- VME-based microcomputer (VBM-2)
- Color graphics display terminal (GDT-200)
- Line printer (LP-6)
- Single display table (TBL-3)
- Front-end interface cabinet (FEC)
- Fiber-optic link (FOL and FOL-4) cabinet
- Front-end interface and fiber-optic link (FEI/FOL)
- Fiber-optic enclosure (FOE-1)

To prepare your site for the installation of peripheral devices, you must provide floor cutouts. Floor cutouts provide an opening for data and power connections. The floor cutouts must be free of burrs and sharp edges to prevent damage to these system connections.

Some floor cutout diagrams indicate a 3.50-in. (9-cm) circular cutout; you may substitute a 4.00-in. (10-cm) square cutout for this circular cutout.

Disk Enclosure (DE-60)

The disk enclosure (DE-60) can house up to ten DD-60, DD-61, or DD-62 disk drives. These disk drives are fan-cooled devices. A DD-60 disk drive has a storage capacity of 1.96 Gbytes. A DD-61 disk drive has a storage capacity of 2.23 Gbytes. A DD-62 disk drives has a storage capacity of 2.73 Gbytes.

Table 6-1 provides additional specifications for the DE-60. Refer to Figure 6-1 for an illustration of the DE-60.

Table 6-1. DE-60 Specifications

Characteristic	Specification
Height	61.75 in. (157 cm)
Width	24.00 in. (61 cm)
Depth	41.50 in. (105 cm)
Weight (maximum)	960 lbs (435 kg)
Access requirements: Side Front Back	 2.00 in. (5 cm) 36.00 in. (91 cm) 30.00 in. (76 cm)
Heat dissipation to air (maximum)	8.53 kBtu/hr (2.50 kW)
Cooling requirements	Ambient air
Power cable	6-ft (1.8-m) pluggable drop cord
Power receptacle	NEMA-type L21-20R (box mounted or in line)

NOTE: The DE-60 must be positioned so that the exhaust air of another heat-rejecting device does not enter the air inlet of the DE-60. The air inlet is located at the front of the DE-60; the air exhaust is located at the top of the DE-60.

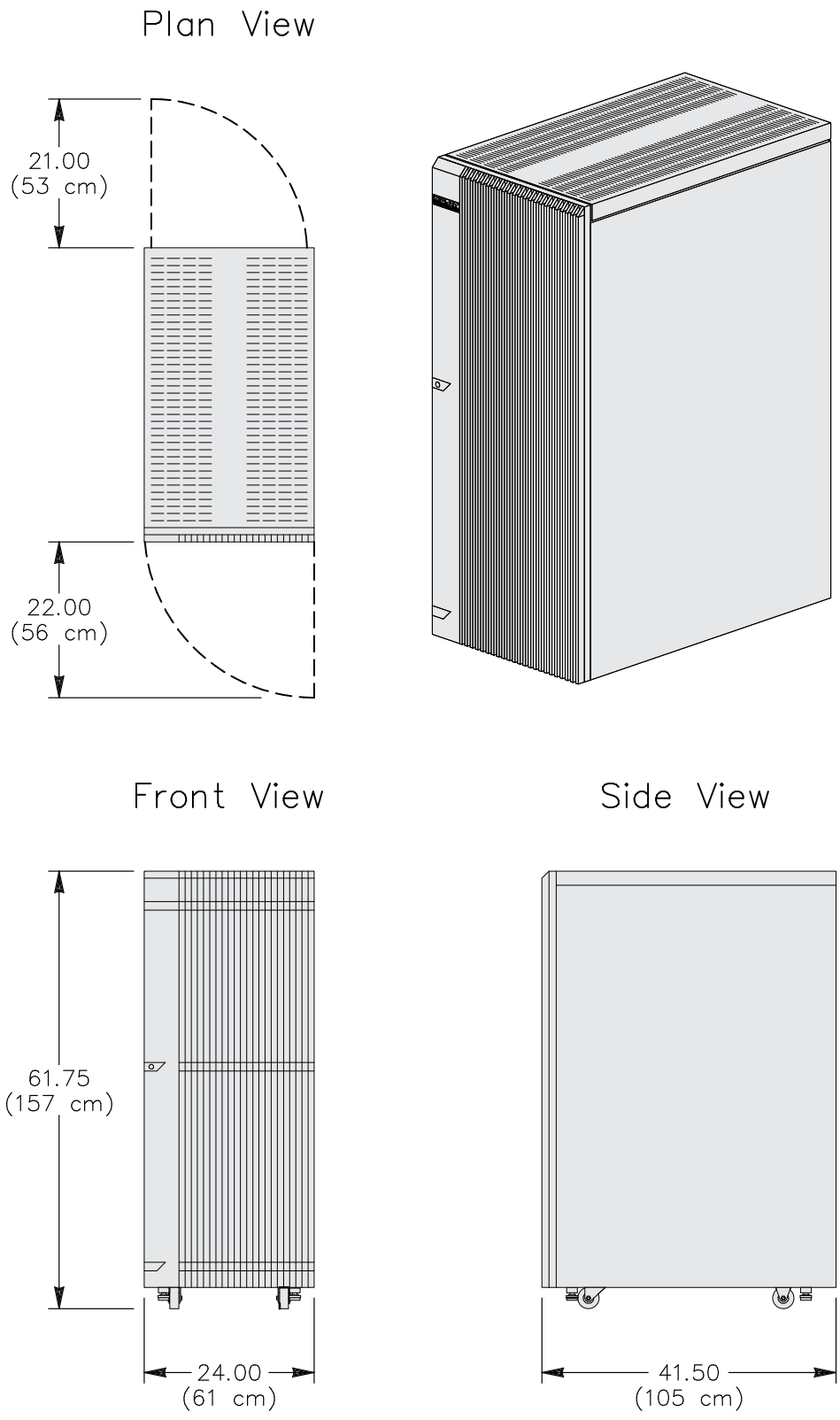


Figure 6-1. Disk Enclosure (DE-60)

You must prepare a single floor cutout for the DE-60. Refer to Figure 6-2 for an illustration of this floor cutout.

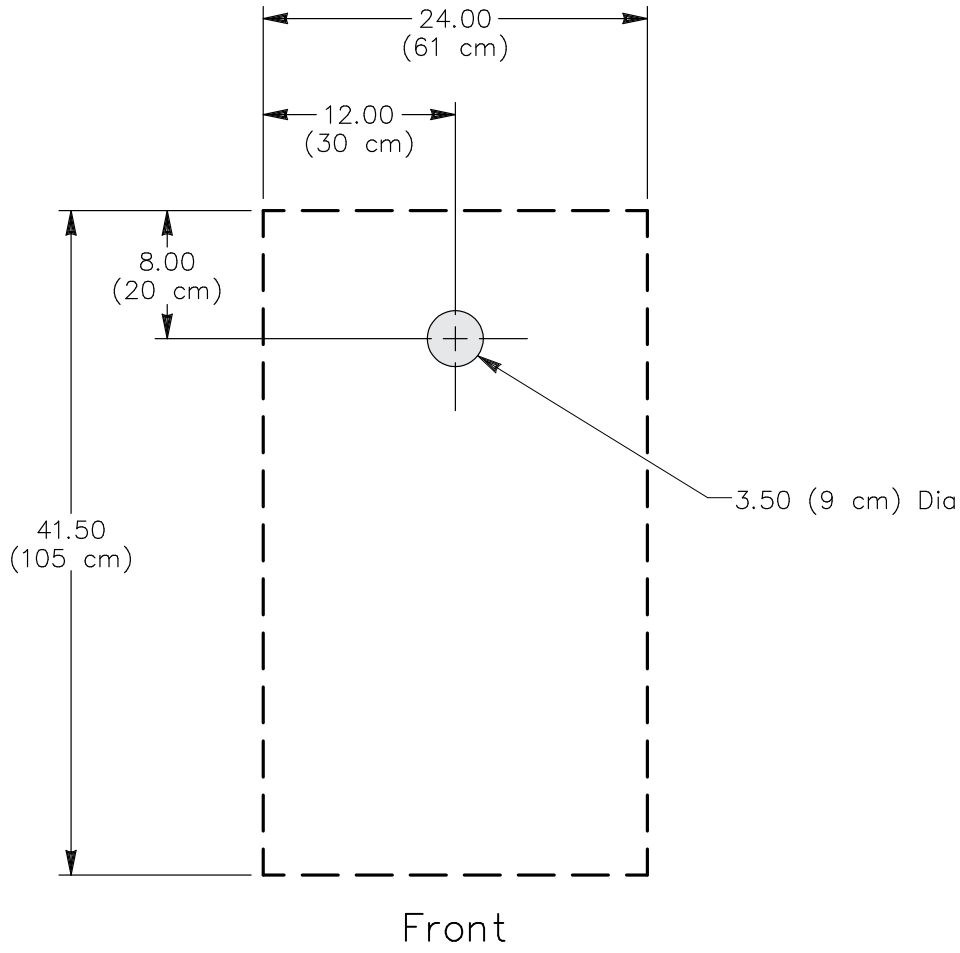


Figure 6-2. DE-60 Floor Cutout Requirements

Disk Enclosure (DE-100)

The disk enclosure (DE-100) houses the DD-301 disk drives. Each DE-100 contains one to four drawers (with a maximum of 20 disk drives per drawer) for a maximum of 80 disk drives per disk enclosure. The DE-100 is equipped with casters and leveling pads.

Refer to Table 6-2 for the DE-100 specifications and to Figure 6-3 for an illustration of the DE-100.

Table 6-2. DE-100 Specifications

Characteristic	Specification
Height	74.75 in. (190 cm)
Width	27.50 in. (70 cm)
Depth	31.50 in. (80 cm)
Weight	940 lbs (426 kg) maximum
Location	Within 60 ft (18.3 m) of the I/O subsystem
Access requirements	
Side	2.00 in. (5 cm)
Front	36.00 in. (91 cm)
Back	30.00 in. (76 cm)
Heat dissipation to air	13.31 kBtu/hr (3.90 kW) maximum
Cooling requirement	Ambient air
Power requirement	4.00 kVA (3.90 kW) maximum
Power cable	6-ft (1.8-m) pluggable drop cable
Power receptacle	
North America and Japan	IEC 309, 3-phase, 208-Vac, 30-amp, Hubbell #430C9W or equivalent
International	IEC 309, 3-phase, 400-Vac, 32-amp, Hubbell #532C6W or equivalent

NOTE: The DE-100 must be positioned so that the exhaust air of another heat-rejecting device does not enter the air inlet of the enclosure. The air inlet is located at the front of the enclosure; the air exhaust is located at the rear of the enclosure.

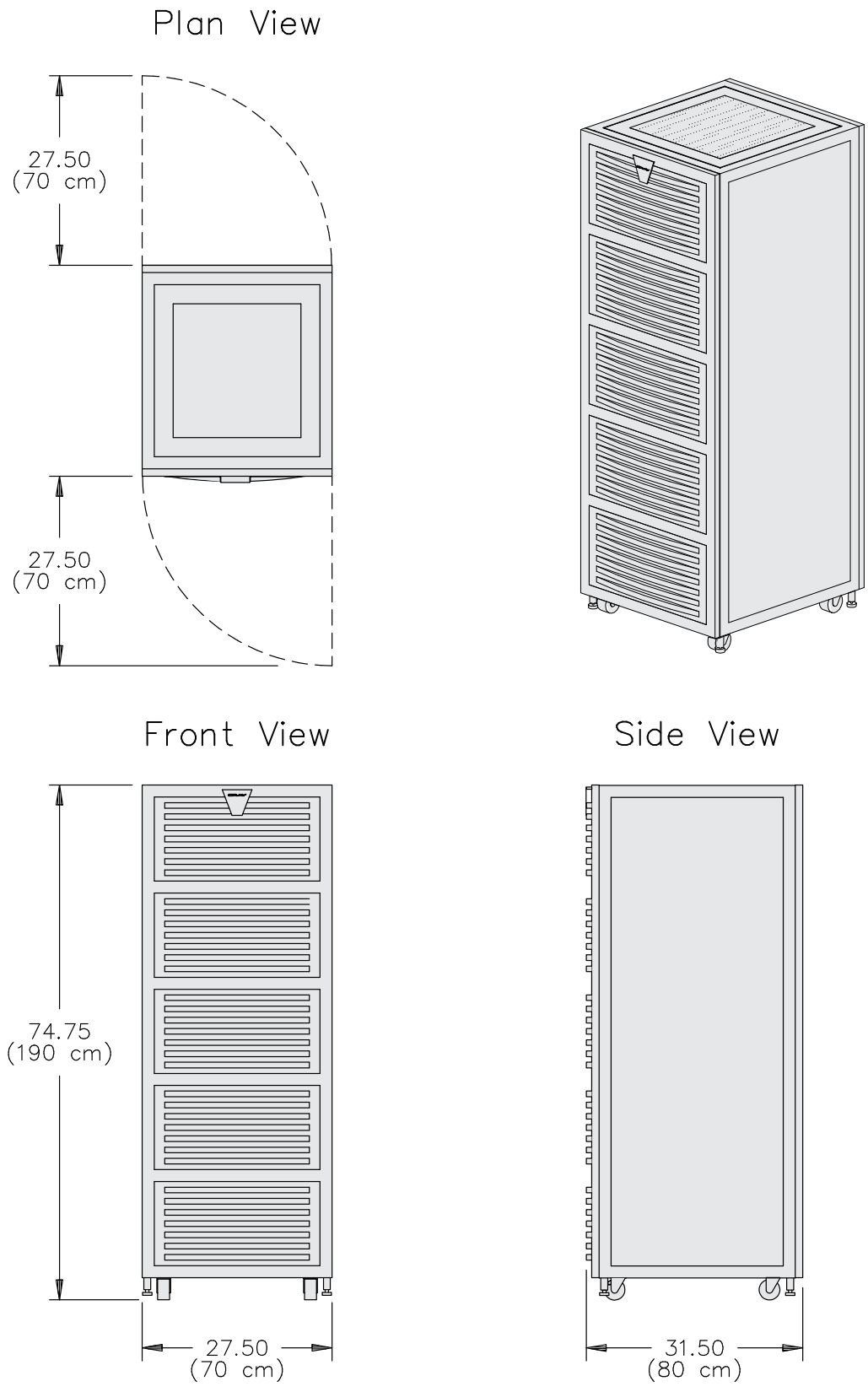


Figure 6-3. Disk Enclosure (DE-100)

A floor cutout is required beneath the DE-100 for entrance of data and power cables. Refer to Figure 6-4 for an illustration of the floor cutout.

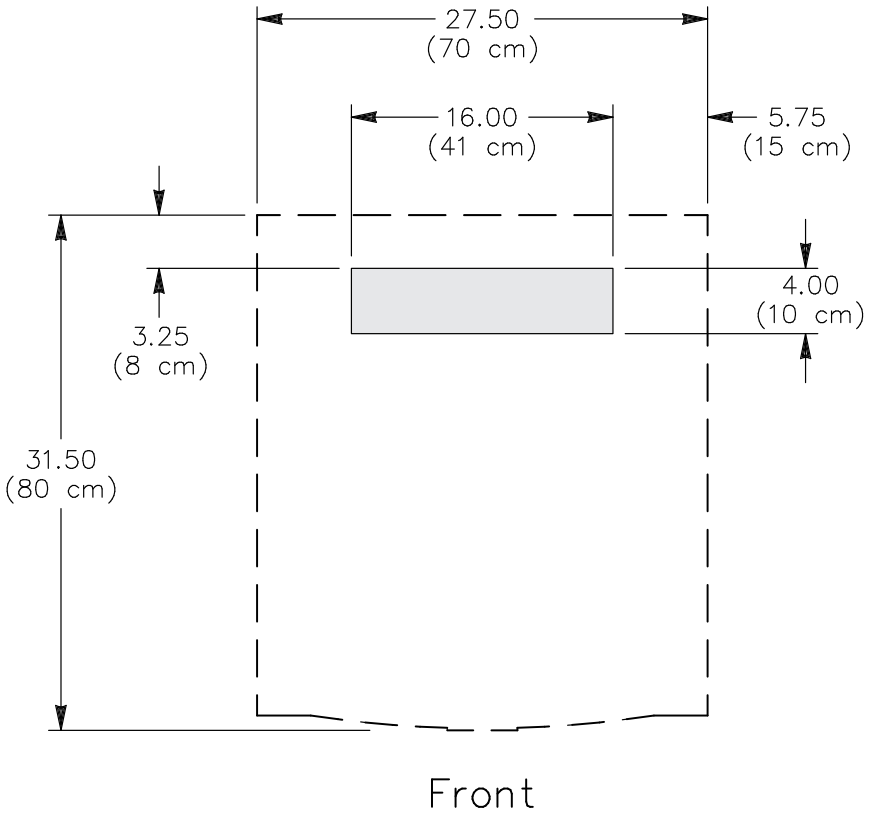


Figure 6-4. Disk Enclosure (DE-100) Floor Cutout

Removable Disk Cabinet (RDE-6)

The removable disk cabinet (RDE-6), shown in Figure 6-5, is an air-cooled device containing up to four removable disk drives (RD-62s). Each RD-62 has a storage capacity of 2.73 Gbytes. The specifications for an RDE-6 are provided in Table 6-3.

Observe the following guidelines when handling and storing RD-62 drives:

- Carefully remove disk drives (RD-62s) from the RDE-6 chassis to minimize the amount of vibration and shock.
- Store the disk drives in a storage area that conforms to the same temperature, humidity, and dewpoint specifications as the computer room.

Table 6-3. RDE-6 Specifications

Characteristic	Specification
Height	41.75 in. (106 cm)
Width	23.00 in. (58 cm)
Depth	36.00 in. (91 cm)
Weight	494 lbs (224 kg)
Location	Within 50 ft (15.2 m) of the I/O subsystem
Access requirements: Front Back	 36.00 in. (91 cm) 30.00 in. (76 cm)
Heat dissipation to air	2,460 Btu/hr (720 W) maximum
Cooling requirements	Ambient air
Power cable	6-ft (1.8-m) pluggable drop cord
Power receptacle: 50 Hz 60 Hz	 Hubbell 320C6W (box mounted or in line) NEMA-type L6-20R

NOTE: The RDE-6 must be positioned so that the exhaust air of another heat-rejecting device does not enter the air inlet of the RDE-6.

You must prepare a single floor cutout for the RDE-6. Refer to Figure 6-6 for the RDE-6 floor cutout requirements.

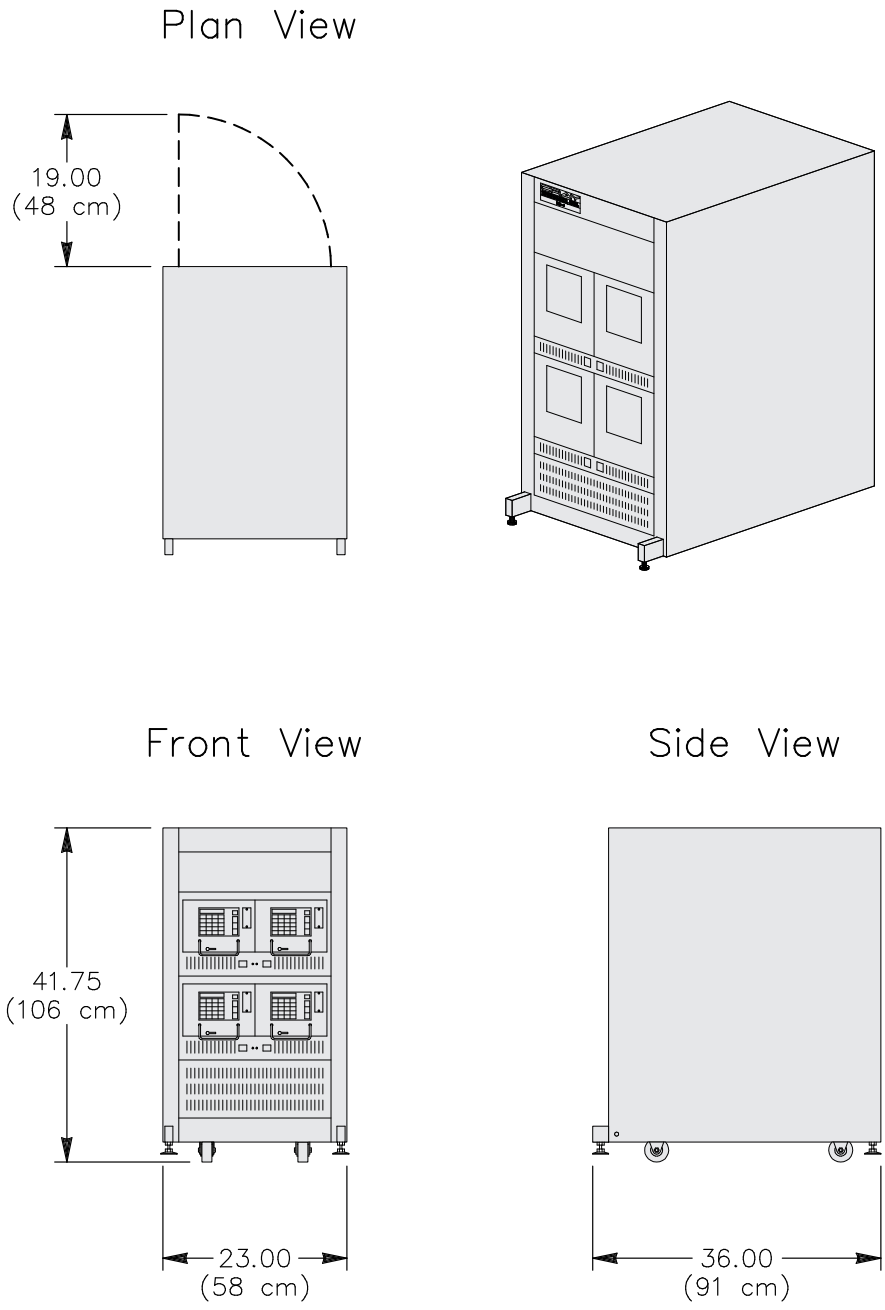


Figure 6-5. Removable Disk Cabinet (RDE-6)

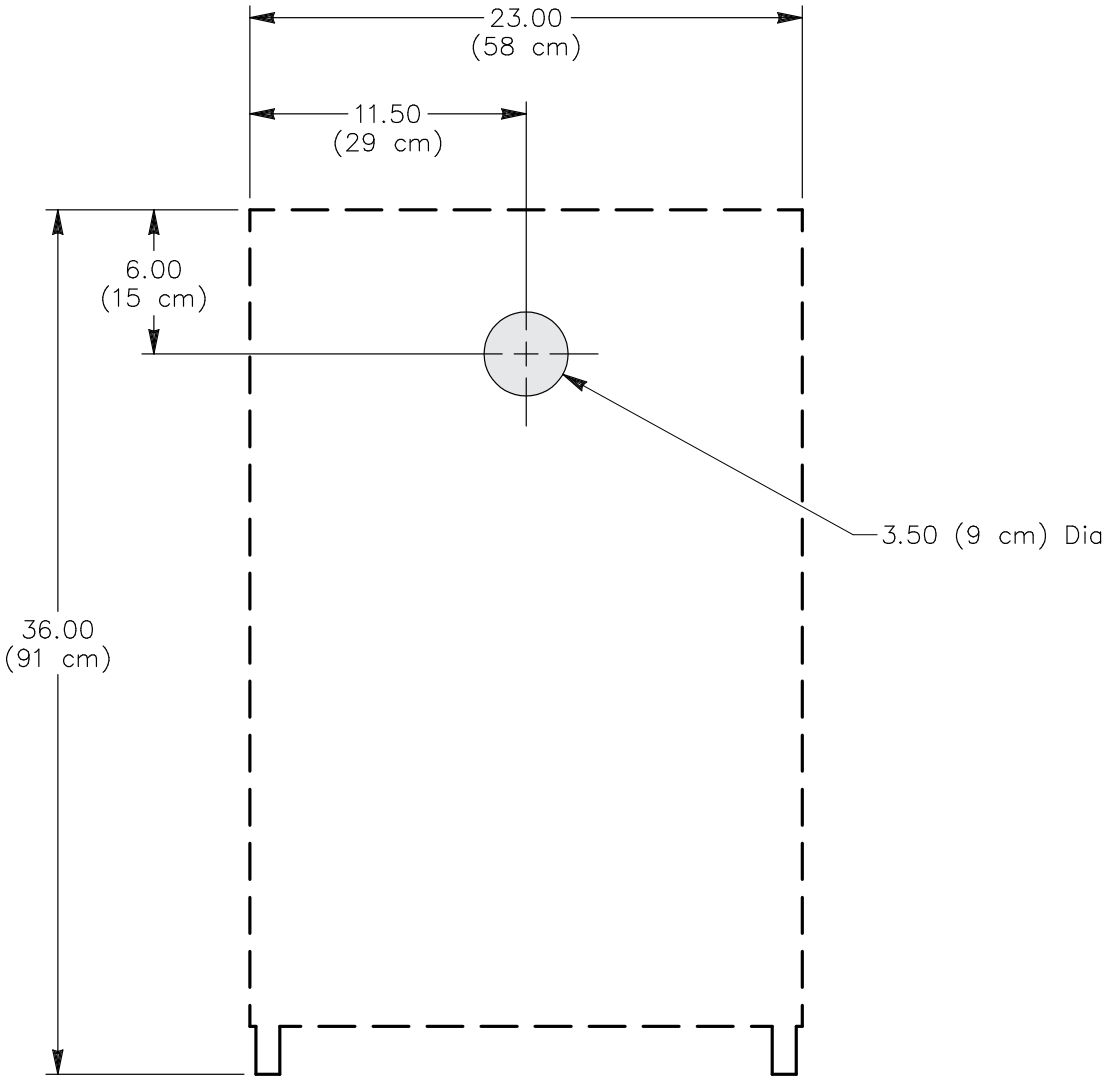


Figure 6-6. RDE-6 Floor Cutout Requirements

ND Series Network Disk Array Enclosure

The ND Series Network Disk Array enclosure (hereafter referred to as the network disk array enclosure) is a high-performance rack-mounted disk array storage system. The network disk array enclosure provides large data-storage capabilities, a high data-transfer rate, and high data availability. It connects directly to the host computer system with a High Performance Parallel Interface (HIPPI) attachment and uses the intelligent peripheral interface (IPI-3) command protocol.

Refer to Table 6-4 for the network disk array enclosure specifications and to Figure 6-7 for an illustration of the network disk array enclosure.

Table 6-4. Network Disk Array Enclosure Specifications

Characteristic	Specification
Height	62.25 in. (158 cm)
Width	29.50 in. (75 cm)
Depth	38.50 in. (98 cm)
Weight	1,329 lbs (603 kg) maximum
Access requirements	
Side	2.00 in. (5 cm)
Front	36.00 in. (91 cm)
Back	30.00 in. (76 cm)
Heat dissipation to air	8.30 kBtu/hr (2.43 kW) maximum
Cooling requirement	Ambient air
Power requirement	2.95 kVA (2.43 kW) maximum
Power cable	6-ft (1.8-m) pluggable drop cable
Power receptacle	
North America and Japan	IEC 309, 3-phase, 208-Vac, 20-amp, Hubbell #420C9W or equivalent
International	IEC 309, 3-phase, 400-Vac, 16-amp, Hubbell #516C6W or equivalent

NOTE: The network disk array enclosures must be positioned so that the exhaust air of another heat-rejecting device does not enter the air inlet of the enclosure. The air inlet is located at the front of the enclosure; the air exhaust is located at the rear of the enclosure.

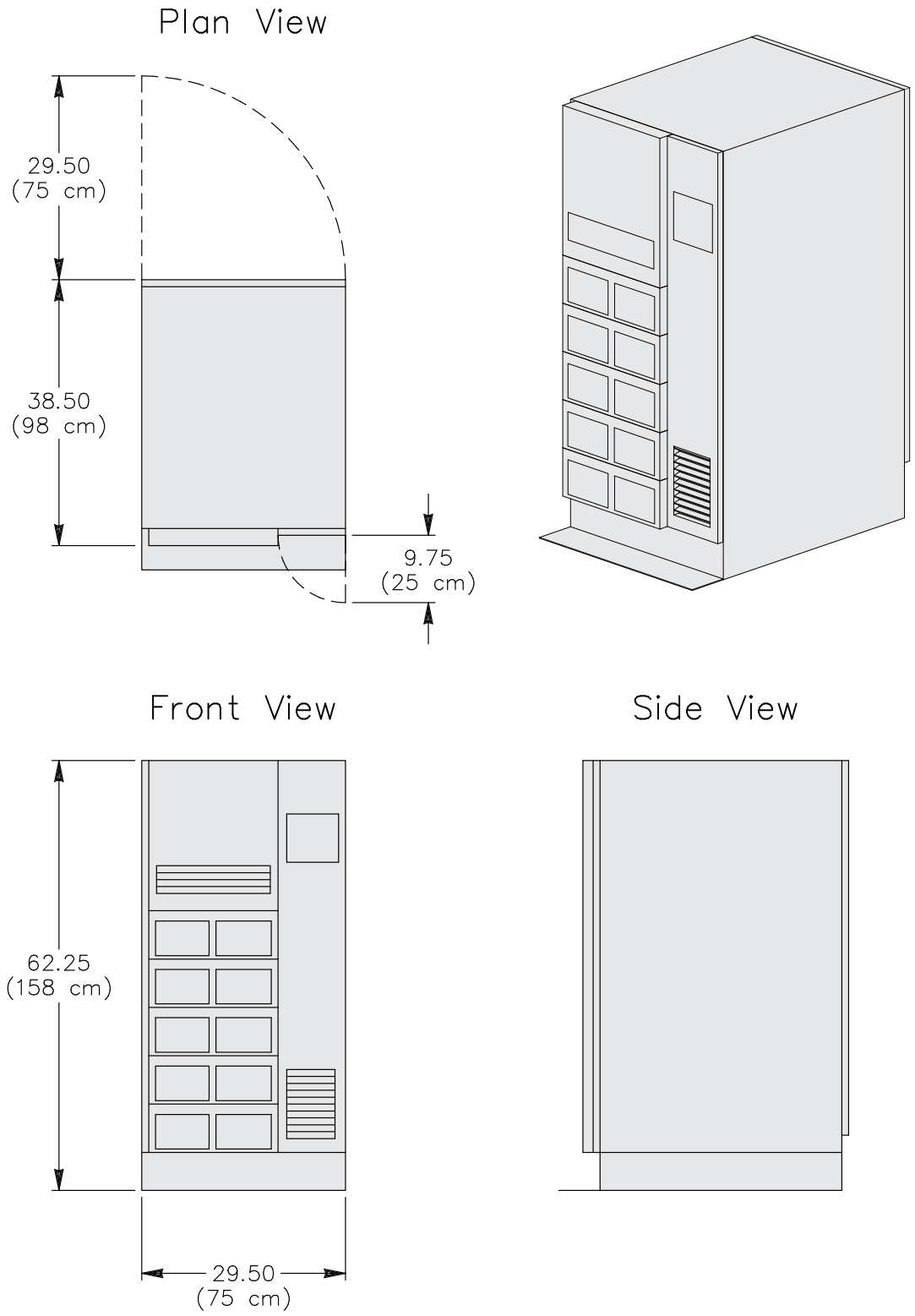


Figure 6-7. Network Disk Array Enclosure

The network disk array is available in two models and two associated expansion cabinets; the dimensions are identical for all cabinets. All network disk arrays are equipped with casters and wire wheel chocks.

Refer to Table 6-5 for the network disk array capacities.

Table 6-5. Network Disk Array Capacities

Network Disk Array Model Number	Data Capacity (32-Kbyte Block)	Data Capacity (64-Kbyte Block)	Number of Drives	Number of Drive Drawers
ND-12	27.4 Gbytes	29.0 Gbytes	20	10
ND-14	54.8 Gbytes	58.1 Gbytes	40	10
ND-22 Expansion Cabinet	27.4 Gbytes	29.0 Gbytes	20	10
ND-24 Expansion Cabinet	54.8 Gbytes	58.1 Gbytes	40	10
ND-4 Capacity Upgrade for an ND-12 or ND-22	27.4 Gbytes	29.0 Gbytes	20	N/A
ND-2 Optional HIPPI Channel Upgrade for an ND-12 or ND-14	N/A	N/A	N/A	N/A

Refer to the following list for additional network disk array and expansion cabinet information.

- The ND-12 and ND-14 disk array enclosures contain the HIPPI interface array controller and disk drives.
- The ND-22 and ND-24 expansion cabinets contain only disk drives and are daisy chained from the array controller.
- The ND-22 and ND-24 expansion cabinets can be used with either the ND-12 or the ND-14 network disk array enclosure.
- Up to three expansion cabinets can be used with each ND-12 or ND-14 disk array enclosure.
- The ND-12 and ND-14 disk array enclosures have a single HIPPI channel as standard equipment. Each expansion cabinet can be ordered with one additional HIPPI channel.

- The ND-12 and ND-14 disk array enclosures must be located within 75 ft. (22.9 m) of the I/O subsystem (IOS). The ND-22 and ND-24 expansion cabinets must be located adjacent to the ND-12 or ND-14 disk array enclosures.

- The ND-4 capacity upgrade is a 29-Gbyte upgrade for an ND-12 network disk array enclosure or ND-22 expansion cabinet. Up to 20 additional disk drives can be added with this upgrade.

- The ND-2 optional HIPPI channel upgrade provides a second HIPPI channel interface for an ND-12 or ND-14 disk array enclosure.

A 4-in. (10-cm) minimum floor cutout (refer to Figure 6-8) is required beneath the enclosure for entrance of data and power cables.

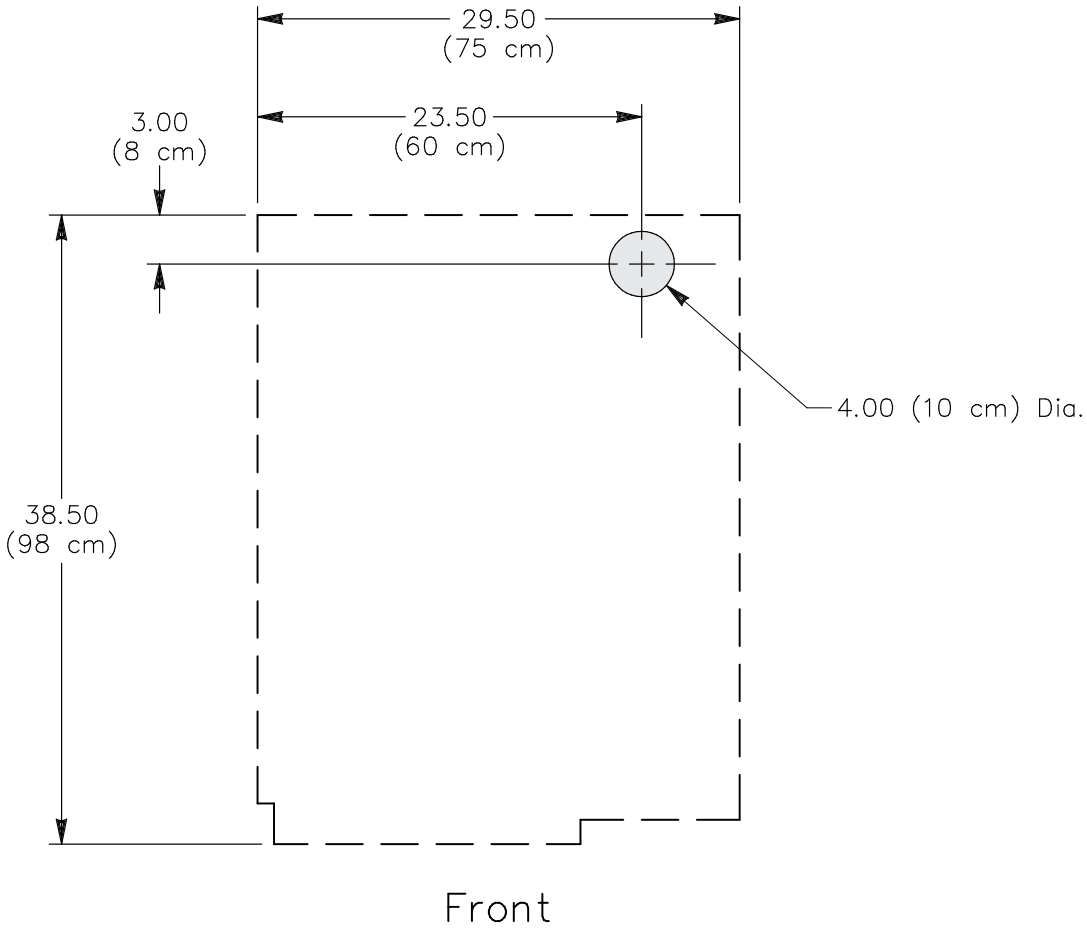


Figure 6-8. Network Disk Array Enclosure Floor Cutout

Network Disk Personal Computer

The network disk personal computer (ND-PC) is a Cray Research-supplied personal computer that has a built-in system maintenance facility. This maintenance facility controls diagnostics, formatting, and data reconstruction utilities, error logging, and status displays.

An ND-PC is required with each ND-12 or ND-14 disk array enclosure; an ND-PC is not included or needed with the ND-22 or ND-24 expansion cabinets. The ND-PC must be located within 25 ft (7.6 m) of the ND-12 or ND-14 enclosure.

Refer to Table 6-6 for the ND-PC specifications and to Figure 6-9 for an illustration of the ND-PC with a Cray Research-supplied table.

Table 6-6. Network Disk Personal Computer Specifications

Characteristic	Specification
Height	19.25 in. (49 cm)
Width	18.00 in. (46 cm)
Depth	23.00 in. (58 cm)
Weight	47 lbs (21 kg)
Heat dissipation to air	0.44 kBtu/hr (0.13 kW)
Cooling requirement	Ambient air
Power requirement	0.14 kVA/hr (0.13 kW)
Power cables (CPU and monitor)	Two 6-ft (1.8-m) pluggable drop cables
Power receptacle:	
North America and Japan	NEMA type 5-15R (box mounted or in-line)
International	Country specific

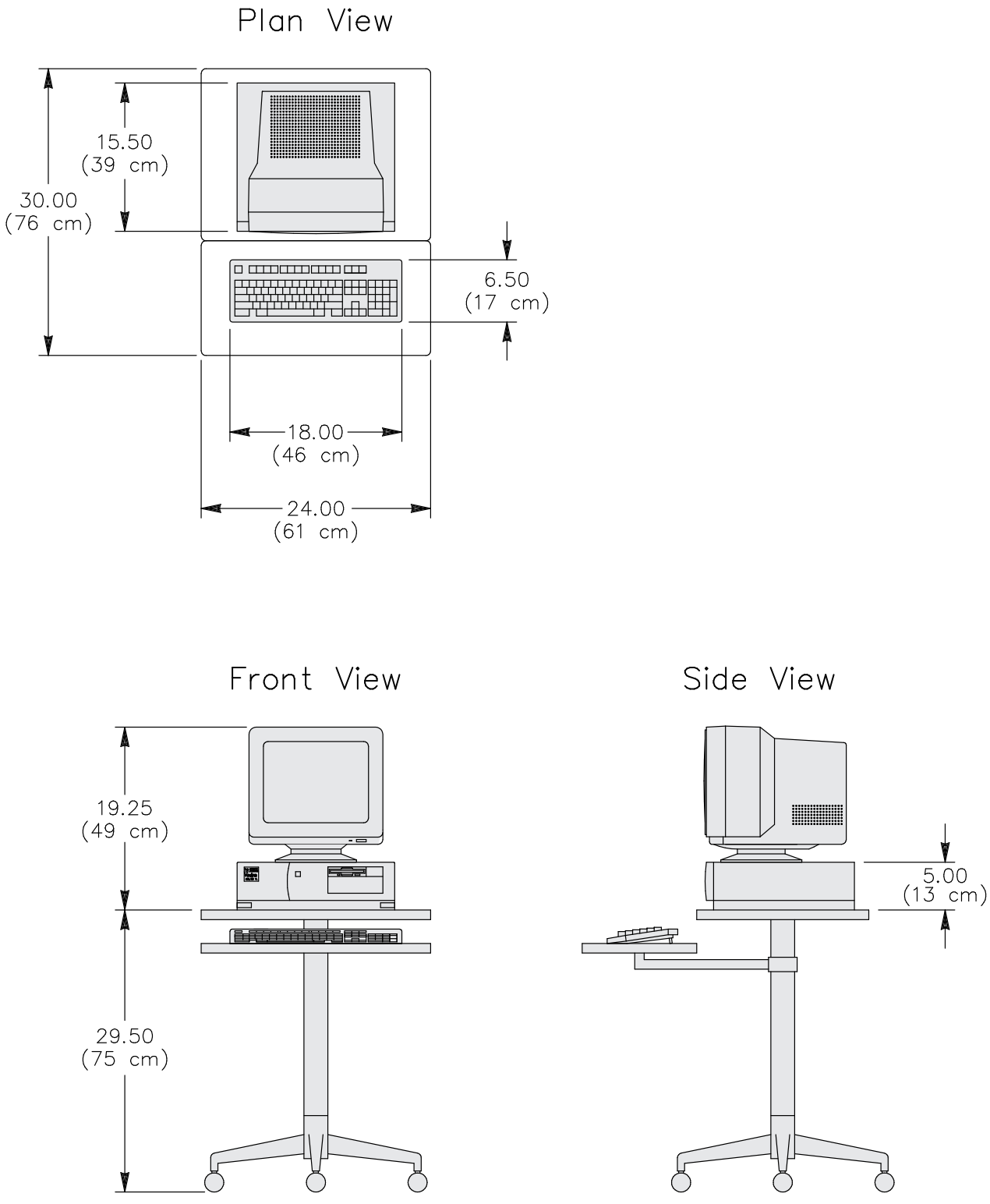


Figure 6-9. Network Disk Personal Computer (ND-PC)

A 3.50-in. (9-cm) minimum floor cutout (refer to Figure 6-10) is required beneath the ND-PC for entrance of data and power cables.

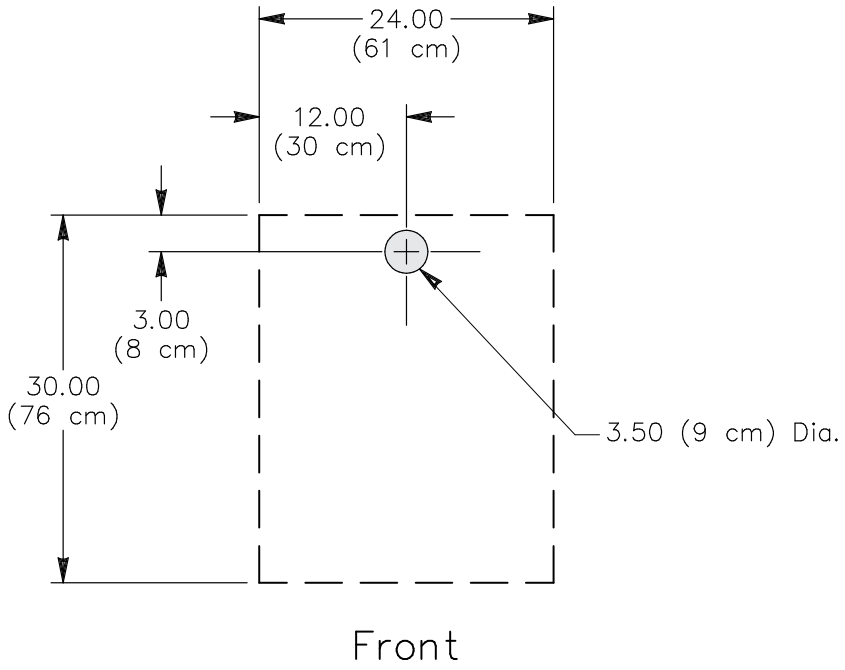


Figure 6-10. Network Disk Personal Computer Floor Cutout

VME-based Microcomputer (VBM-2)

The VME-based microcomputer (VBM-2) is configured in both the maintenance workstation (MWS) and the operator workstation (OWS). The VBM-2 is used for hardware maintenance, system operation, and system monitoring. The VBM-2 contains one 200-Mbyte removable disk module, one 150-Mbyte streaming tape drive, a Control Subsystem Network (CSN) interface, a time-of-day clock, and additional interfaces and communication ports.

Table 6-7 provides additional specifications for the VBM-2. Refer to Figure 6-11 for an illustration of the VBM-2.

Table 6-7. VBM-2 Specifications

Characteristic	Specification
Height	26.00 in. (66 cm)
Width	19.00 in. (48 cm)
Depth	28.50 in. (72 cm)
Weight	220 lbs (100 kg)
Access requirements	36.00 in. (91 cm) front 6.00 in. (15 cm) back
Heat dissipation to air	4.50 kBtu/hr (1.32 kW)
Cooling requirements	Ambient air
Power cable	6-ft (1.8-m) pluggable drop cord
Power receptacle	NEMA-type L5-20R (box mounted or in line)

You must prepare a single floor cutout for the VBM-2. Refer to Figure 6-12 for an illustration of this floor cutout.

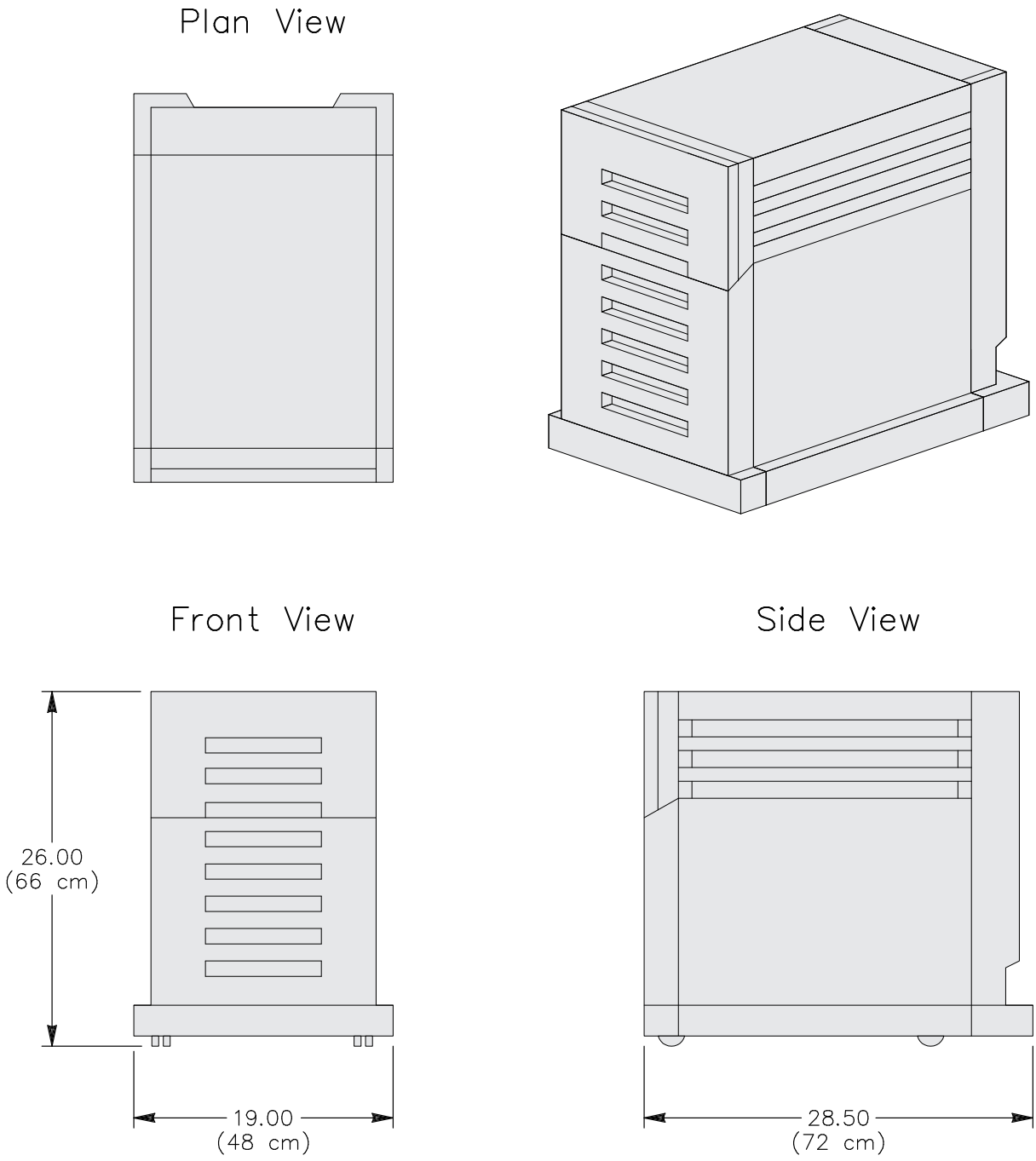


Figure 6-11. VME-based Microcomputer (VBM-2)

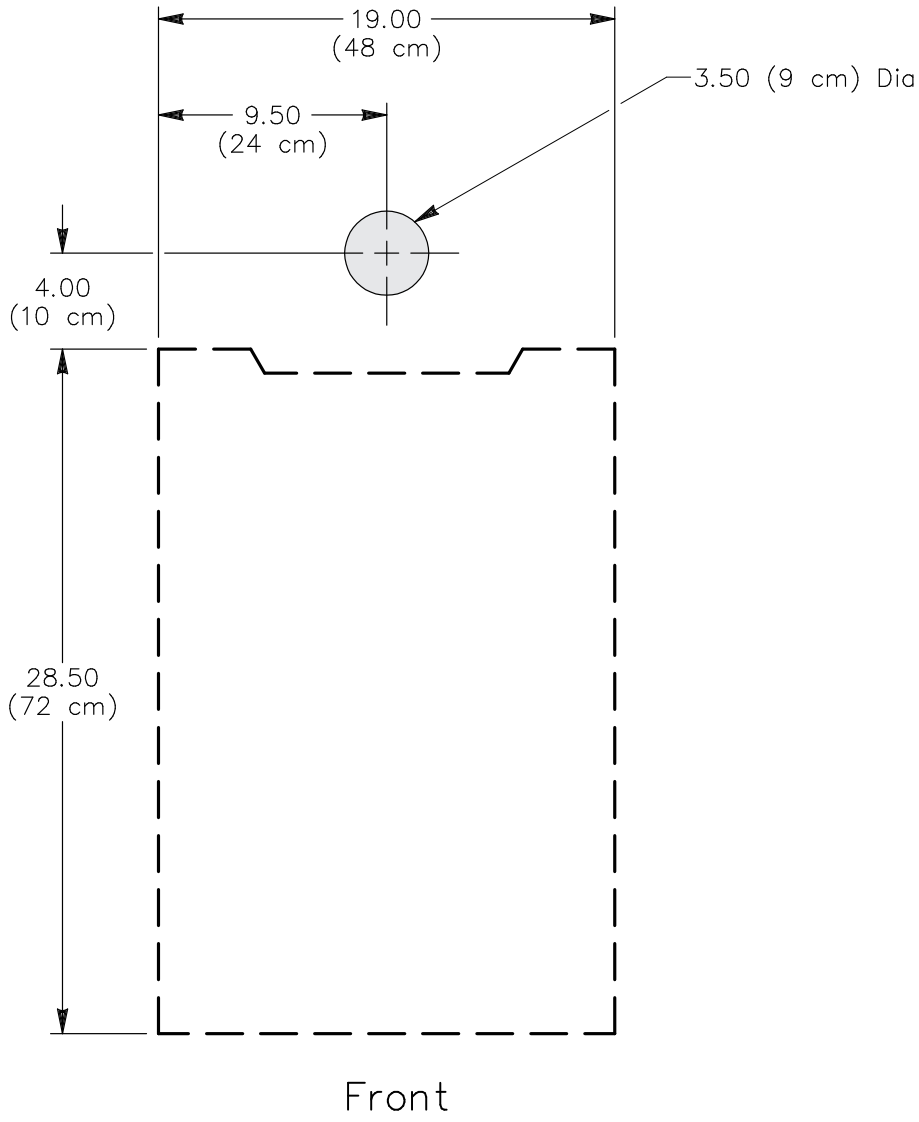


Figure 6-12. VBM-2 Floor Cutout Requirements

Color Graphics Display Terminal (GDT-200)

The color graphics display terminal (GDT-200) is configured with the maintenance workstation (MWS) and operator workstation (OWS) for device monitoring and system communication activities. Additional GDT-200 terminals can be ordered for operator use. The GDT-200 is designed to be table mounted and consists of a color monitor, a keyboard unit, and a mouse. The GDT-200 is located on the single display table (TBL-3) adjacent to the VBM-2.

Table 6-8 provides additional specifications for the GDT-200. Refer to Figure 6-13 for an illustration of the GDT-200.

Table 6-8. GDT-200 Specifications

Characteristic	Specification
Height	18.75 in. (48 cm)
Width	19.00 in. (48 cm)
Depth	28.50 in. (72 cm)
Weight	72 lbs (33 kg)
Heat dissipation to air	1,360 Btu/hr (400 W)
Cooling requirements	Ambient air
Power cable	6-ft (1.8-m) pluggable drop cord
Power receptacle	NEMA-type 5-15R (box mounted or in line)

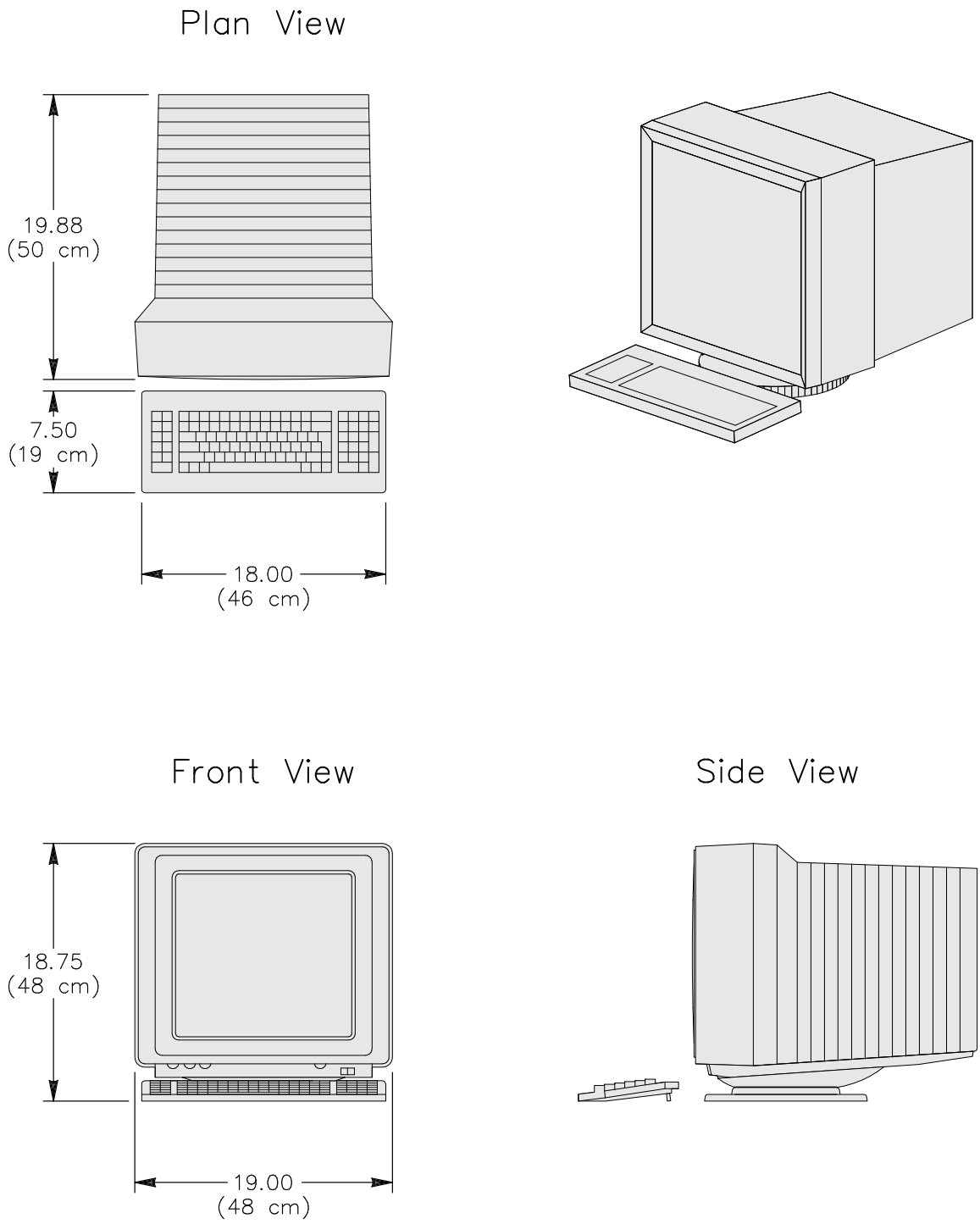


Figure 6-13. Color Graphics Display Terminal (GDT-200)

Line Printer (LP-6)

The line printer (LP-6) is a laser printing device equipped with numerous character sets. The LP-6 is an element of the OWS and is located on the VBM-2 in the computer room.

Table 6-9 provides additional specifications for the LP-6. Refer to Figure 6-14 for an illustration of the LP-6.

Table 6-9. LP-6 Specifications

Characteristic	Specification
Height	11.75 in. (30 cm)
Width	16.50 in. (42 cm)
Depth	16.00 in. (41 cm)
Weight	38 lbs (17 kg)
Heat dissipation to air	665 Btu/hr (195 W)
Cooling requirements	Ambient air
Power cable	8-ft (2.4-m) pluggable drop cord
Power receptacle	NEMA-type 5-15R (box mounted or in line)

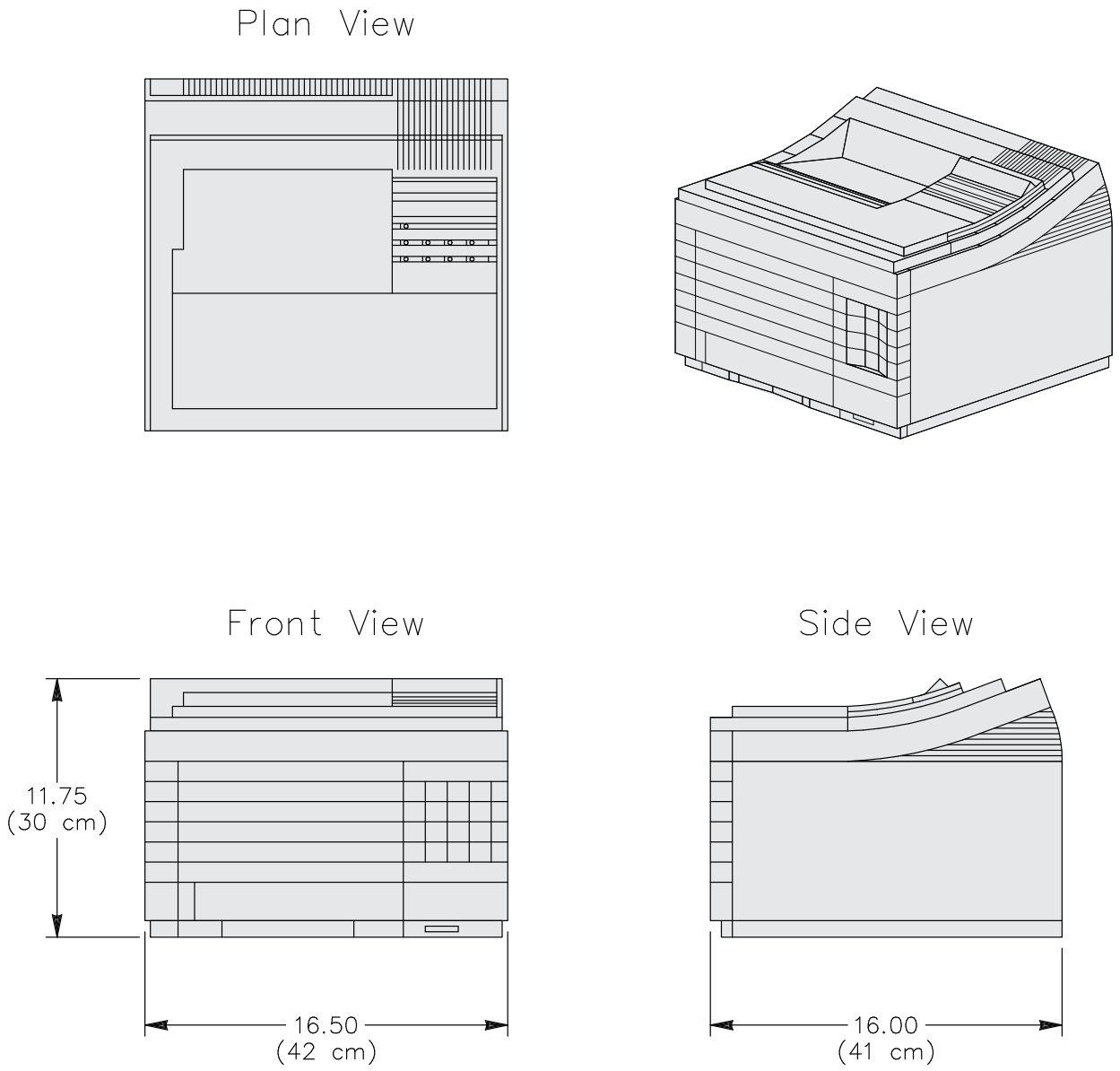


Figure 6-14. Line Printer (LP-6)

Single Display Table (TBL-3)

The single display table (TBL-3) accommodates one color graphics display terminal (GDT-200). Cray Research also supplies one operator's chair for each maintenance workstation (MWS) and one for each operator workstation (OWS).

Table 6-10 provides additional specifications for the TBL-3. Refer to Figure 6-15 for an illustration of the TBL-3.

Table 6-10. TBL-3 Specifications

Characteristic	Specification
Height	32.00 in. (81 cm)
Width	30.00 in. (76 cm)
Depth	33.00 in. (84 cm)
Weight	95 lbs (43 kg)
Access requirements	48.00 in (122 cm) front

You must prepare a single floor cutout for the TBL-3 to accommodate the power and data connections for the GDT-200. Refer to Figure 6-16 for an illustration of this floor cutout.

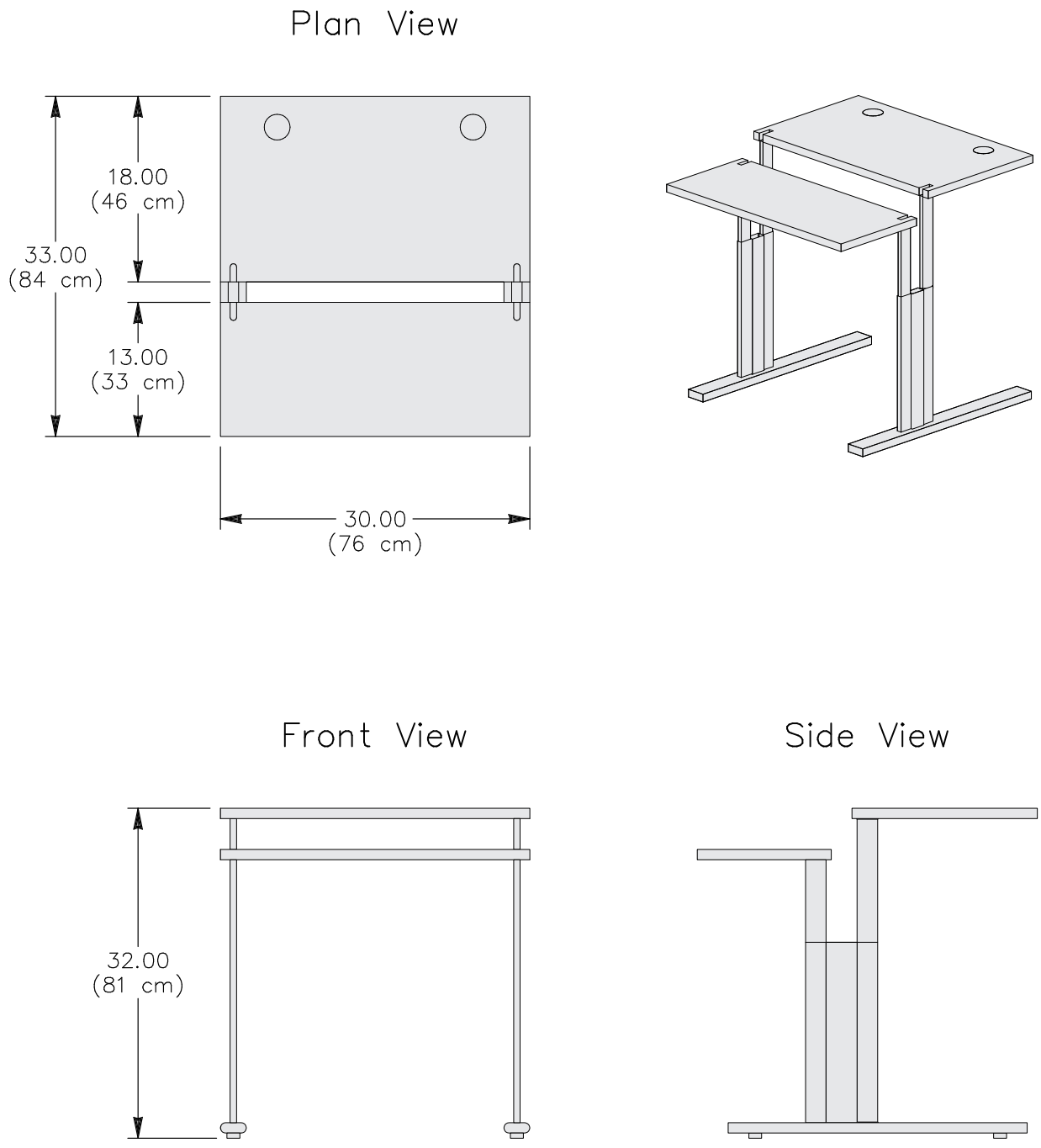


Figure 6-15. Single Display Table (TBL-3)

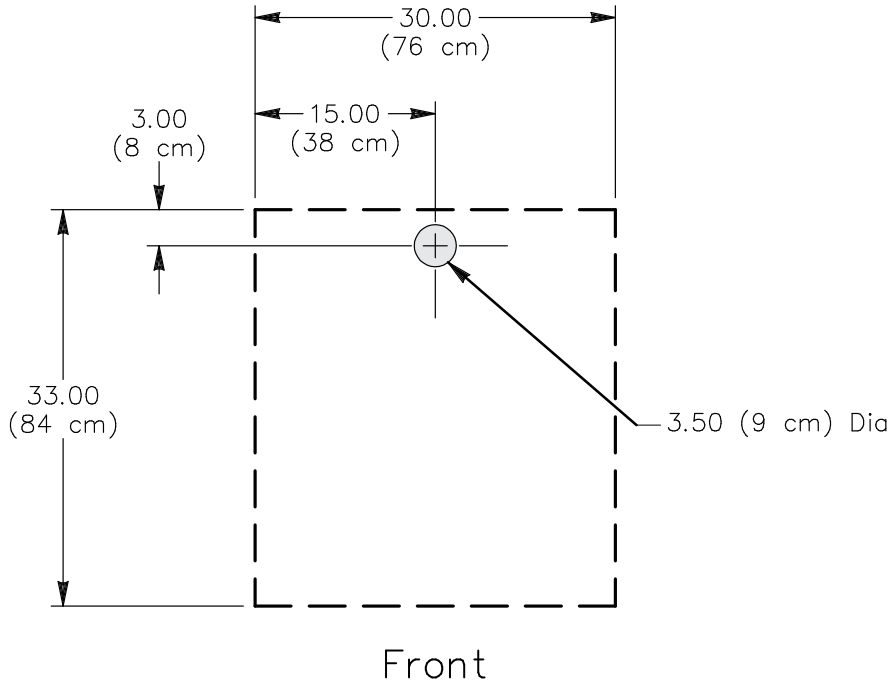


Figure 6-16. TBL-3 Floor Cutout Requirements

Front-end Interface Cabinet (FEC)

The front-end interface cabinet (FEC) houses special interface modules, power supplies, and controls.

Table 6-11 provides additional specifications for the FEC. Refer to Figure 6-17 for an illustration of the FEC. When multiple FECs are configured, an optional kit enables two FECs to be stacked. Refer to Figure 6-18 for an illustration of the FEC stacking cabinet kit.

Table 6-11. FEC Specifications

Characteristic	Specification
Height	23.00 in. (58 cm)
Width	26.25 in. (67 cm)
Depth	20.00 in. (51 cm)
Weight	200 lbs (91 kg)
Access requirements: Front and back Sides	 36.00 in. (91 cm) 6.00 in. (15 cm)
Heat dissipation to air	1,810 Btu/hr (530 W)
Cooling requirements	Ambient air
Power cable	10-ft (3-m) pluggable drop cord
Power receptacle	NEMA-type 5-15R (box mounted or in line)

Table 6-12 identifies the Cray Research front-end interfaces (FEIs) that are currently available and the signal-cable lengths for each. In some instances, the FEI is located within the mainframe chassis (MFC) or input/output subsystem (IOS) chassis. In all other instances, the FEI is located within front-end interface cabinets (FECs).

Cray Research supplies all signal cables associated with the FEIs, including the front-end computer system channel cables. Cray Research also installs all FEI signal cables except the front-end channel cables. You must arrange for the installation of the Cray Research-supplied front-end channel cables.

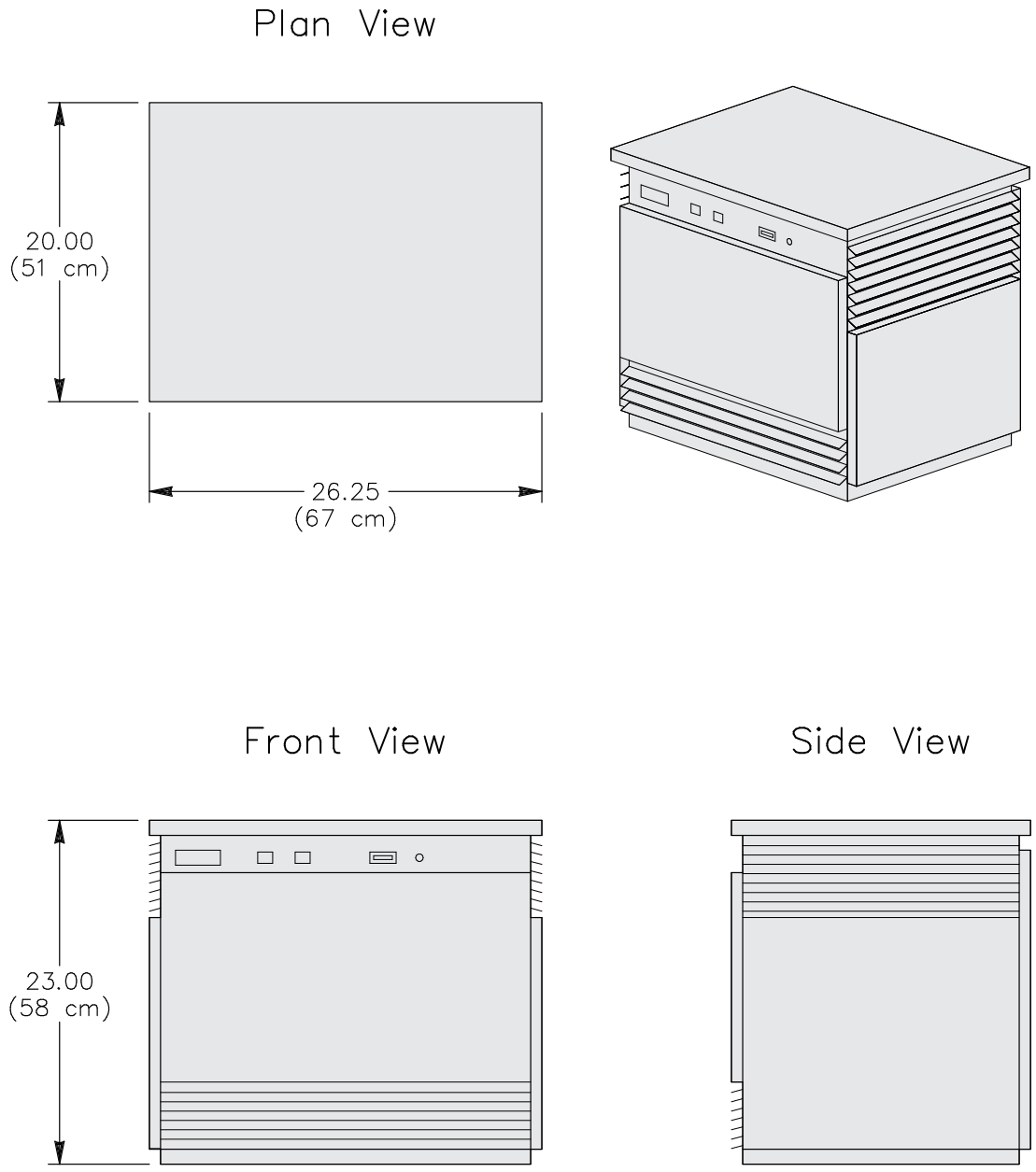


Figure 6-17. Front-end Interface Cabinet (FEC)

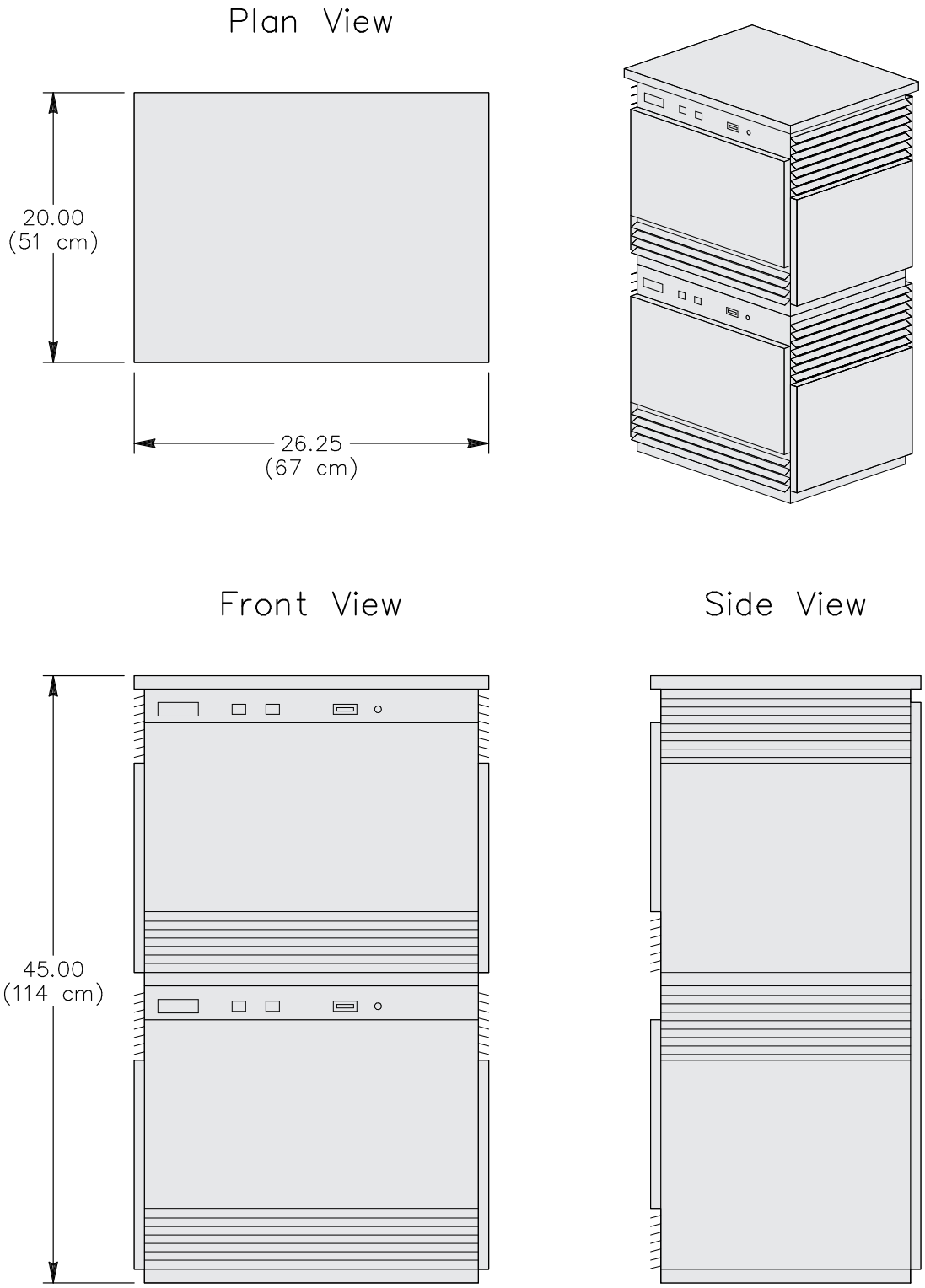


Figure 6-18. FEC Stacking Cabinet Kit

The separation limits from the IOS to an interfacing computer system are defined in Table 6-12. In some instances, the FEI is located within the front-end computer system, mainframe chassis, or IOS chassis. In all other instances, the FEI is located within the FECs. The IOS refers to the IOS contained within the CRAY C94, CRAY D94, CRAY C98, or DRAY D98 mainframe or to the IOS in the IOS/SSD chassis.

Table 6-12. Signal-cable Lengths for Cray Research Standard FEIs

Front-end Interface (FEI-1)	Standard	Maximum
IOS to standard FEC	200 ft (61.0 m) †	500 ft (152.5 m) †
FEC to CDC 6000	65 ft (19.8 m)	65 ft (19.8 m)
FEC to CDC 7600 computer system	30 ft (9.2 m)	70 ft (21.4 m)
FEC to Honeywell, Inc. computer system	40 ft (12.2 m)	75 ft (22.9 m)
FEC to IBM computer system data-streaming mode nondata-streaming mode	 25 ft (7.6 m) 25 ft (7.6 m)	 400 ft (122.0 m) 200 ft (61.0 m)
FEC to DEC PDP/VAX computer system	15 ft (4.6 m)	15 ft (4.6 m)
FEC to Unisys computer system	25 ft (7.6 m)	200 ft (61.0 m)
FEC to Amdahl computer system	25 ft (7.6 m)	200 ft (61.0 m)
FEC to Fujitsu computer system	25 ft (7.6 m)	200 ft (61.0 m)
Front-end Interface (FEI-2)	Standard	Maximum
IOS to NSC computer system	50 ft (15.3 m)	50 ft (15.3 m)
IOS to Data General computer system	50 ft (15.3 m)	50 ft (15.3 m)
IOS to DEC BI computer system	50 ft (15.3 m)	50 ft (15.3 m)
IOS to another Cray Research MFC or IOS	50 ft (15.3 m)	500 ft (152.5 m) †
IOS to Model E MFC or IOS	50 ft (15.3 m)	550 ft (167.8 m) †
IOS to CRAY-2 MFC	50 ft (15.3 m)	550 ft (167.8 m) †
Front-end Interface (FEI-3)	Standard	Maximum
IOS to Sun computer system	50 ft (15.3 m)	50 ft (15.3 m)
IOS to Motorola computer system	50 ft (15.3 m)	50 ft (15.3 m)

† An FEC adapter cabinet is required.

When an FEC is configured, or when the distance between the IOS and another Cray Research computer system is more than 50 ft (15.3 m), adapter FECs are required. Refer to Figure 6-19 through Figure 6-22 for illustrations of these configurations and separation limits. The site preparation requirements for an adapter FEC are identical to FEC requirements.

NOTE: Only a single cable of a channel pair is shown in Figure 6-19 through Figure 6-22.

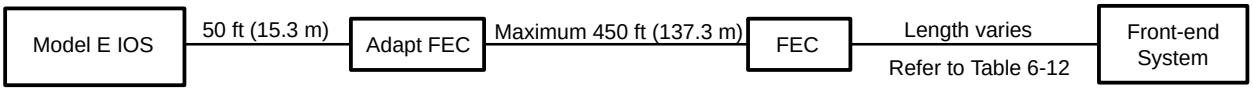


Figure 6-19. Separation Limit from a Model E IOS to an Interfacing Computer System when the FEI is Located within the FEC

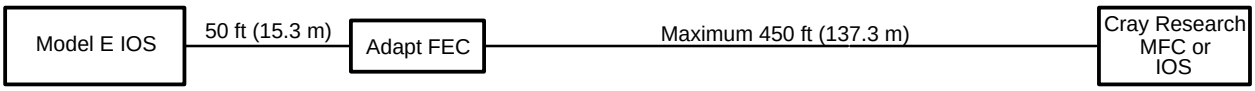


Figure 6-20. Separation Limit from a Model E IOS to a Cray Research MFC/IOS Computer System beyond 50 ft (15.3 m)

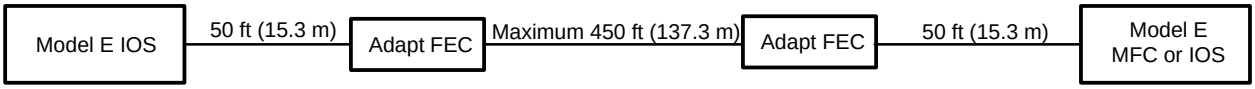


Figure 6-21. Separation Limit from an IOS to a Model E MFC or IOS beyond 50 ft (15.3 m)

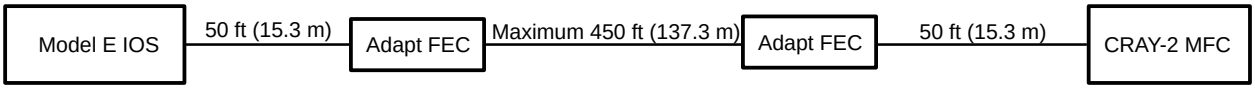


Figure 6-22. Separation Limit from a Model E IOS to a CRAY-2 Computer System beyond 50 ft (15.3 m)

You must prepare a single floor cutout for the FEC. Refer to Figure 6-23 for an illustration of this floor cutout.

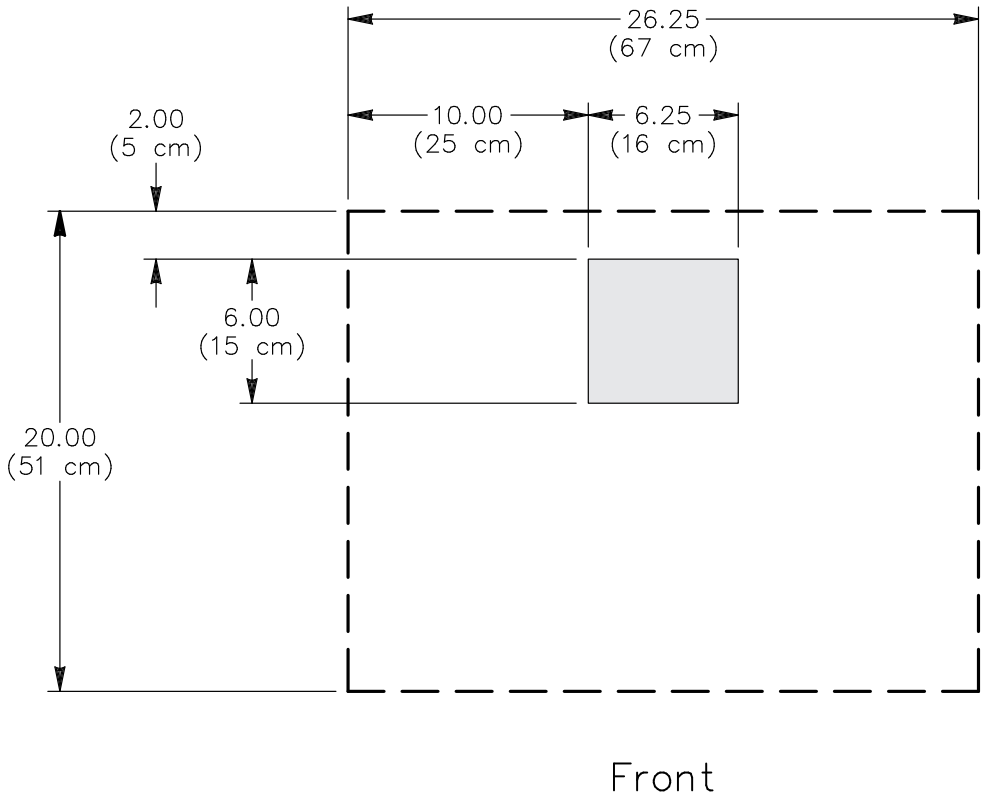


Figure 6-23. FEC Floor Cutout Requirements

Fiber-optic Link (FOL)

The fiber-optic link (FOL) extends the standard distance between the Cray Research computer system and the front-end system and enables complete electrical isolation. The FOL consists of two cabinets connected with fiber-optic cable: the FOL and the front-end interface (FEI/FOL). The FOL cabinet houses devices that convert the electronic signal to an optical signal; the FEI/FOL cabinet houses the interface modules and the devices to convert the optical signal to an electronic signal. The FOL and the FEI/FOL cabinets have identical site planning requirements.

The FOL and FEI/FOL cabinets are used in pairs (refer to Figure 6-24). You must position the FOL cabinet within 40 ft (12.2 m) of the IOS chassis. The FEI/FOL cabinet is usually positioned close to the front-end computer system.

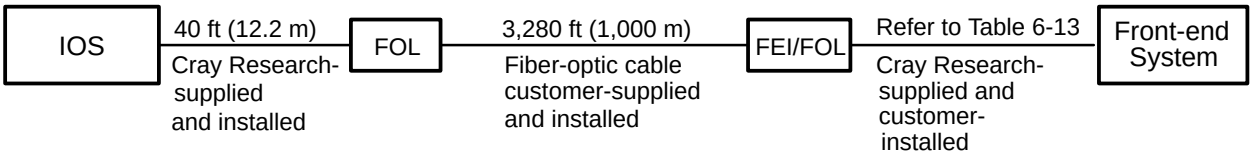


Figure 6-24. FOL and FEI/FOL Separation Limits

When multiple FOL or FEI/FOL cabinets are configured, an optional stacking kit, similar to the FEC stacking cabinet kit (refer again to Figure 6-18), permits two FOL or FEI/FOL cabinets to be stacked.

You must supply and install the fiber-optic cable between the FOL and the FEI/FOL cabinets as indicated in Figure 6-24. Cray Research site planning documentation (available on request) specifies which type of fiber-optic cable you must install.

Cray Research supplies and installs the signal cables between the IOS and the FOL. You must arrange for the installation of the Cray Research-supplied signal cables between the front-end system and the FEI/FOL cabinet.

The cable-length restrictions between the FEI/FOL cabinet and the various front-end systems are listed in Table 6-13. The maximum cable length between the FOL and the FEI/FOL cabinets is 3,280 ft (1,000 m).

Table 6-13. Signal-cable Lengths for FOL Interfaces

Front-end Interface (FEI)	Standard	Maximum
FEI/FOL to CDC 6000 computer system	65 ft (19.8 m)	65 ft (19.8 m)
FEI/FOL to CDC 7600 computer system	30 ft (9.2 m)	70 ft (21.4 m)
FEI/FOL to Honeywell, Inc. computer system	40 ft (12.2 m)	75 ft (22.9 m)
FEI/FOL to IBM computer system data-streaming mode nondata-streaming mode	 25 ft (7.6 m) 25 ft (7.6 m)	 400 ft (122.0 m) 200 ft (61.0 m)
FEI/FOL to PDP/VAX computer system	15 ft (4.6 m)	15 ft (4.6 m)
FEI/FOL to Unisys computer system	25 ft (7.6 m)	200 ft (61.0 m)
FEI/FOL to Amdahl computer system	25 ft (7.6 m)	200 ft (61.0 m)
FEI/FOL to Fujitsu computer system	25 ft (7.6 m)	200 ft (61.0 m)

Table 6-14 provides additional specifications for the FOL and FEI/FOL cabinets. Refer to Figure 6-25 for an illustration of the FOL and FEI/FOL.

Table 6-14. FOL and FEI/FOL Specifications

Characteristic	Specification
Height	27.00 in. (69 cm)
Width	26.25 in. (67 cm)
Depth	22.50 in. (57 cm)
Weight	240 lbs (109 kg)
Access requirements: Front and back Sides	 36.00 in. (91 cm) 6.00 in. (15 cm)
Heat dissipation to air	1,190 Btu/hr (350 W)
Cooling requirements	Ambient air
Power cable	10-ft (3-m) pluggable drop cord
Power receptacle	NEMA-type 5-15R (box mounted or in line)

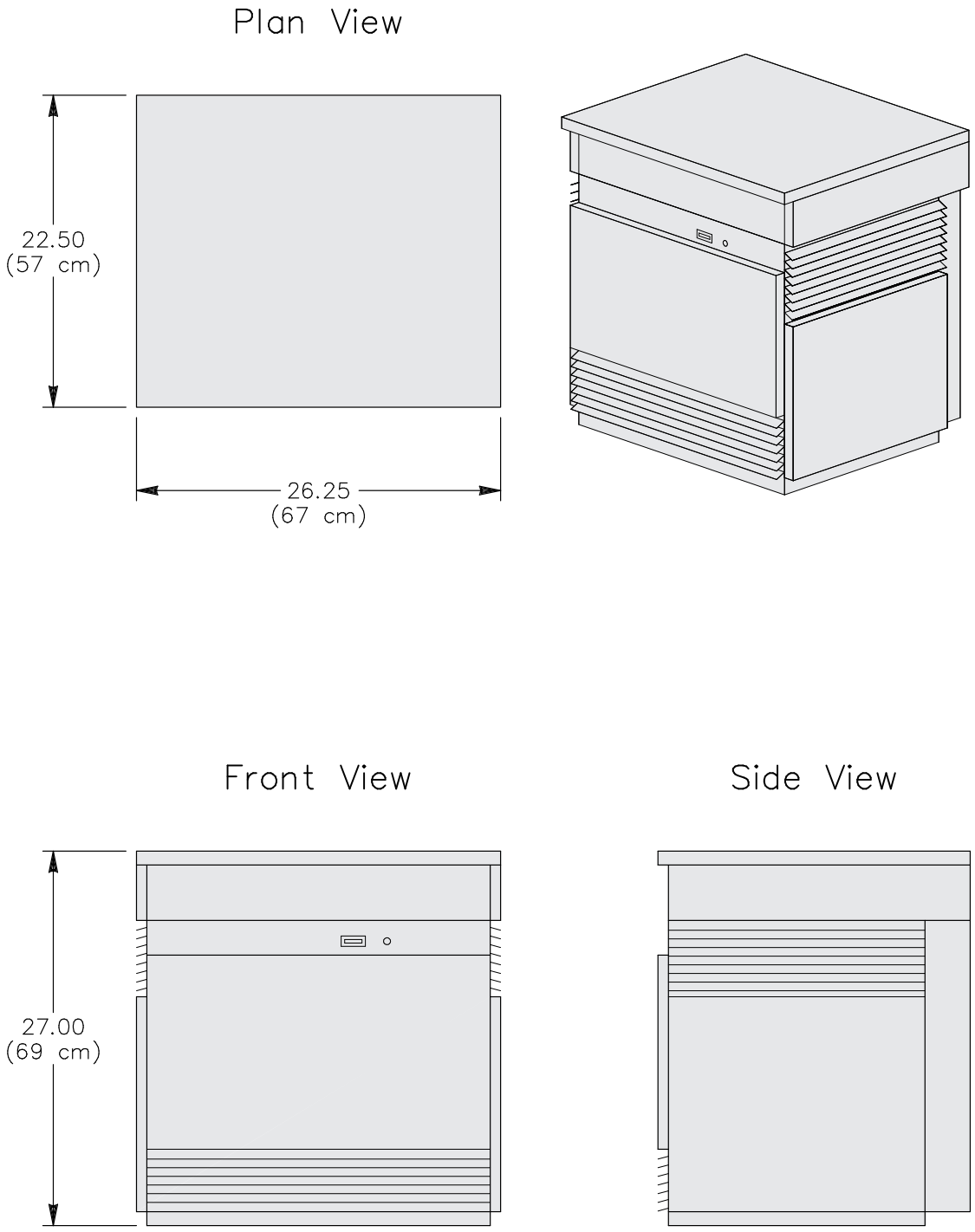


Figure 6-25. FOL and FEI/FOL Cabinets

You must prepare three floor cutouts for the FOL and FEI/FOL. Refer to Figure 6-26 for an illustration of these floor cutouts.

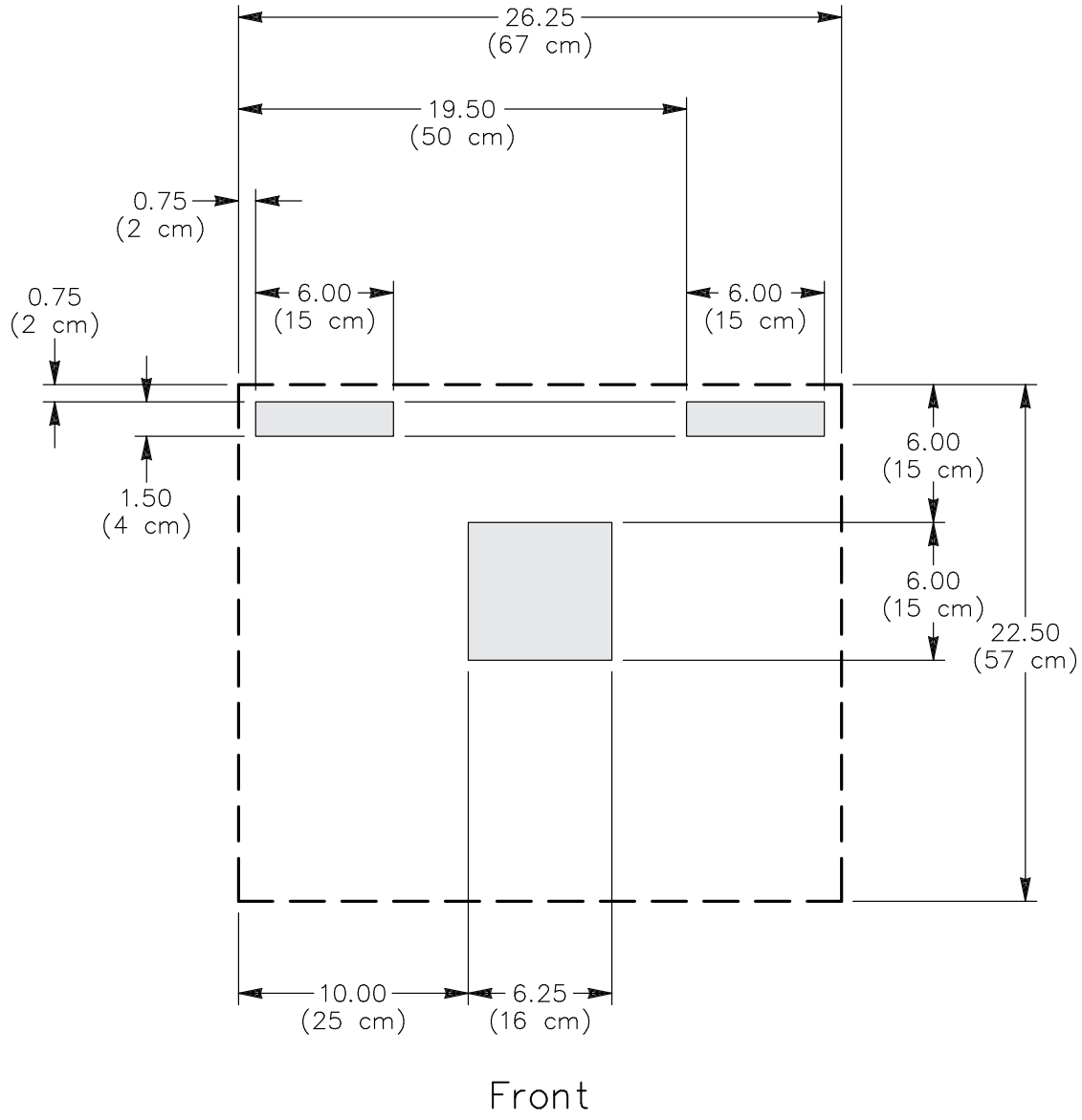


Figure 6-26. FOL and FEI/FOL Floor Cutout Requirements

Fiber-optic Link (FOL-4)

The fiber-optic link (FOL-4) is desk-mounted and extends the standard distances [up to 2.5 miles (4 km)] between a Cray Research computer system and a front-end system. Refer to Figure 6-27 and Figure 6-28 for illustrations of the FOL-4 separation limits.

Two FOL-4s are needed to provide an extension of this distance. One FOL-4 converts the electronic signal to an optical signal; the other FOL-4 converts the optical signal to an electronic signal. Refer to Figure 6-29 for an illustration of the FOL-4.

The FOL-4 operates at rates up to 100 Mbits/s and is compatible with all Cray Research computer systems. The FOL-4 supports both 6-Mbyte/s and 12-Mbyte/s speeds and provides complete electrical isolation. The FOL-4 specifications are provided in Table 6-15.

Table 6-15. FOL-4 Specifications

Characteristic	Specification
Height	7.25 in. (18 cm)
Width	19.00 in. (48 cm)
Depth	11.00 in. (28 cm)
Weight	15 lbs (7 kg)
Access requirements: Sides Front and back	 6.00 in. (15 cm) 36.00 in. (91 cm)
Cooling requirements	Ambient air
Power cable	Country specific
Power receptacle	Country specific

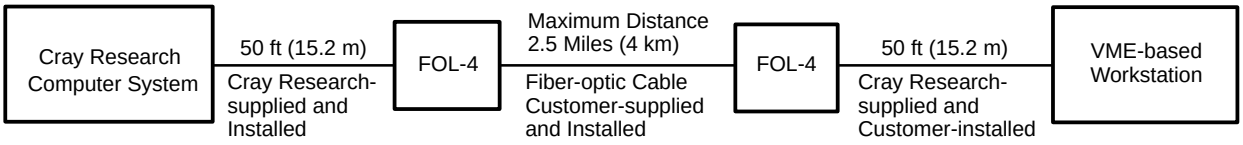


Figure 6-27. FOL-4 Separation Limits

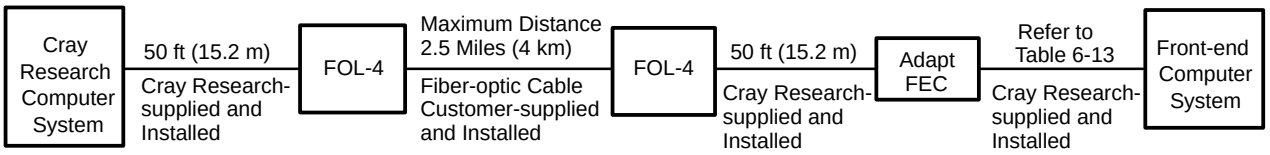


Figure 6-28. FOL-4 Separation Limits with Adapter FEC

You must supply and install the fiber-optic cable between the FOL-4s. Contact your site planning representative for specific information on the type of fiber-optic cable you must install.

Cray Research supplies and installs the signal cables between the CRAY C916 IOS/SSD, or the CRAY C98, CRAY D98, CRAY C94, or CRAY D94 MFC and the FOL-4. You must arrange for the installation of the Cray Research-supplied signal cables between the front-end system and the FOL-4 cabinet. The site preparation requirements for an adapter FEC are identical to those for an FEC (refer to the subsection on the FEC).

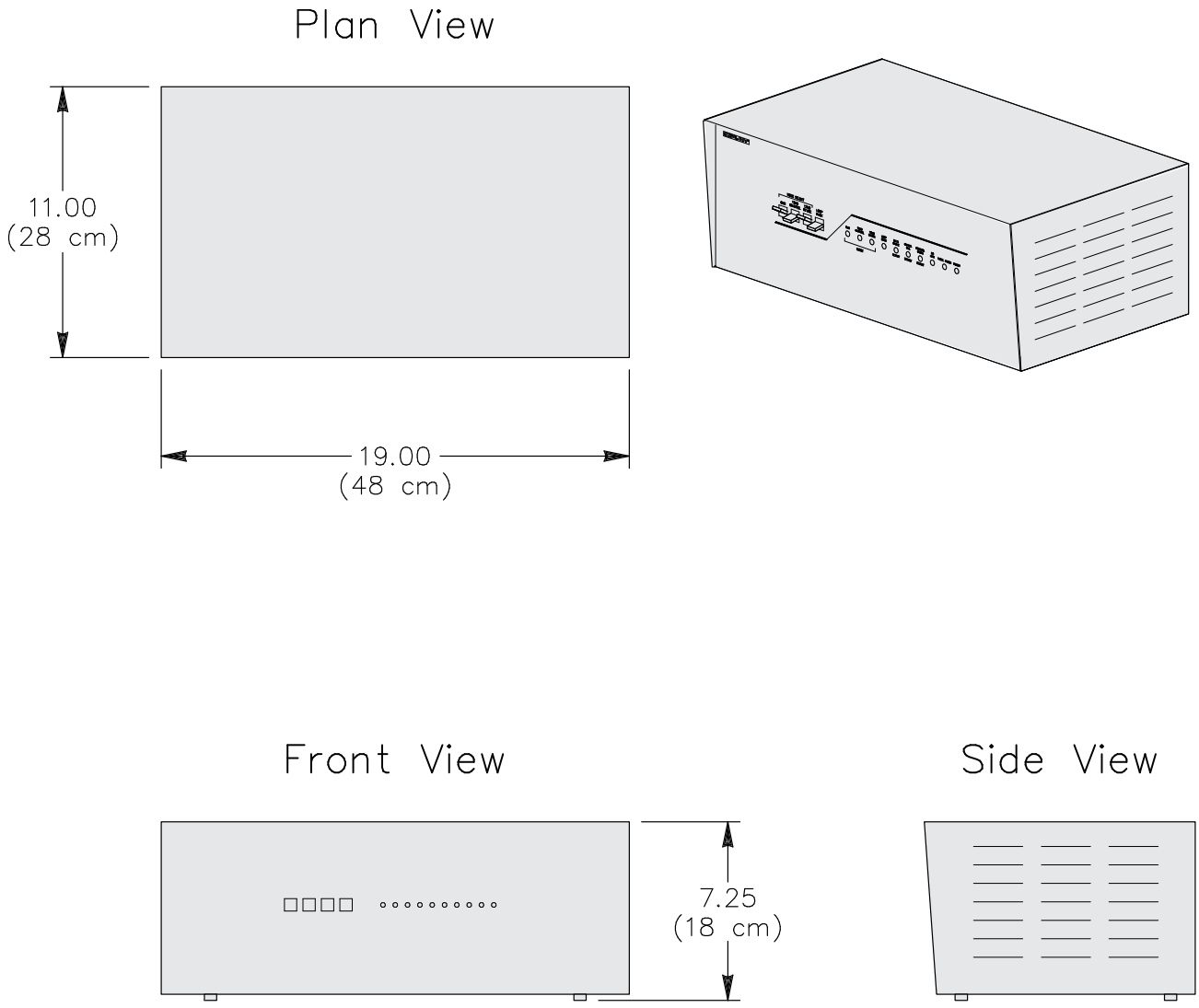


Figure 6-29. FOL-4

Fiber-optic Enclosure (FOE-1)

The fiber-optic enclosure (FOE-1) is a small air-cooled device designed to to support various Cray Research, Inc. fiber-optic converters and extender products. The FOE-1 internal logic chassis can accommodate up to four fiber-channel extender [FCE-1 (FDDI) or FCE-2 (ESCON)] modules. Refer to Figure 6-30 for an illustration of the FOE-1 enclosure.

FOE-1 enclosures can be stacked on top of each other or rack mounted into an industry standard 19-inch cabinet. The FOE-1 enclosure can also be located under the raised floor.

The separation limits for the FOE-1 enclosure and the front-end system varies, depending upon the type of module that is used in the FOE-1. Figure 6-31 represents the separation limits for an FOE-1 enclosure with FCE-1 modules. Figure 6-32 represents the separation limits for an FOE-1 enclosure with FCE-2 modules.

Table 6-16. FOE-1 Specifications

Characteristic	Specification
Height	6.75 in. (17 cm)
Width	17.00 in. (43 cm)
Depth	15.00 in. (38 cm)
Weight	34 lbs (15 kg)
Heat dissipation to aire	573 Btu/hr (168 W)
Cooling requirements	Ambient air
Voltage	100 to 120 or 200 to 240 Vac
Frequency	50 or 60 Hz
Power cable	6-ft (1.8-m) pluggable drop cord
Power receptacle	Country specific

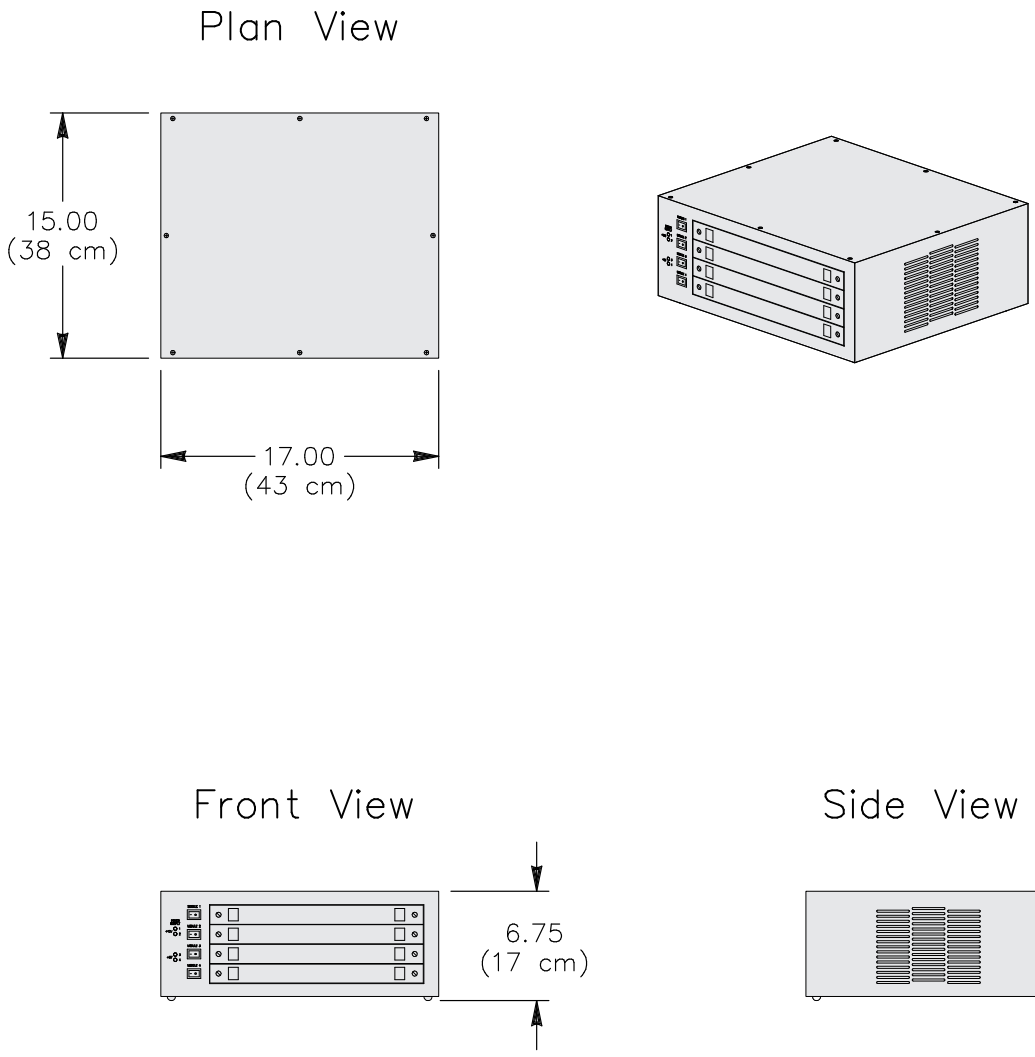


Figure 6-30. Fiber-optic Enclosure (FOE-1)

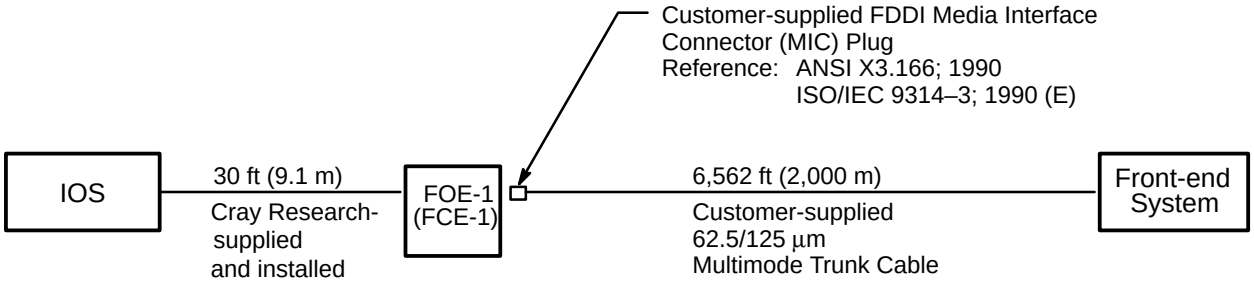


Figure 6-31. FOE-1 Enclosure with FCE-1 Modules Separation Limits

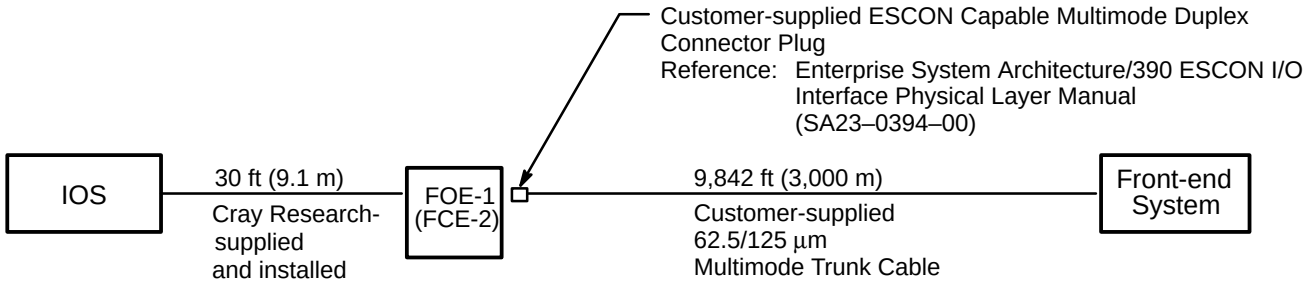


Figure 6-32. FOE-1 Enclosure with FCE-2 Modules Separation Limits

7 SUPPORT EQUIPMENT

Support equipment is divided into two categories: refrigeration condensing units (RCUs) and power and distribution equipment. Refrigeration condensing units are used with the heat exchanger units (HEUs) to remove heat from the computer system. The power distribution devices include motor-generator sets (MGSs), the motor-generator parallel cabinet (MGPC), and the power distribution cabinet (PDC). These devices are used to generate and distribute power to the computer system components. The following subsections provide information about these devices.

Refrigeration Condensing Units

Refrigeration condensing units (RCUs) are used to remove heat from Cray Research electronic hardware. The following subsections provide general refrigeration piping requirements and specifications, floor preparation requirements, power requirements, and refrigeration piping requirements for the RCU-5A and RCU-9.

General Refrigeration and Water Piping Requirements

Cray Research supplies the *Refrigeration Piping and Component Installation Requirements*, Site Engineering document number 10650228, at the initial site planning meeting. This document details the requirements for installing and testing the refrigerant piping. The following list provides general piping information:

- Cray Research recommends that you install all refrigerant and cooling water piping in the immediate area of the RCU after receiving the RCU. You must ensure you have time to discover and correct any discrepancies in the piping locations before installing the computer system.

- The cooling water system must include a water strainer on the inlet side of the water circuit close to the RCU. The location of the water strainer must be designed with a bypass or similar construction to enable it to be cleaned or replaced without disrupting water flow.

- The RCU incorporates a two-way water flow regulating valve.
- You must install temperature, pressure, and flow-rate indicators within your cooling-water piping system.
- The RCU is equipped with pressure relief valves that must be routed to a safe venting location. The pressure relief valve accepts a 5/8-in. (1.6-cm) flare fitting.
- The RCU liquid- and suction-line service valves must not be opened by you or by your subcontractor before, during, or after installation of the RCU and the associated pipework. The RCU is minimally charged with refrigerant at the factory. At the time of system installation, Cray Research system installation personnel open the valves, adjust all controls and valves, power up the RCU, and add additional R-22 refrigerant to fully charge the system.

Refrigeration Condensing Unit (RCU-5A)

The RCU-5A contains major components of the refrigeration system used to cool Cray Research electronic hardware. The RCU-5A is shown in Figure 7-1.

The RCU-5A contains the following components:

- Two 40-HP, motor-driven compressors that operate in tandem
- A water-cooled condenser
- Pressure controls
- A suction-line accumulator
- Filter driers
- An active oil-level control system
- A liquid-line sight glass
- A two-way water regulating valve
- A programmable controller
- A water-flow meter

Table 7-1 provides specifications for the RCU-5A. None of the specifications include the optional noise-reduction panels. Refer to Figure 7-2 for an illustration of the RCU-5A with noise-reduction panels installed.

Table 7-1. RCU-5A Specifications

Characteristic		Specification
Height		44.00 in. (112 cm)
Width		34.00 in. (86 cm)
Depth		110.00 in. (279 cm)
Weight		3,015 lbs (1,367 kg)
Heat dissipation to air		25.86 kBtu/hr (7.58 kW) maximum
Access requirements		24.00 in. (61 cm) minimum on all sides †
Shipping size:	Height Width Depth	45.00 in. (114 cm) 34.00 in. (86 cm) 144.00 in. (366 cm)
Shipping weight		3,419 lbs (1,551 kg)

† Provide an adequate working clearance in front of the input power box.

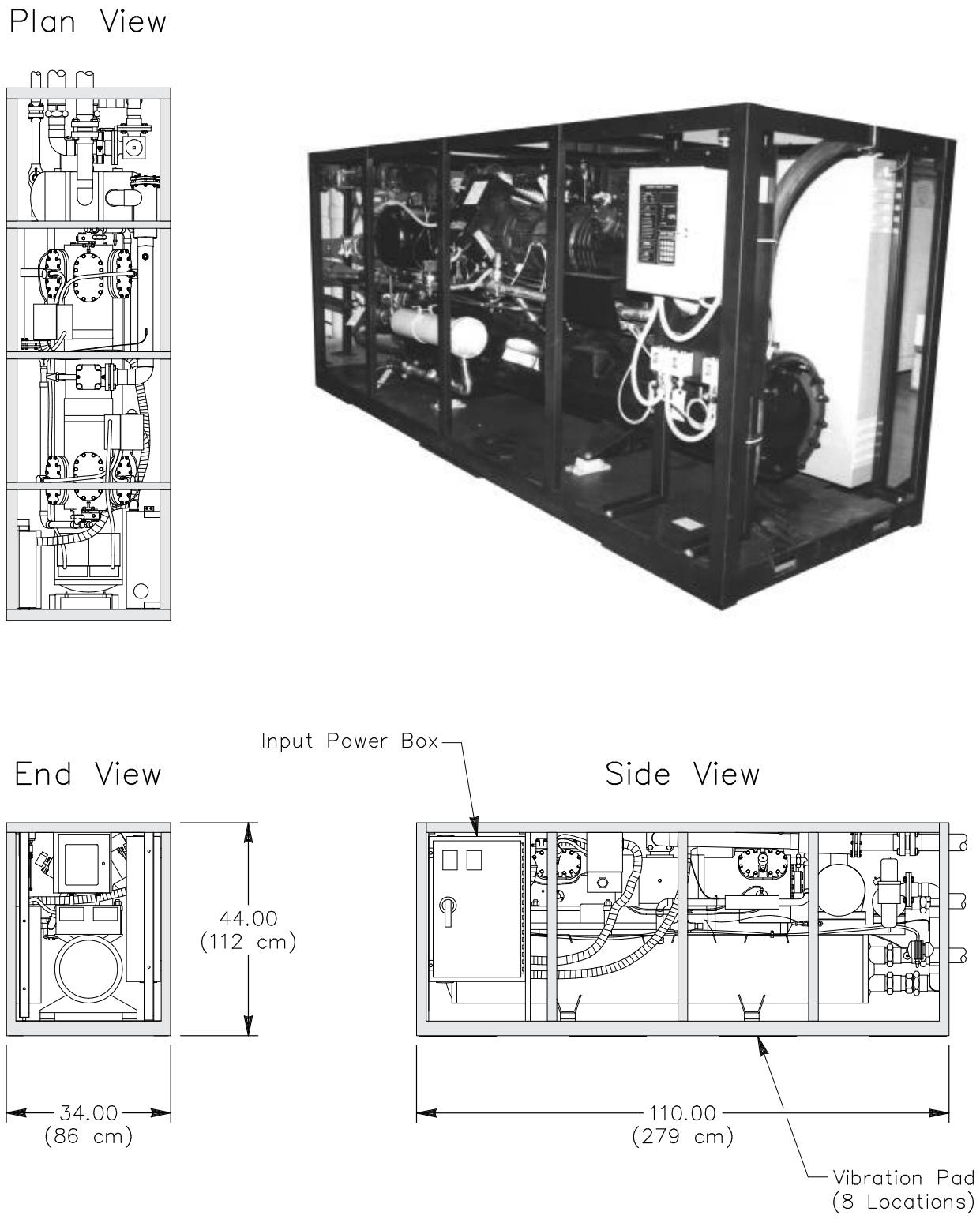


Figure 7-1. Refrigeration Condensing Unit (RCU-5A)

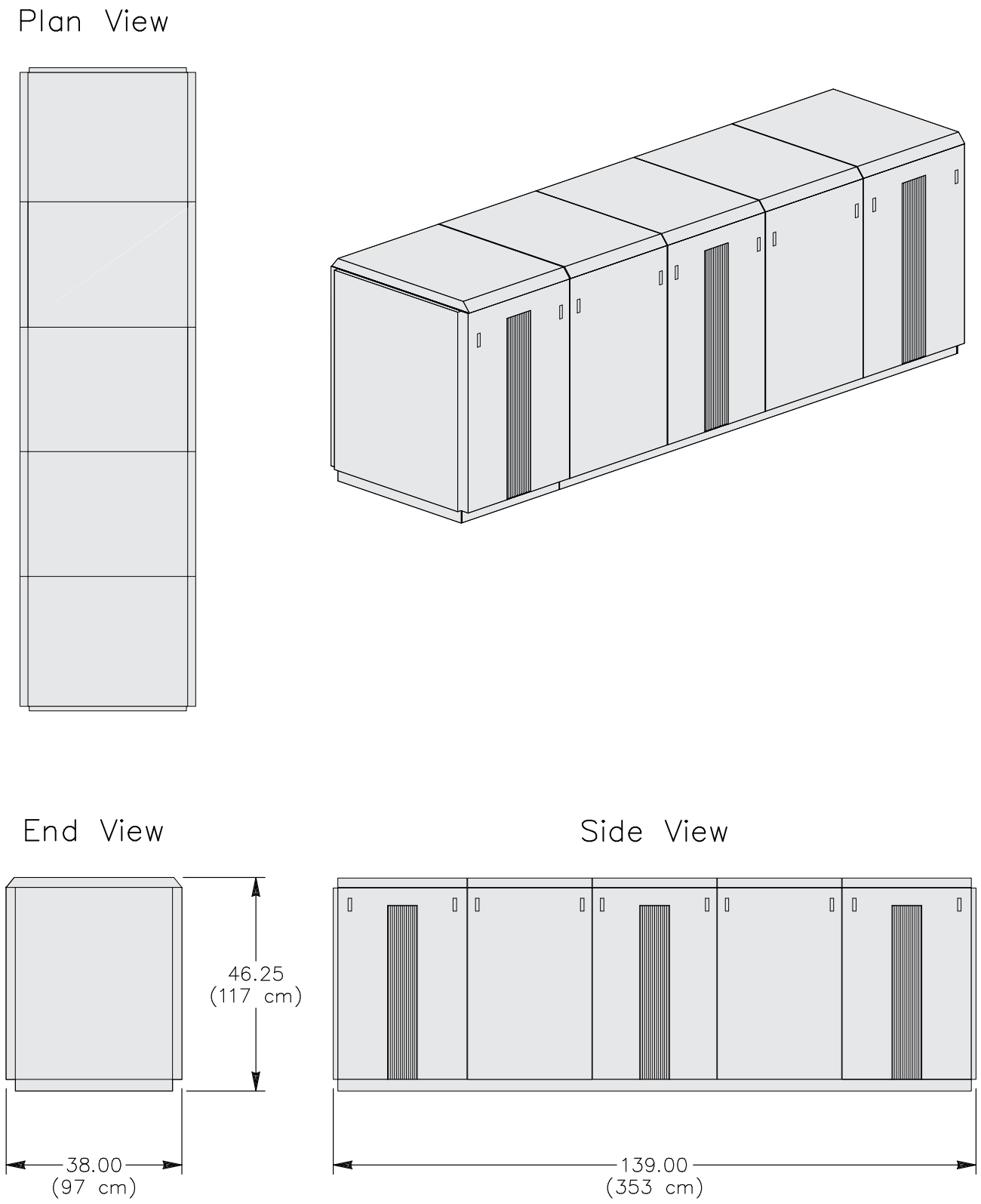


Figure 7-2. RCU-5A with Optional Noise-reduction Panels

Floor Preparation

If the RCU-5A will be located in the computer room and not on a mounting frame, you must prepare two floor cutouts. Figure 7-3 shows the floor cutout areas for the RCU-5A that enable connections of the water pipes, refrigeration pipes, and electrical connections.

In addition to preparing the floor cutouts, you must install eight vibration pads supplied by Cray Research with the RCU-5A. Space the vibration pads under each side as shown in Figure 7-4.

Cray Research recommends that you provide a mounting frame if the RCU-5A is located in the computer room. The mounting frame isolates vibration generated by the RCU-5A and should be bolted to the subfloor. Figure 7-4 shows the RCU-5A mounting frame.

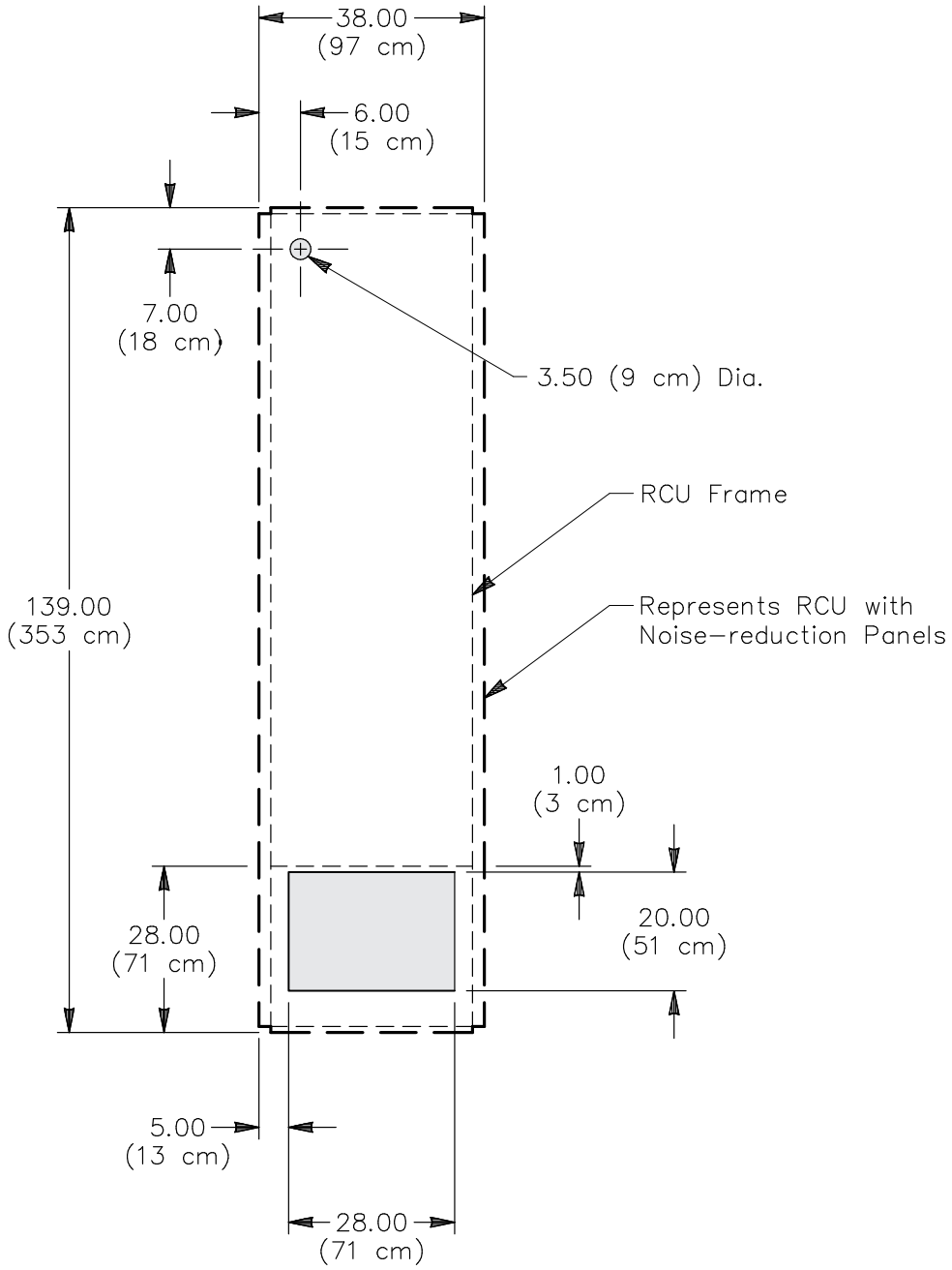
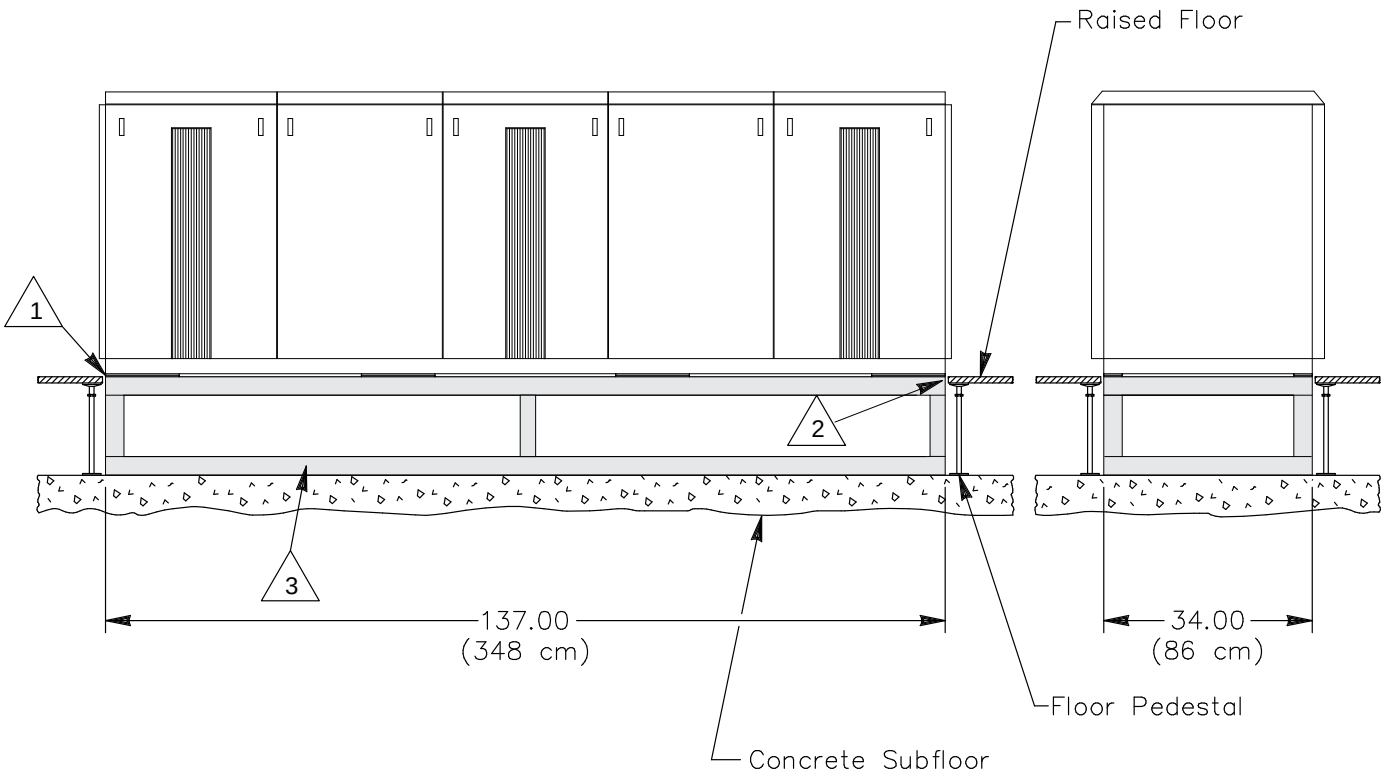


Figure 7-3. RCU-5A Floor Cutouts



NOTES:

1. Cray Research-supplied vibration pads.
2. Mounting frame should be flush with computer room raised flooring ±0.25 in. (0.6 cm) minimum.
3. Mounting frame is constructed from angle iron, which measures 3 in. (7.6 cm) x 3 in. (7.6 cm) x 0.25 in. (0.6 cm) minimum.

Figure 7-4. RCU-5A Mounting Frame

Refrigeration Piping Requirements

The RCU-5A has piping requirements that are additional to those outlined in the "General Refrigeration and Water Piping Requirements" subsection in this section.

Figure 7-5 shows the locations of the refrigerant-liquid piping and cooling-water connections on the RCU-5A. Figure 7-6 is a schematic of the typical piping requirements for the RCU-5A. The following information further describes the refrigerant-liquid piping and cooling-water connections.

- Figure 7-5 shows the locations of the refrigerant suction- and liquid-line connection ports. Cray Research supplies mating halves of the refrigerant flange couplings with associated gaskets and capped copper tubing to connect the remaining customer-supplied refrigerant piping circuitry. The liquid-line flange coupling stub is 1 5/8-in. (4.1-cm) o.d. copper tubing, and the suction-line flange coupling stub is 3 1/8-in. (7.9-cm) o.d. copper tubing. The length of both the liquid- and suction-line stubs is approximately 6 in. (15.2 cm). You must provide and install all materials and components necessary to complete the refrigerant-piping circuitry connection to these ports in the vertical position.

- You must provide and install refrigerant-line vibration absorbers, which are sized according to the suction- and liquid-line flange couplings. Install the vibration absorbers directly in front of the RCU-5A connection ports in the vertical position.

- The refrigerant lines must be routed downward and covered by an RCU-5A cabinet extension if the RCU-5A is installed in the computer room.

- Figure 7-5 shows the RCU-5A cooling-water inlet and outlet ports used to connect the cooling water lines. Cray Research supplies mating halves for the cooling-water union couplings. The couplings accept a 3 1/8-in. (7.9-cm) o.d. copper tube.

- You are responsible for providing and installing the vibration absorbers in the cooling water lines. Install the vibration absorbers directly in front of the RCU-5A connection ports in the vertical position.

- You must supply a minimum of 300 lbs (136 kg) of R-22 refrigerant per RCU-5A. Cray Research personnel use the R-22 refrigerant to fully charge the system during installation.

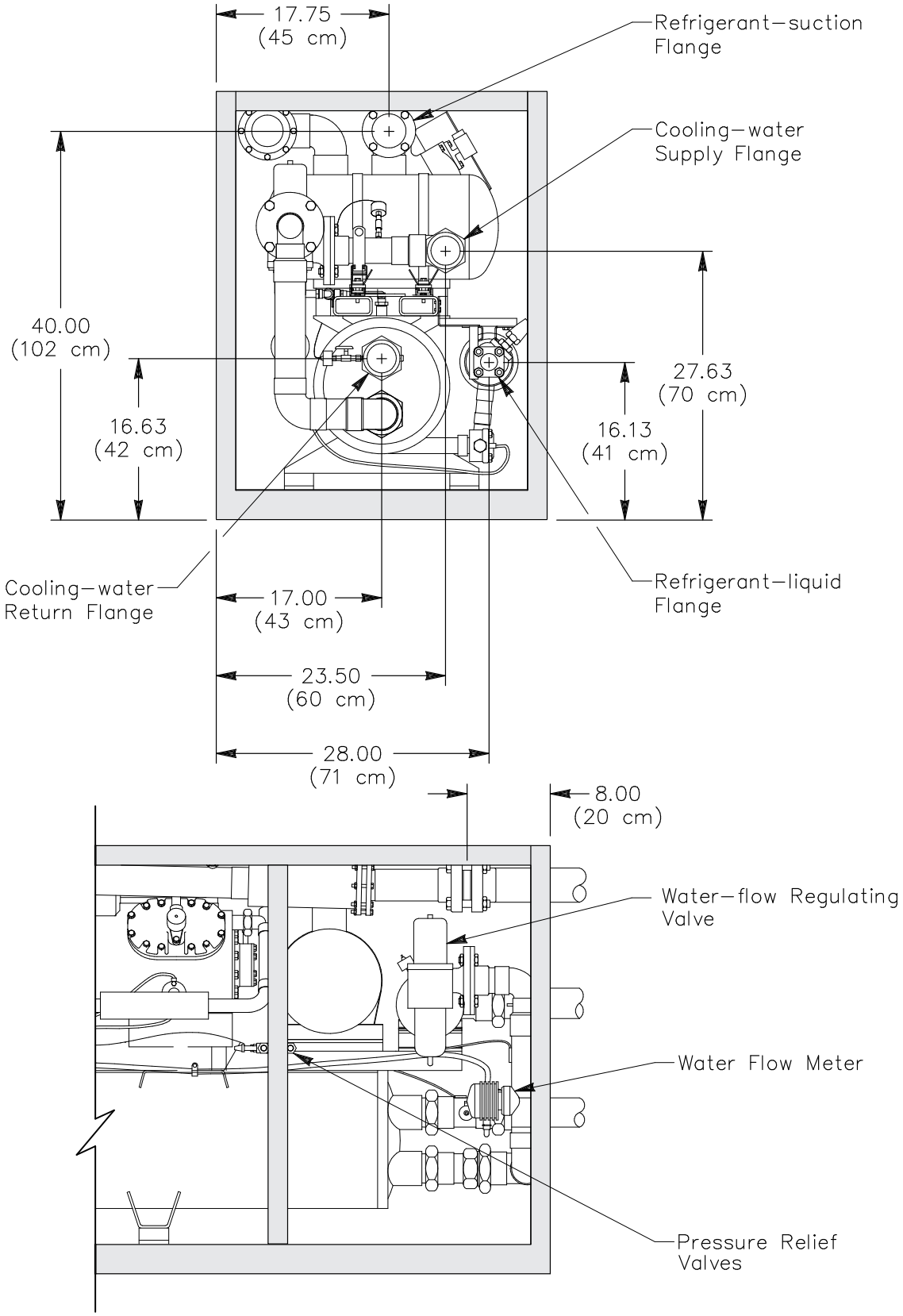
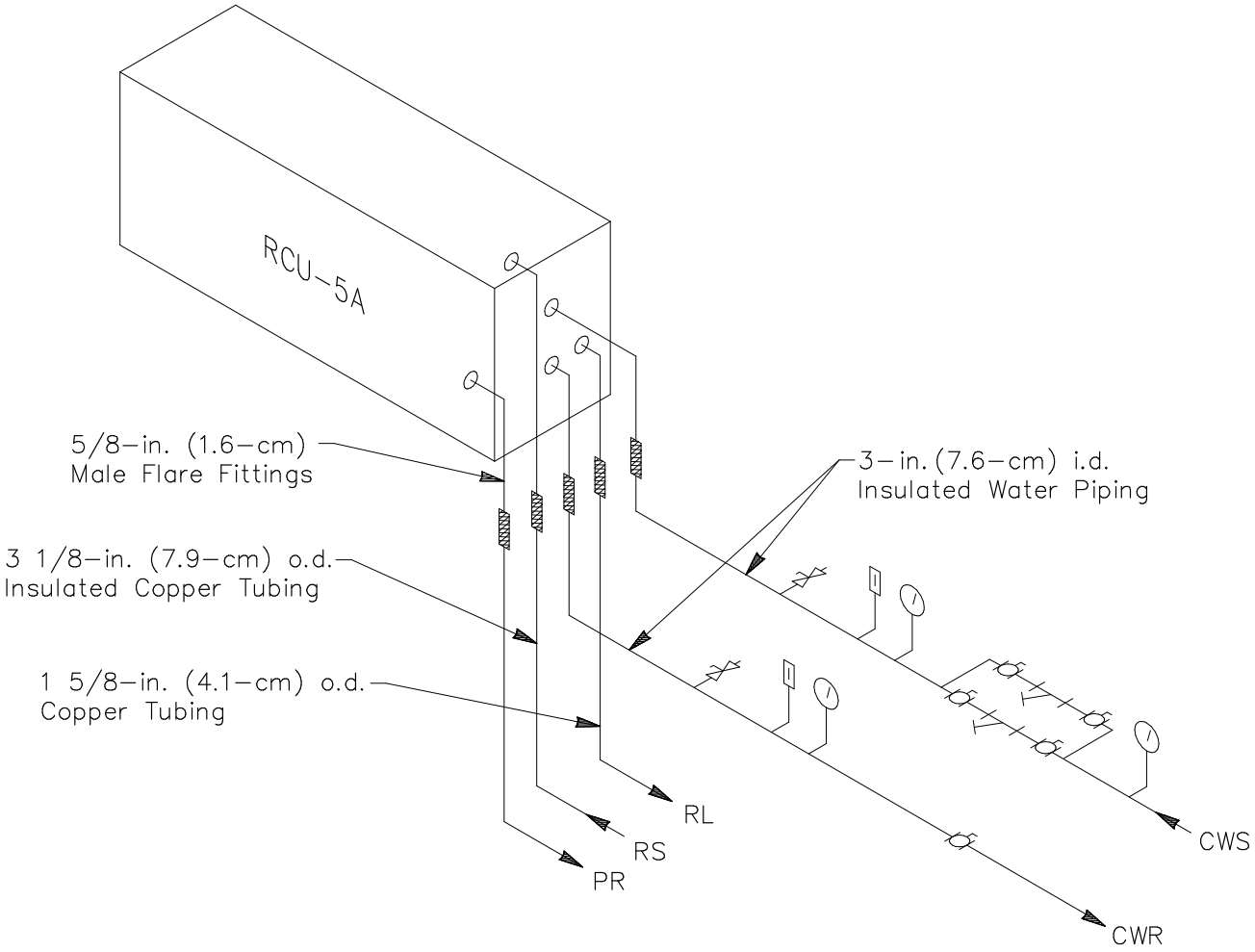


Figure 7-5. RCU-5A Piping Locations



KEY

PR	Pressure Relief		Hose Bib
RS	Refrigerant Suction		Flow Meter
RL	Refrigerant Liquid		Ball Valve
CWS	Cooling-water Supply		Temperature Gauge
CWR	Cooling-water Return		Pressure Gauge
	Vibration Eliminator		Direction of Flow
	Strainer with #40 Mesh		

Figure 7-6. Typical RCU-5A Piping Requirements

Power Wiring Requirements

You must supply and install the following power and control wiring for the refrigeration condensing unit (RCU-5A):

- One of the following 4-wire input power circuits (three phases plus one ground) rated at 175 amps:
  - 460 Vac, 60 Hz
  - 398 Vac, 50 Hz

- One 2-wire plus ground monitor circuit to the HEU-C90

If the RCU-5A is installed in the computer room, the 4-wire input power must enter the RCU-5A electrical box from the bottom. The location of the RCU-5A input power box is shown in Figure 7-1. The incoming power and monitoring circuits can enter the RCU-5A electrical box from either the top or bottom if the RCU-5A is installed in an equipment plant room.

CAUTION

Do not energize the RCU-5A prior to system installation. The compressor motor windings of the RCU-5A will overheat if operated without a heat load.

Refrigeration Condensing Unit (RCU-9)

The RCU-9 contains the major components of the refrigeration system used to cool electronic hardware in the mainframe. The RCU-9 is shown in Figure 7-7.

The RCU-9 contains the following components:

- Two 30-HP, motor-driven compressors that operate in tandem
- A water-cooled condenser
- Head-pressure and suction-pressure controls and gauges
- A suction-line accumulator
- Filter driers
- A liquid-line sight glass
- A two-way water regulating valve
- Capacity-reduction controls

Table 7-2 provides specifications for the RCU-9. None of the specifications include the optional noise-reduction panels. Refer to Figure 7-8 for an illustration of the RCU-9 with the noise-reduction panels installed.

Table 7-2. RCU-9 Specifications

Characteristic	Specification
Height	44.00 in. (112 cm)
Width	34.00 in. (86 cm)
Depth	110.00 in. (279 cm)
Weight	2,470 lbs (1,120 kg)
Heat dissipation to air	18.02 kBtu/hr (5.28 kW) maximum
Access requirements	24.00 in. (61 cm) minimum on all sides †
Shipping weight	2,874 lbs (1,303 kg)

† Provide an adequate working clearance in front of the input power box.

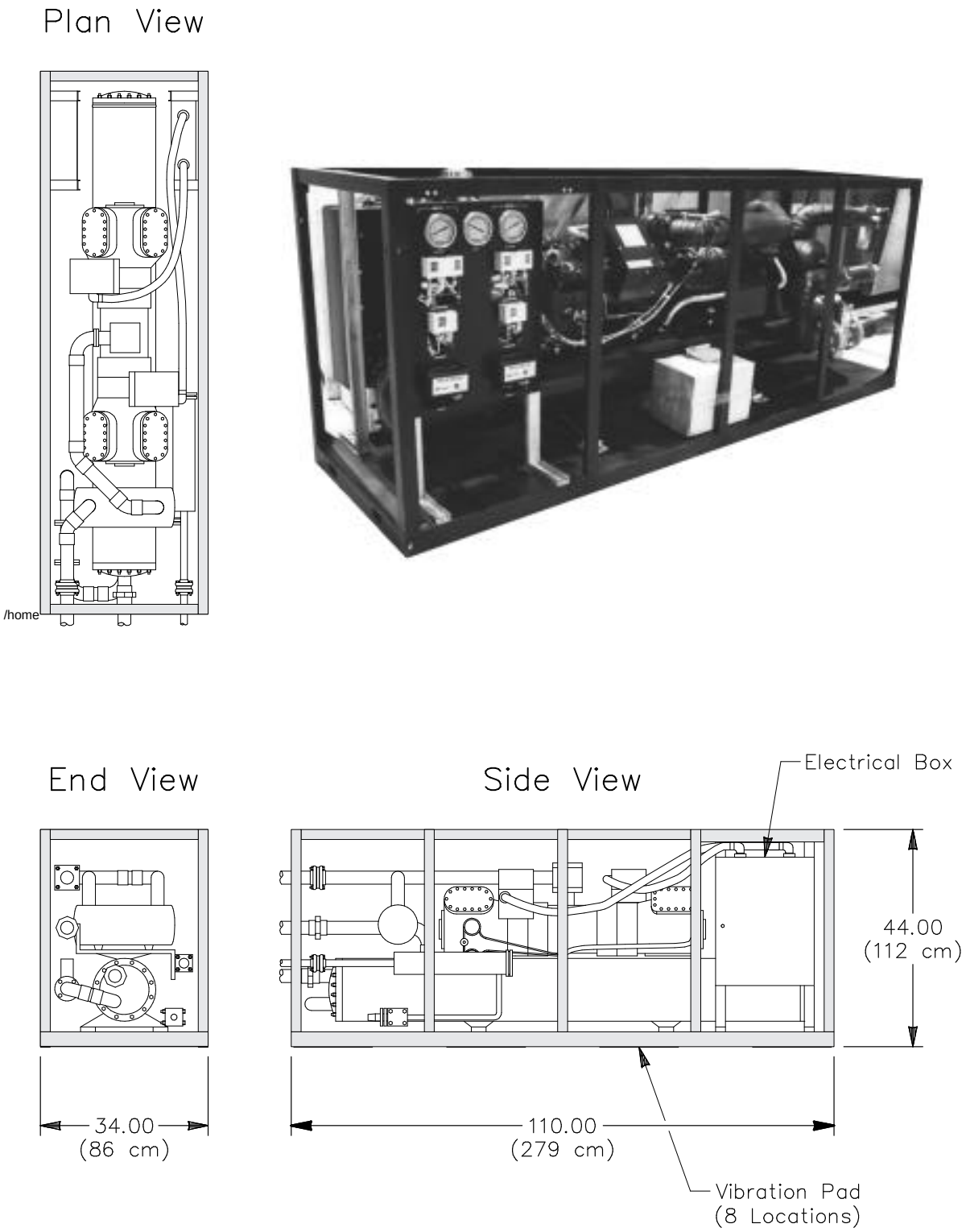


Figure 7-7. Refrigeration Condensing Unit (RCU-9)

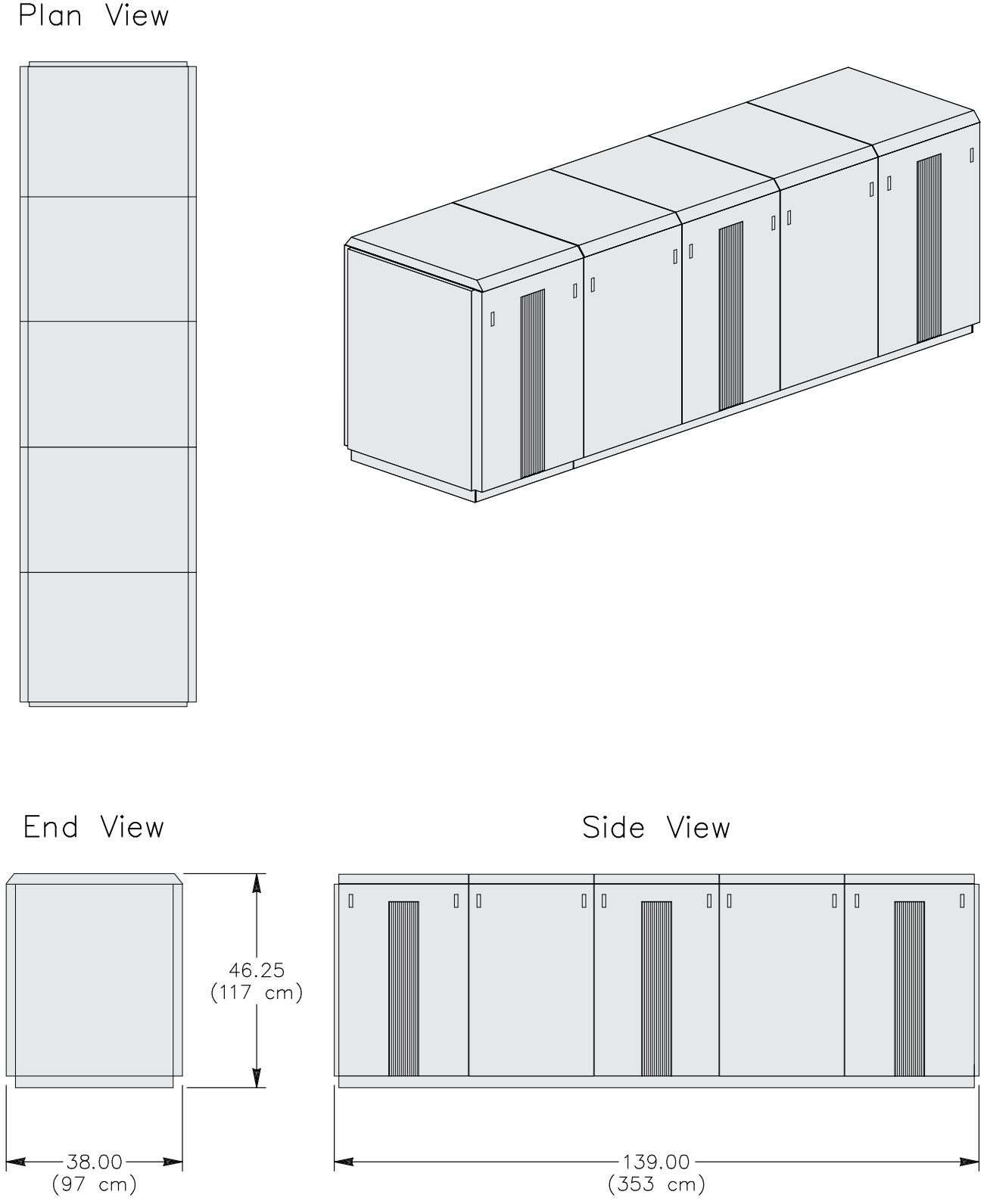


Figure 7-8. RCU-9 with Optional Noise-reduction Panels

Floor Preparation

If the RCU-9 is located in the computer room and not on a mounting frame, you must prepare floor cutouts. Figure 7-9 shows the floor cutout areas for the RCU-9 that enable interconnection of the water pipes, refrigeration pipes, and electrical connections.

In addition to preparing the floor cutouts, you must install the eight vibration pads supplied by Cray Research with the RCU-9. Space the vibration pads along each side, as shown in Figure 7-10.

Cray Research recommends that you provide a mounting frame if the RCU-9 is located in the computer room. The mounting frame isolates vibration generated by the RCU-9 and should be bolted to the subfloor. Figure 7-10 shows the RCU-9 mounting frame.

Power Wiring Requirements

You must supply and install the power and control wiring listed below for the RCU-9. Refer to the appropriate mainframe site planning manual for detailed power wiring information.

- One 460-Vac, 60-Hz, or 398-Vac, 50-Hz, 150-A, 4-wire input power circuit (three phases plus one ground) with service disconnect within sight of the RCU-9
- One 3-wire monitoring circuit between the RCU-9 and heat exchanger unit (HEU-C90)

If the RCU-9 is installed in the computer room, these circuits must enter the RCU-9 electrical box from the bottom. The incoming power and monitoring circuits can enter the RCU-9 electrical box from either the top or bottom if the RCU-9 is installed in an equipment plant room. The location of the electrical box is shown in Figure 7-7.

CAUTION

Do not energize the RCU-9 prior to system installation. The compressor motor windings of the RCU-9 will overheat if operated without a heat load.

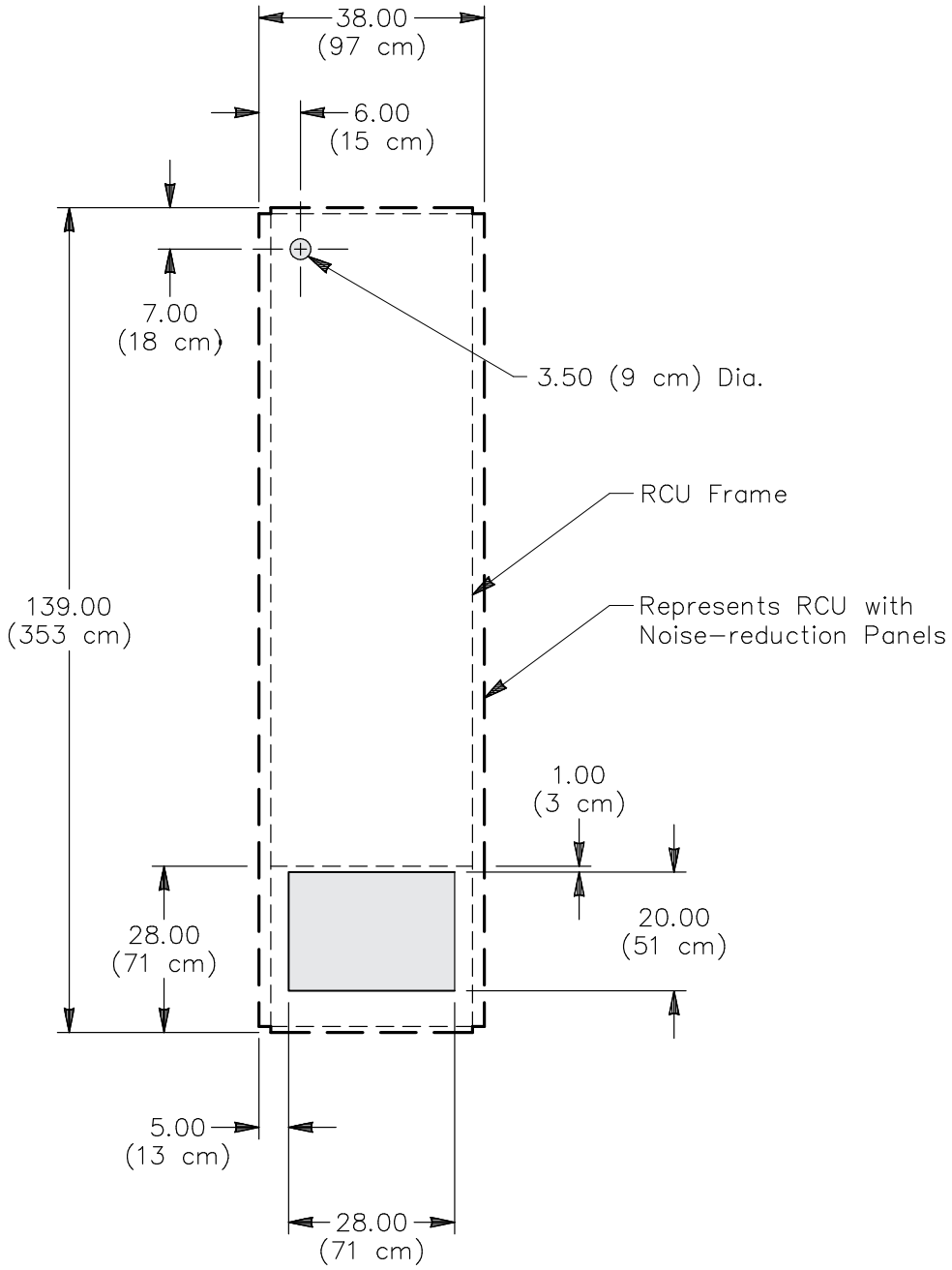
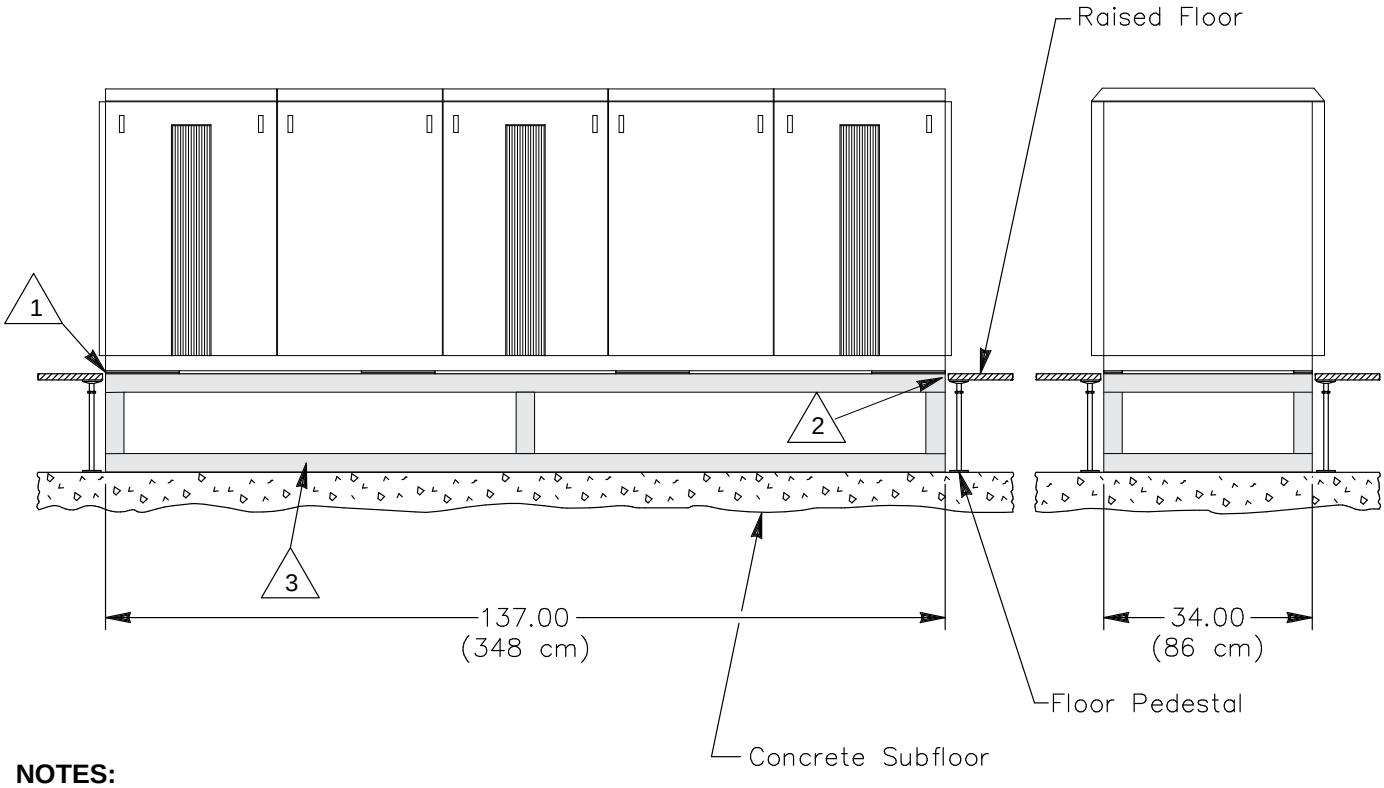


Figure 7-9. RCU-9 Floor Cutouts



NOTES:

1. Cray Research-supplied vibration pads.
2. Mounting frame should be flush with computer room raised flooring ±0.25 in. (0.6 cm) minimum.
3. Mounting frame is constructed from angle iron, which measures 3 in. (7.6 vm) x 3 in. (7.6 cm) x 0.25 in. (0.6 cm) minimum.

Figure 7-10. RCU-9 Mounting Frame

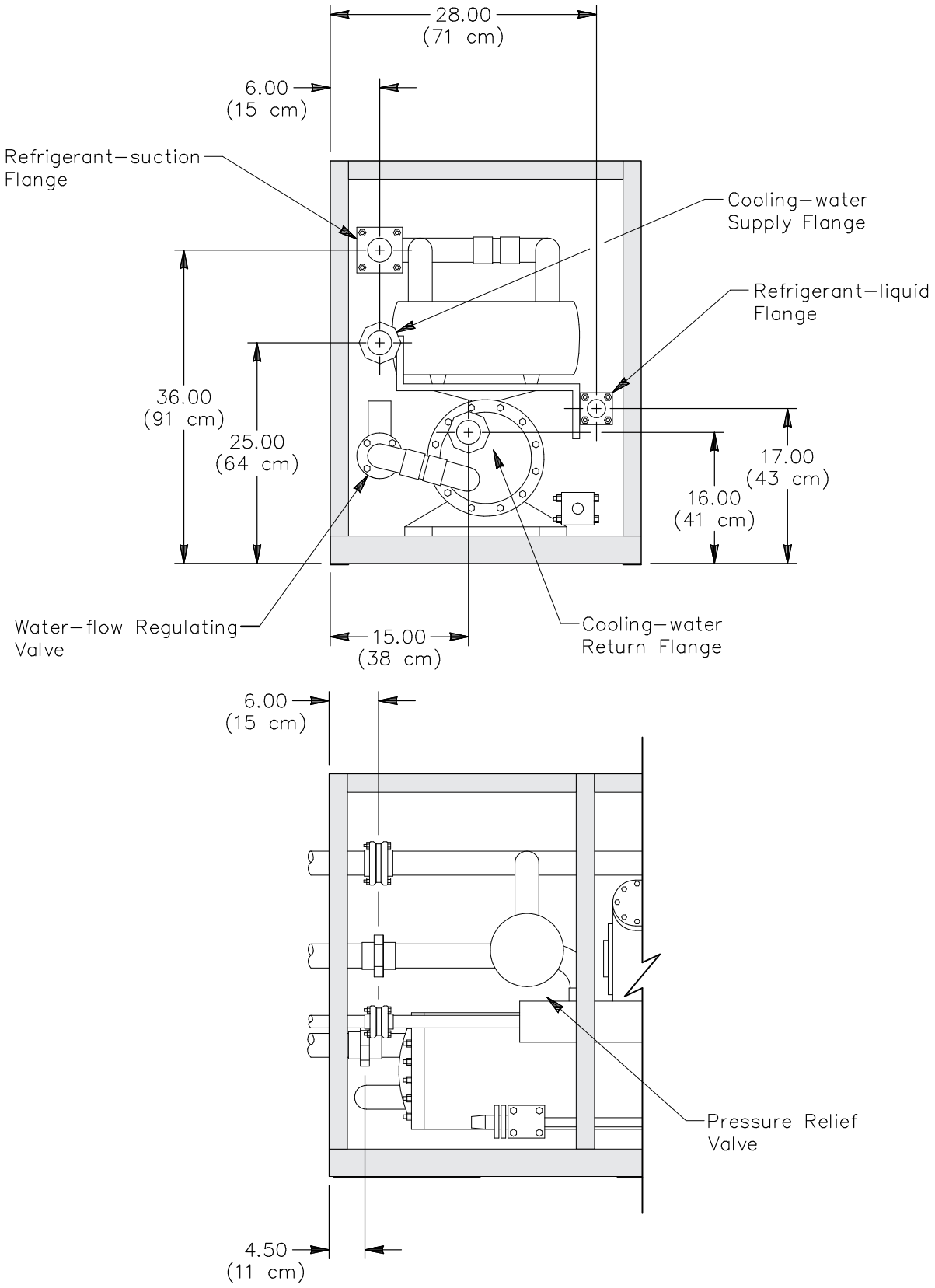
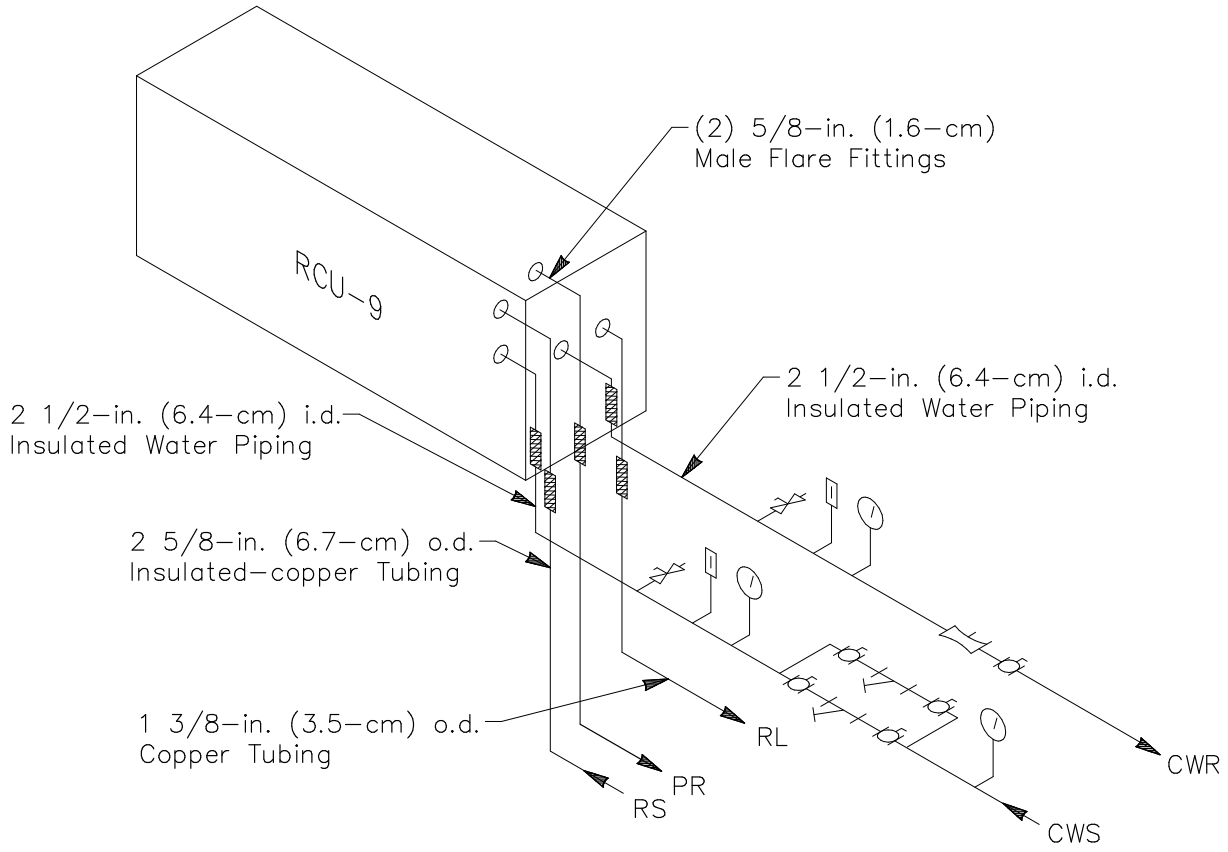


Figure 7-11. RCU-9 Piping Locations



KEY

RS	Refrigerant Suction		Hose Bib
PR	Pressure Relief		Flow Meter
RL	Refrigerant Liquid		Ball Valve
CWS	Cooling-water Supply		Temperature Gauge
CWR	Cooling-water Return		Pressure Gauge
	Vibration Eliminator		Direction of Flow
	Strainer with #40 Mesh		

Figure 7-12. Typical RCU-9 Piping Requirements

Refrigeration Piping Requirements

The RCU-9 has piping requirements that are additional to the general piping requirements outlined in this section. Refer to the "General Refrigeration and Water Piping Requirements" subsection for further piping requirement information.

Figure 7-11 shows the locations of the cooling-water and refrigerant piping connections on the RCU-9. Figure 7-12 is a schematic of the typical piping requirements for the RCU-9. The following information further describes the piping connections.

- Figure 7-12 shows the locations of the refrigerant suction- and liquid-line connection ports. Cray Research supplies mating halves of the refrigerant flange couplings with associated gaskets and capped copper tubing to connect the remaining customer-supplied refrigerant-piping circuitry. The liquid-line flange coupling stub is 1 3/8-in. (3.5-cm) o.d. copper tubing, and the suction-line flange coupling stub is 2 5/8-in. (6.7-cm) o.d. copper tubing. The length of both the liquid- and suction-line stubs is approximately 6 in. (15.2 cm). You must provide and install all materials and components to complete the refrigerant-piping circuitry connection to these ports in the vertical position.

- You must provide and install refrigerant-line vibration absorbers, which are sized according to the suction- and liquid-line flange couplings. Install the vibration absorbers directly in front of the RCU-9 connection ports in the vertical position.

- If the RCU-9 is installed in the computer room, the refrigerant lines must be routed downward and covered by an RCU-9 cabinet extension.

- The RCU-9 cooling-water inlet and outlet ports used to connect the cooling water lines are located as shown in Figure 7-12. Cray Research supplies mating halves for the cooling-water union couplings. The couplings accept a 2 5/8-in. (6.7-cm) o.d. copper tube.

- You are responsible for providing and installing the vibration absorbers in the cooling water lines. Install the vibration absorbers directly in front of the RCU-9 connection ports in the vertical position.

- You must supply a minimum amount of 250 lbs (113 kg) of R-22 refrigerant for each RCU-9. Cray Research personnel fully charge the system with additional R-22 refrigerant during installation.

Power Distribution Equipment

Power distribution equipment is the equipment used to generate and distribute power to the computer system equipment. Power distribution devices include motor-generator sets (MGSs), the motor-generator parallel cabinet (MGPC), and a power distribution cabinet (PDC). The following subsections provide specifications, floor preparation requirements, and power wiring requirements for each device.

Kato Quietized Motor-generator Set (MGS-4)

The Kato quietized motor-generator set (MGS-4) consists of a motor-generator unit (MGU) and all associated motor-generator control and power components packaged in a common cabinet (refer to Figure 7-13). The MGS-4 cabinet design incorporates a sound-attenuated enclosure to keep noise from exceeding a maximum sound pressure level of 63.5 dBa at a distance of 3.3 ft (1 m).

The MGS-4 has two possible configurations: one for 50-Hz operation and the other for 60-Hz operation. Table 7-3 provides specifications for both of these configurations.

Table 7-3. MGS-4 Specifications

Characteristic	50-Hz Unit	60-Hz Unit
Height	78.00 in. (198 cm)	78.00 in. (198 cm)
Width	102.00 in. (259 cm)	96.00 in. (244 cm)
Depth	40.00 in. (102 cm)	40.00 in. (102 cm)
Weight	8,035 lbs (3,644 kg)	7,265 lbs (3,295 kg)
Airflow	3,200 cfm (1.5 m^3/s)	4,300 cfm (2.0 m^3/s)
Access requirements: Front Ends	 42.00 in. (107 cm) 36.00 in. (91 cm)	 42.00 in. (107 cm) 36.00 in. (91 cm)
Heat dissipation to air	78.48 kBtu/hr (23.00 kW) maximum	78.48 kBtu/hr (23.00 kW) maximum
Shipping weight	8,837 lbs (4,008 kg)	7,669 lbs (3,478 kg)

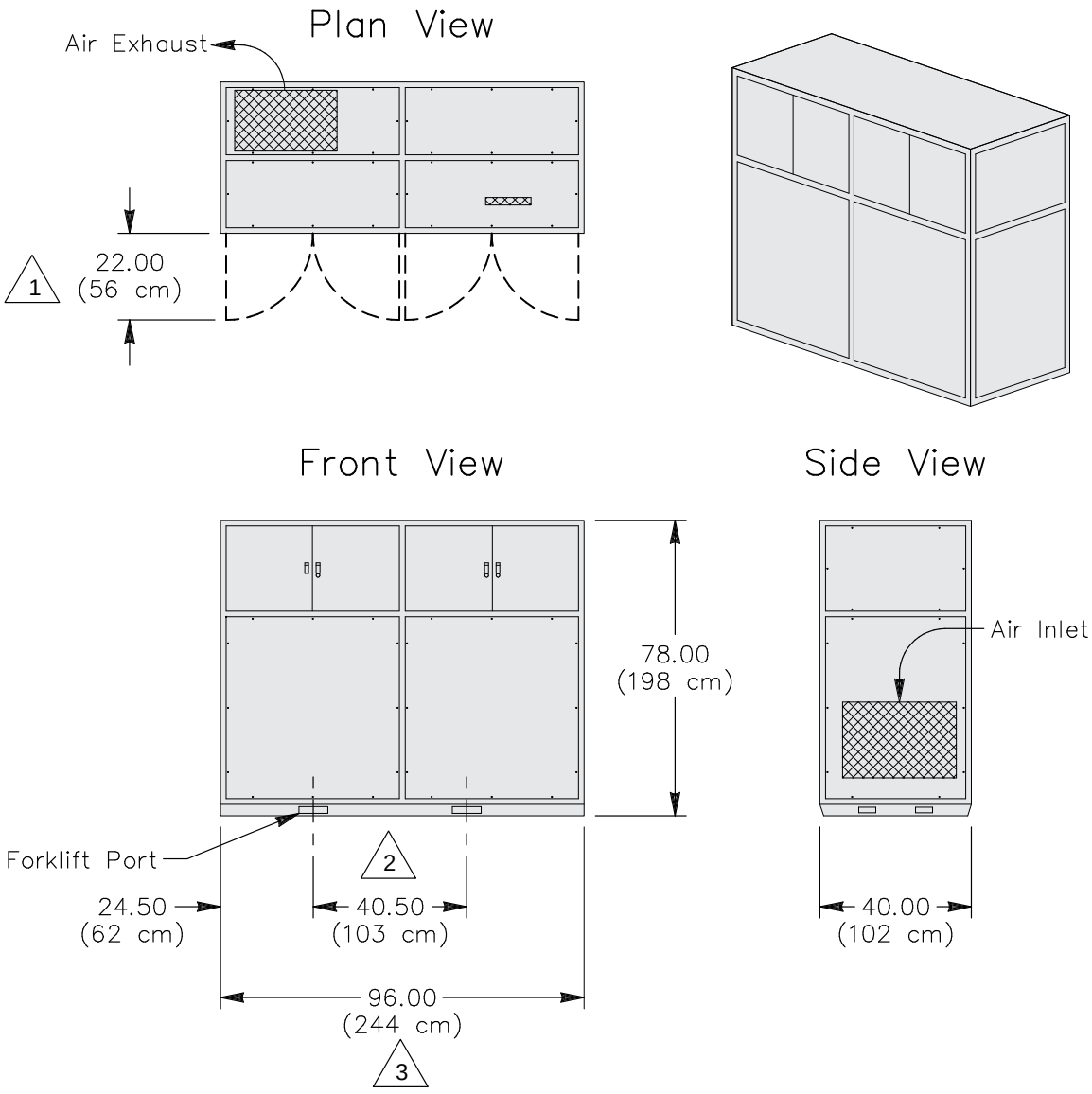
Motor-generator Unit

The MGS-4 incorporates an MGU, which is equipped with a 250-HP, 1800-RPM, 460-Vac, 3-phase, 60-Hz drive motor and a 40-HP starting motor. Generator output ratings are 150 kW at 0.90 to 1.0 PF, 225 Vac, 3 phase, 400 Hz.

For international locations equipped to supply only 50-Hz power, the MGU will be supplied for operation with 380- to 415-Vac, 3-phase, 50-Hz main power.

Motor-generator Controls

The MGS-4 contains control circuitry that provides the mainframe with remote control of the motor and excitation fields. The controls and regulating devices are contained within the MGS-4 cabinet and are located immediately above the MGU.



NOTES:

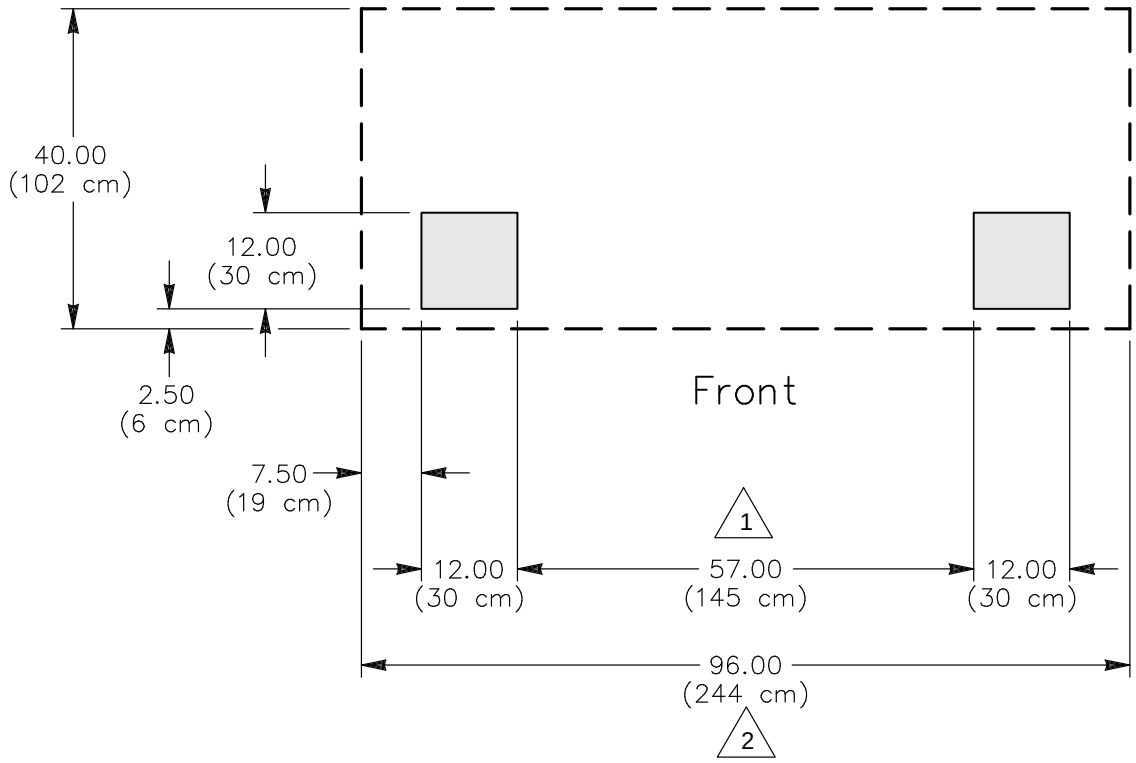
1. 50-Hz unit measures 24.00 in. (61 cm).
2. 50-Hz unit measures 46.50 in. (118 cm).
3. 50-Hz unit measures 102.00 in. (259 cm).

Figure 7-13. Kato Quietized Motor-generator Set (MGS-4)

Floor Preparation

If the MGS-4 is located in the computer room, you must prepare floor cutouts to enable electrical connections. Figure 7-14 illustrates the area in the base of the MGS-4 that corresponds to the floor cutout.

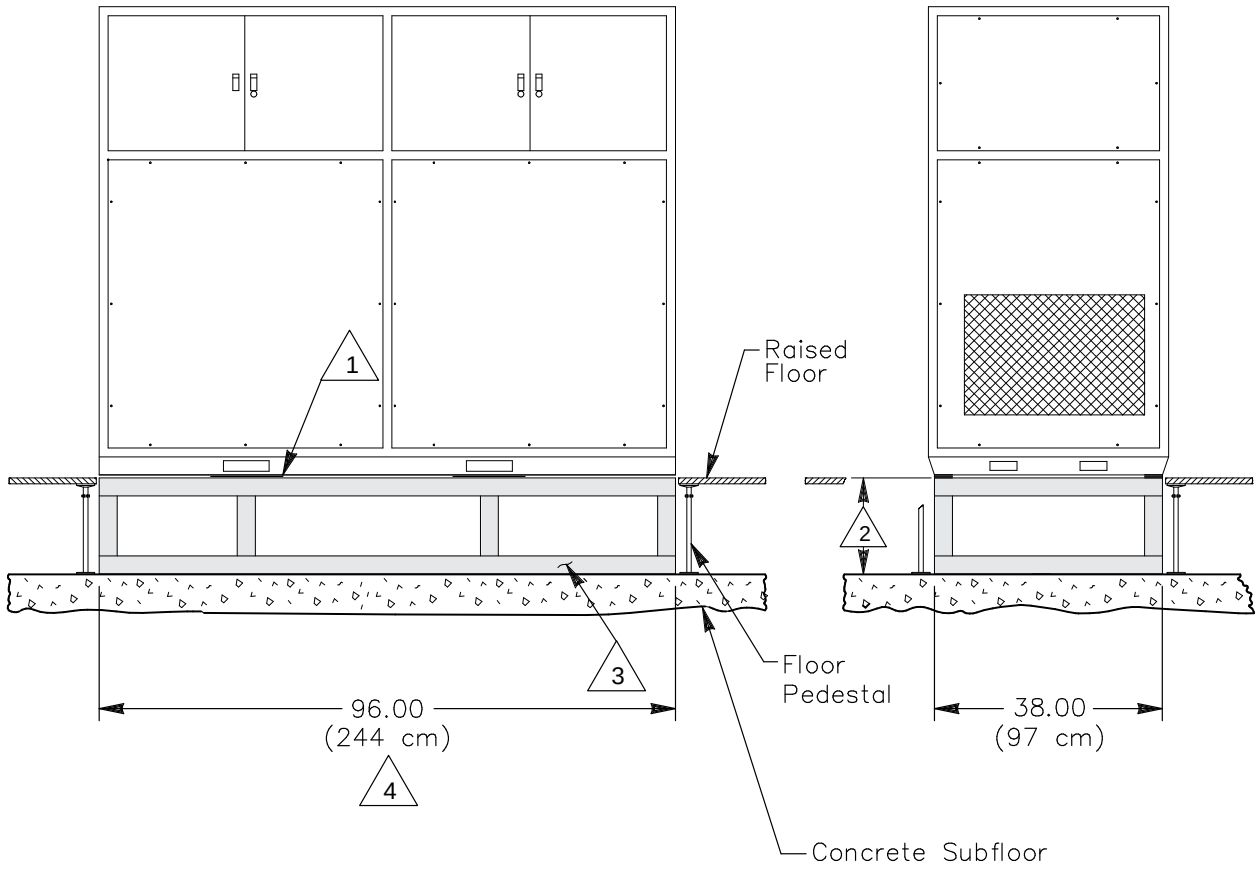
Cray Research recommends that you provide a mounting frame as illustrated in Figure 7-15 if the MGS-4 is placed in the computer room. Bolt the frame to the subfloor.



NOTES:

1. 50-Hz units measure 63.00 in. (160 cm).
2. 50-Hz units measure 102.00 in. (259 cm).

Figure 7-14. MGS-4 Floor Cutouts



NOTES:

1. Cray Research supplied vibration pads.
2. Mounting frame should be flush with computer room raised flooring ± 0.25 in. (0.6 cm).
3. Mounting frame is constructed from angle iron, which measures 3 in. (7.6 cm) x 3 in. (7.6 cm) x 0.25 in. (0.6 cm) minimum.
4. 50-Hz unit measures 102.00 in. (259 cm).

Figure 7-15. MGS-4 Mounting Frame

Power Wiring Requirements

You must provide and install all primary wiring (50 Hz or 60 Hz), all secondary wiring (400 Hz), and all associated control wiring for the MGS-4. Cray Research will provide a detailed wiring diagram early in the site planning process.

All primary, secondary, and control wiring is connected within the MGS-4 cabinet. The MGS-4 cabinet construction provides a wiring entrance through the top or base of the unit. Terminal blocks are provided in the unit and are located immediately above the motor-generator unit.

For general planning purposes, you must provide and install the following items:

- One 400-A circuit breaker rated for 10 times instantaneous overcurrent trip close to (within sight of) each MGS-4
- One 4-wire (three phases and ground) input-power circuit (50 Hz or 60 Hz) connected to each MGS-4
- One 5-wire (three phases, neutral, and ground) secondary circuit (400 Hz) between the MGS-4 and the MGPC or mainframe

NOTE: To prevent excessive voltage drops, this circuit requires multiple conductors per phase.

- One 5-wire (plus ground) control circuit between the MGS-4 and the Cray Research mainframe or MGPC located in the computer room for start, stop, excitation field control, and temperature detection
- One 2-wire shielded cable between the MGS-4 and the Cray Research mainframe or MGPC located in the computer room for voltage regulation
- One twisted 3-wire (plus ground) control circuit for remote voltage sensing between the MGS-4 and the MGPC or mainframe

In addition to the items listed above, various 400-Hz and control wiring circuits will be required between associated MGS-4 online units and optional standby units. Specific quantities of circuits depend on the proposed Cray Research system configuration.

The 400-Hz circuits must each consist of three phase lines, a neutral line, and a ground. The voltage drop from the MGS-4 unit to the computer equipment must not exceed 2%. The conductor size and quantity must be approved by Cray Research. The conduit and raceways used for 400-Hz wiring must be constructed of aluminum or nonferrous materials.

Motor-generator Parallel Cabinet (MGPC)

The motor-generator parallel cabinet (MGPC) is used to combine the 400-Hz output of the two MGS-4s together. The MGPC is used with the MGS-4s in facilities where the installation of the MGS-6 or MGS-6A is not feasible. Refer to Figure 7-16 for an illustration of the MGPC.

The MGPC consists of the control circuitry needed to monitor and control the 400-Hz output of two MGS-4s. The MGPC also consists of two 400-Hz output circuit breakers that distribute power to the mainframe and IOS/SSD cabinets, and compression screw terminals that attach the input and output power and control wiring. Refer to Table 7-4 for the MGPC specifications.

Table 7-4. MGPC Specifications

Characteristic	Specification
Height	78.00 in. (198 cm)
Width	30.00 in. (76 cm)
Depth	40.00 in. (102 cm)
Weight	1,000 lbs (454 kg)
Access requirements	36 in. (91 cm) front and sides
Heat dissipation to air	Negligible

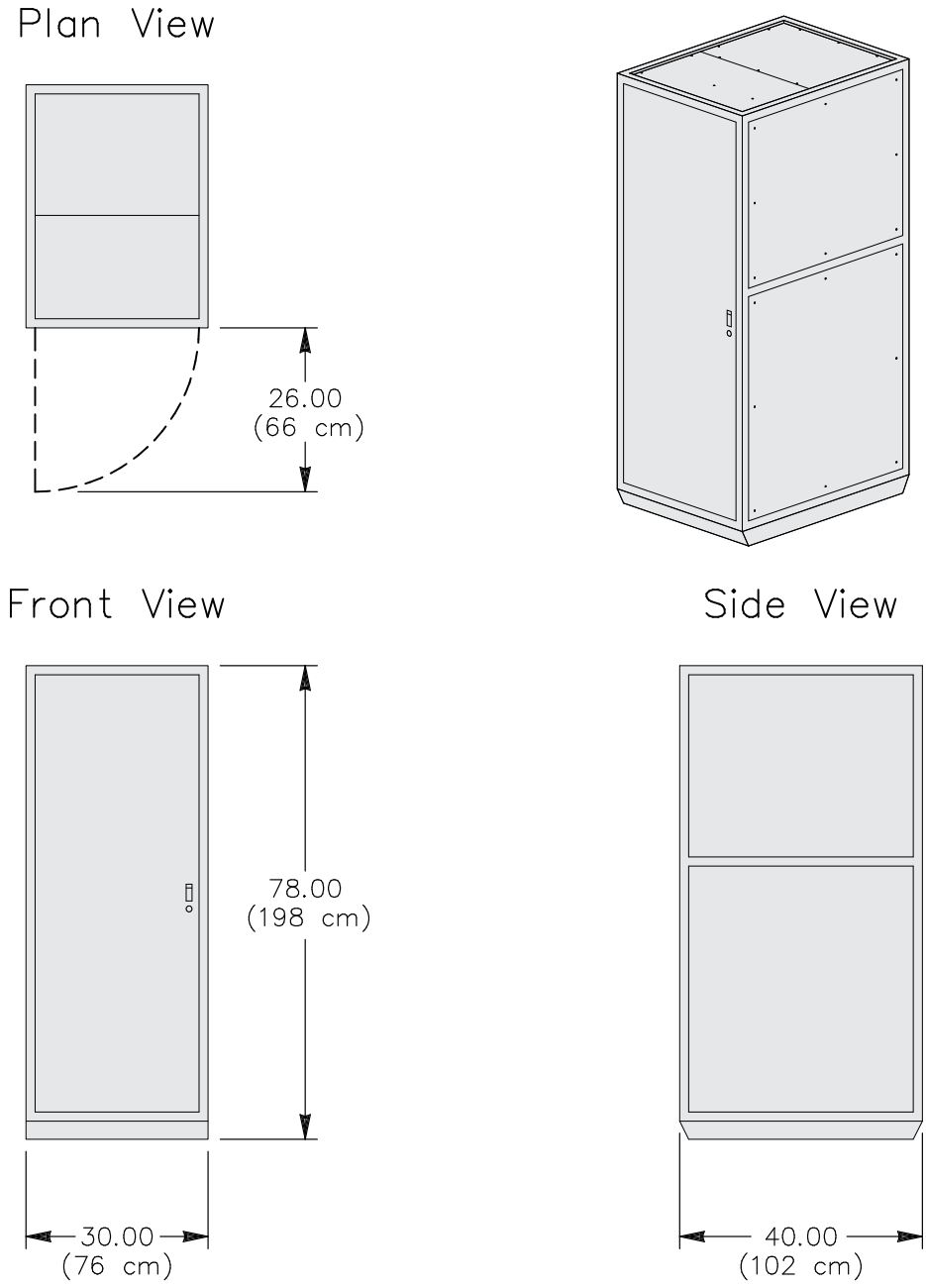


Figure 7-16. Motor-generator Parallel Cabinet (MGPC)

Floor Preparation

The MGPC can be located in the computer room or the equipment plant room. If the MGPC is located in the computer room, you must prepare a single floor cutout. Refer to Figure 7-17 for an illustration of the MGPC floor cutout.

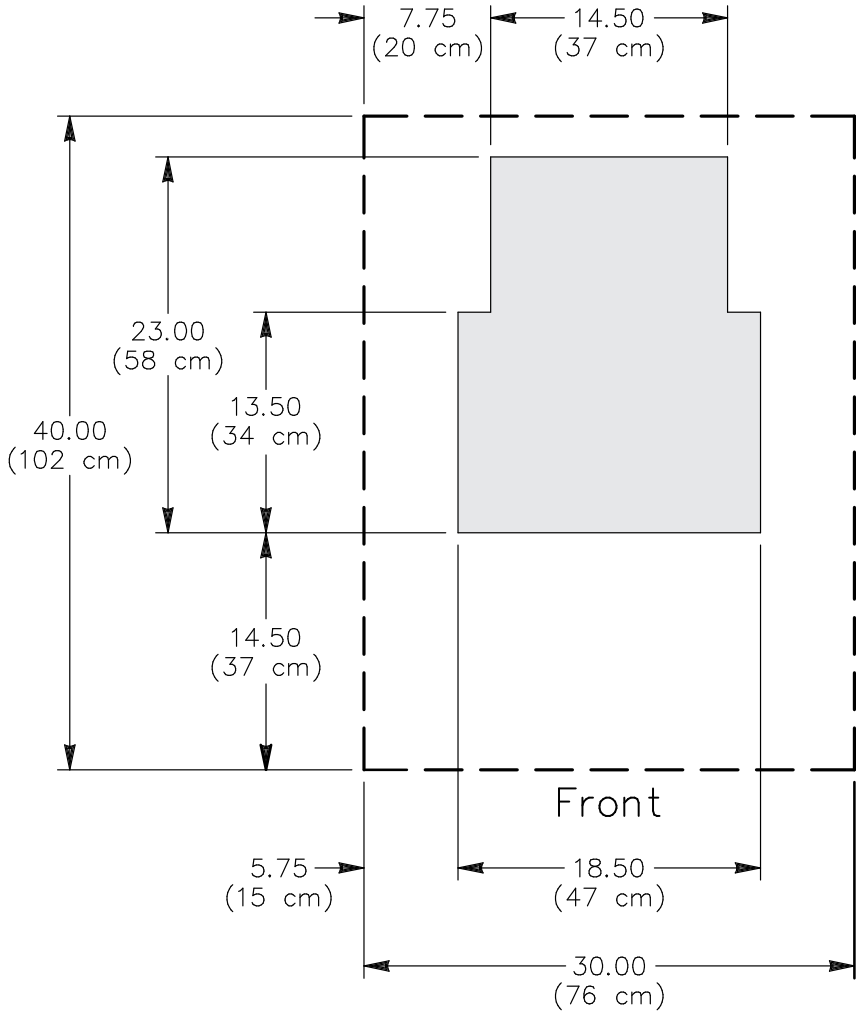


Figure 7-17. MGPC Floor Cutout

Power Wiring Requirements

You must provide and install all 400-Hz input and output power wiring and all associated control wiring for the MGPC. Cray Research will provide a detailed wiring diagram early in the site planning process.

For general planning purposes, you must provide and install the following items:

- One 5-wire (three phases, neutral, and ground) 400-Hz circuit between the MGS #1 and the MGPC
- One 5-wire (three phases, neutral, and ground) 400-Hz circuit between the MGS #2 and the MGPC

NOTE: To prevent excessive voltage drops, these circuits require multiple conductors per phase.

- One 5-wire (plus ground) control circuit between the MGS #1 and the MGPC for start, stop, excitation field control, and temperature detection
- One 5-wire (plus ground) control circuit between the MGS #2 and the MGPC for start, stop, excitation field control, and temperature detection
- One 2-wire shielded cable between the MGS #1 and the MGPC for voltage regulation
- One 2-wire shielded cable between the MGS #2 and the MGPC for voltage regulation
- One twisted 3-wire (plus ground) control circuit for remote voltage sensing between the MGS #1 and MGPC
- One twisted 3-wire (plus ground) control circuit for remote voltage sensing between the MGS #2 and MGPC
- One 6-wire (plus ground) control circuit between the MGS #1 and the MGPC for 400-Hz control
- One 6-wire (plus ground) control circuit between the MGS #2 and the MGPC for 400-Hz control

- One 5-wire (three phases, one neutral, and one ground) 400-Hz power circuit between the MGPC and the Cray Research mainframe
- One 5-wire (three phases, one neutral, and one ground) 400-Hz power circuit between the MGPC and the IOS/SSD cabinet
- One 5-wire (plus ground) control circuit between the MGPC and the mainframe for start, stop, excitation field control, and temperature detection
- One 2-wire shielded cable between the MGPC and the mainframe for voltage regulation
- One 120/220-Vac, 15-A, 60/50-Hz control power input circuit for the MGPC

Kato Quietized Motor-generator Set (MGS-6)

The Kato quietized motor-generator set (MGS-6) consists of a motor-generator unit (MGU) and all associated motor-generator control and power components packaged in a common cabinet (refer to Figure 7-18). The MGS-6 cabinet design incorporates a sound-attenuated enclosure to keep noise from exceeding a maximum sound pressure level of 63.5 dBa at a distance of 3.3 ft (1.0 m).

The MGS-6 consists of two components: the main cabinet and the power distribution cabinet. Table 7-5 provides specifications for both of these components.

Table 7-5. MGS-6 Specifications

Characteristic		Specification
Height		78.00 in. (198 cm)
Width:	Total	119.00 in. (302 cm)
	Main cabinet	98.00 in. (249 cm)
	Power cabinet	21.00 in. (53 cm)
Depth		50.00 in. (127 cm)
Weight:	Total	11,775 lbs (5,340 kg)
	Main cabinet	11,025 lbs (5,000 kg)
	Power cabinet	750 lbs (340 kg)
Airflow		5,000 cfm (2.3 m^3/s)
Access requirements:		
	Front	42.00 in. (107 cm)
	Sides	36.00 in. (91 cm)
Heat dissipation to air		150.80 kBtu/hr (44.19 kW) maximum
Shipping size:		
Main cabinet	Height	79.00 in. (201 cm)
	Width	133.00 in. (338 cm)
	Depth	50.00 in. (127 cm)
Power cabinet	Height	79.00 in. (201 cm)
	Width	23.00 in. (58 cm)
	Depth	84.00 in. (213 cm)
Shipping weight:	Total	12,657 lbs (5,740 kg)
	Main cabinet	11,503 lbs (5,217 kg)
	Power cabinet	1,154 lbs (523 kg)

Motor-generator Unit (MGU)

The MGS-6 houses an MGU equipped with a 500-HP, 1800-RPM, 460-Vac, 3-phase, 60-Hz drive motor. The generator output is rated at 300 kW at 0.9 to 1.0 power factor, 225-Vac, 3-phase, 400-Hz power.

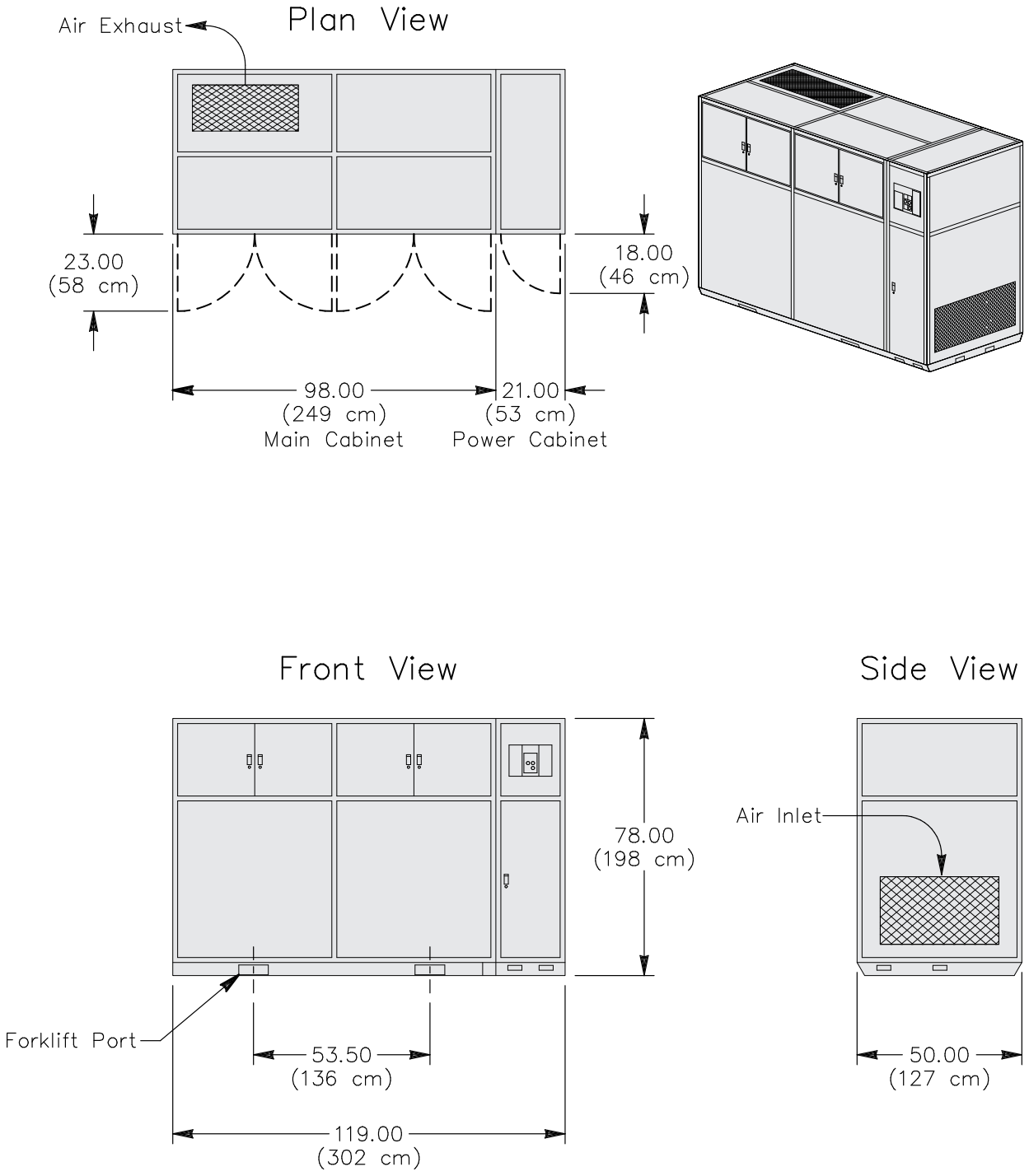


Figure 7-18. Kato Quietized Motor-generator Set (MGS-6)

Motor-generator Controls

The MGS-6 contains control circuitry that provides the Cray Research mainframe with remote control of the motor and excitation fields. The controls and regulating devices are contained within the MGS-6 cabinet and are located immediately above the MGU.

Power Cabinet

The MGS-6 is designed with a detachable power cabinet for convenient handling and installing. This power cabinet must be attached to the main cabinet for wiring and operation.

Shipping

The main MGS-6 cabinet is shipped as illustrated in Figure 7-19. The lifts on each end are not part of the MGS-6 and are used only for transportation. The power cabinet is moved using lifts similar to those shown in Figure 7-19.

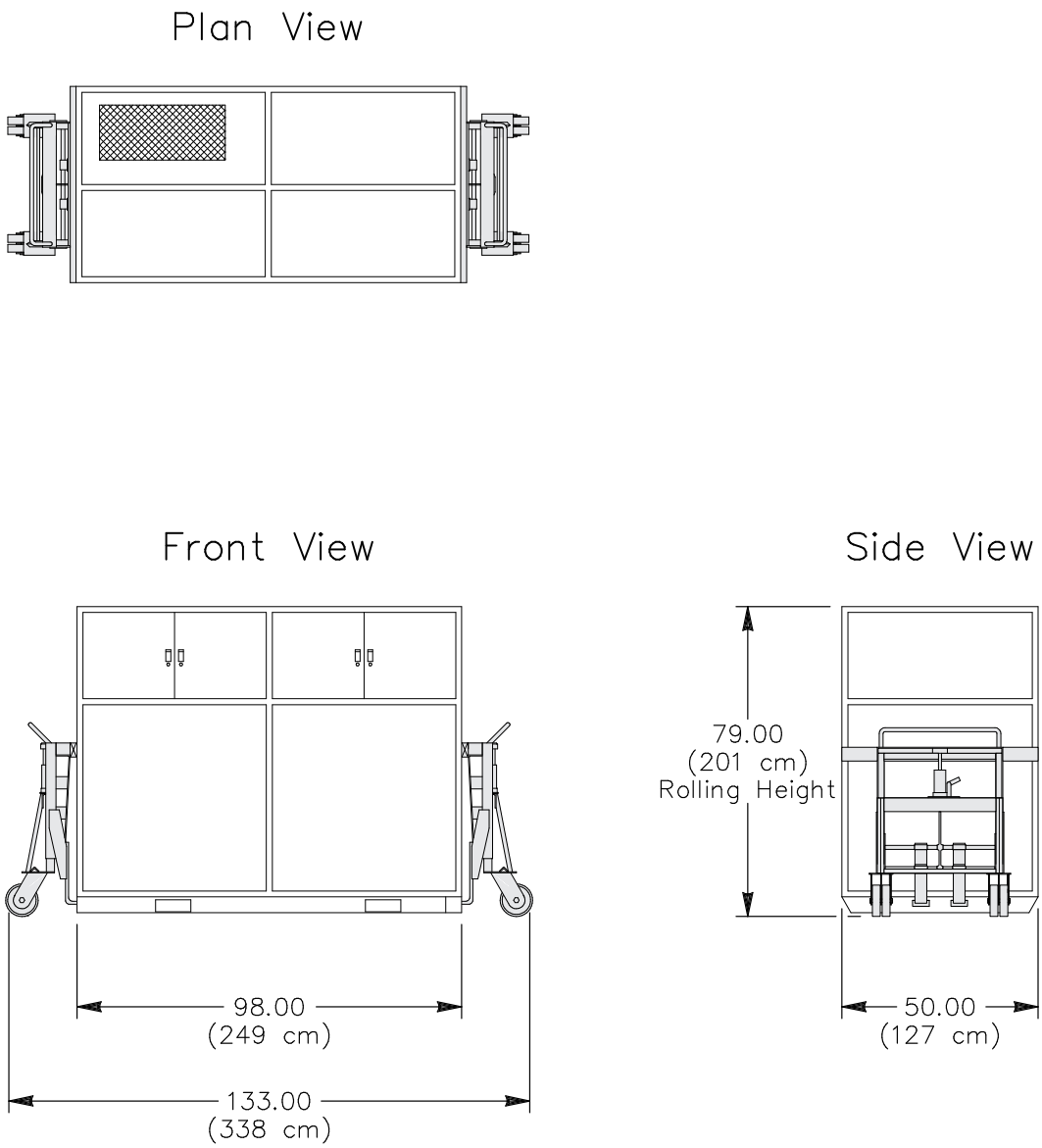


Figure 7-19. MGS-6 Main Cabinet Shipping Configuration

Floor Preparation

If the MGS-6 is located in the computer room, you must prepare floor cutouts to enable electrical connections. Figure 7-20 illustrates the corresponding floor cutout area in the base of the MGS-6.

Cray Research recommends that you provide a mounting frame as illustrated in Figure 7-21 if the MGS-6 is placed in the computer room. Bolt the frame to the subfloor.

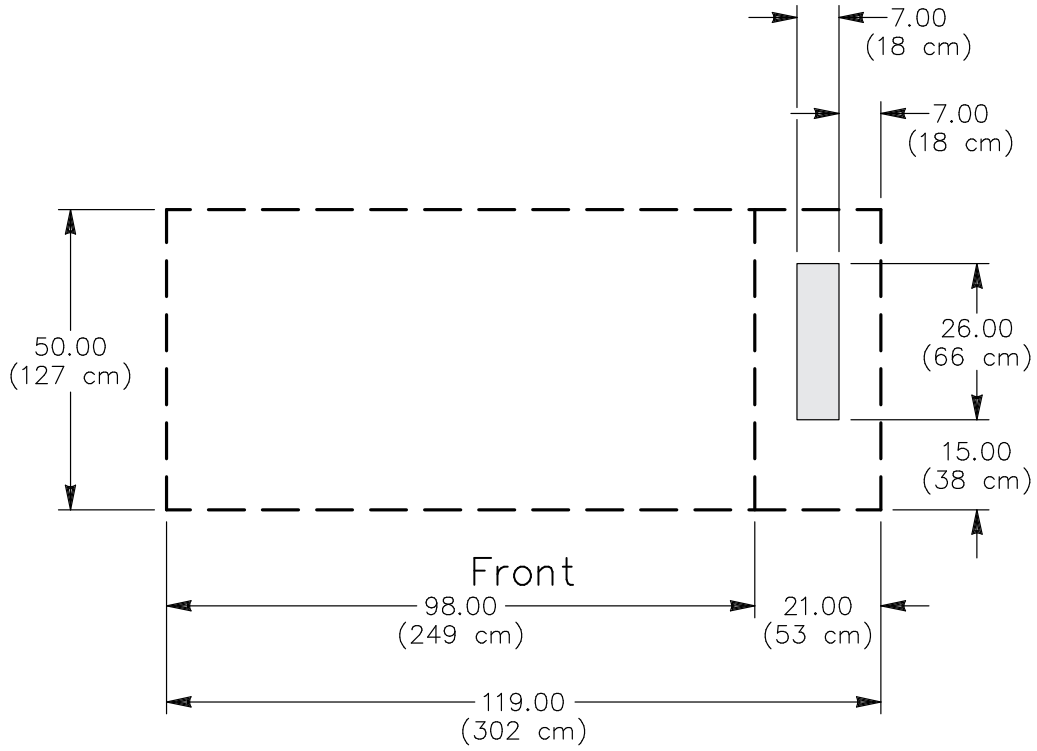
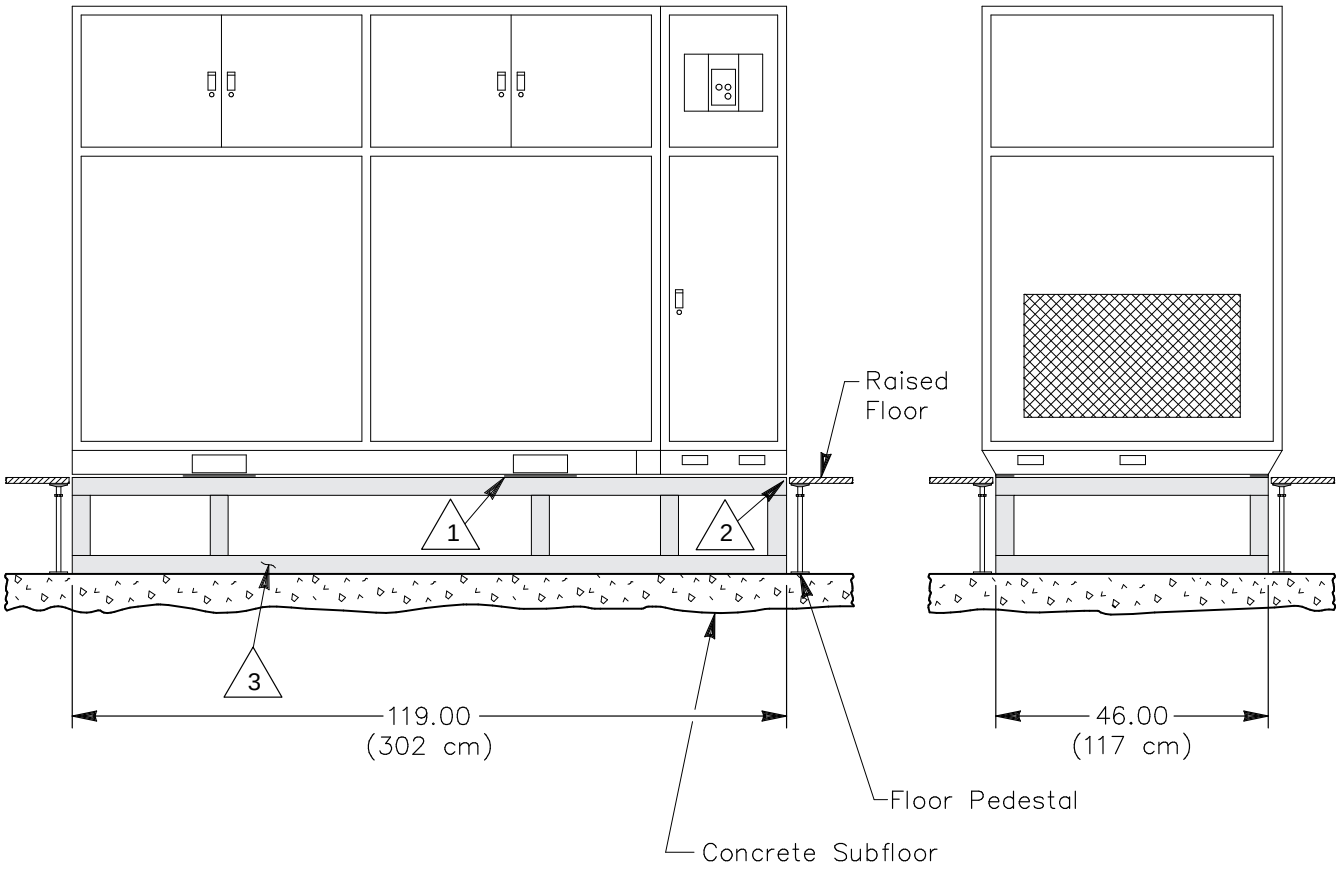


Figure 7-20. MGS-6 Floor Cutout



NOTES:

1. Cray Research supplied vibration pads.
2. Mounting frame should be flush with computer room raised flooring ±0.25 in. (0.6 cm).
3. Mounting frame is constructed from angle iron, which measures 3 in. (7.6 cm) x 3 in. (7.6 cm) x 0.25 in. (0.6 cm) minimum.

Figure 7-21. MGS-6 Mounting Frame

Power Wiring Requirements

You must provide and install all primary wiring (60 Hz), all secondary wiring (400 Hz), and all associated control wiring for the MGS-6. Cray Research will provide a detailed wiring diagram early in the site planning process.

All primary, secondary, and control wiring is connected within the MGS-6 cabinet. The MGS-6 cabinet construction provides a wiring entrance through the top or the base of the unit.

For general planning purposes, you must provide and install the following items:

- One 800-A, 4-wire (three phases and ground) input-power circuit for each MGS-6 power cabinet. The MGS-6 has an equipment disconnect rated at 800 A.

- One 5-wire (three phases, neutral, and ground) secondary circuit (400 Hz) between the MGS-6 power cabinet and the computer room circuit breaker panel or PDC.

NOTE: To prevent excessive voltage drops, this circuit requires multiple conductors per phase.

- One 5-wire (plus ground) control circuit between the MGS-6 power cabinet and the Cray Research mainframe located in the computer room for start, stop, excitation field control, and temperature detection.

- One 2-wire shielded cable between the MGS-6 and the Cray Research mainframe for voltage regulation.

- One twisted 3-wire (plus ground) control circuit for remote voltage sensing between the MGS-6 power cabinet and the computer room circuit breaker panel or PDC.

In addition to the items above, various 400-Hz and control-wiring circuits are required between associated MGS-6 online units and optional standby units. The specific number of circuits required depends on the proposed Cray Research system configuration.

The 400-Hz circuits must each consist of three phase lines, a neutral line, and a ground line. The voltage drop from the MGS-6 unit to the computer equipment should not exceed 2%. The conductor size and quantity must be approved by Cray Research. The conduit and raceways used for 400-Hz wiring must be constructed of aluminum or nonferrous materials.

Kato Quietized Motor-generator Set (MGS-6A)

The Kato quietized motor-generator set (MGS-6A) consists of a motor-generator unit (MGU) and all associated motor-generator control and power components packaged in a common cabinet (refer to Figure 7-22). The MGS-6A cabinet design incorporates a sound-attenuated enclosure to keep noise from exceeding a maximum sound pressure level of 71.5 dBa at a distance of 3.3 ft (1.0 m).

The MGS-6A can be installed in the computer room or in an equipment plant room. If the MGS-6A is located in the computer room, an optional extension cabinet (refer to Figure 7-22) is provided for bottom entry of the 400-Hz electrical connections. Table 7-6 provides specifications for both the MGS-6A and the optional extension cabinet.

Table 7-6. MGS-6A Specifications

Characteristic	Specification
Height	78.00 in. (198 cm)
Width: Main cabinet Optional extension cabinet	 104.00 in. (264 cm) 9.00 in. (23 cm)
Depth	50.00 in. (127 cm)
Weight: Main cabinet Optional extension cabinet	 12,845 lbs (5,825 kg) 75 lbs (34 kg)
Airflow	2,200 cfm (1.0 m^3/s)
Access requirements	36.00 in. (91 cm) front and sides
Heat dissipation to air	189.67 kBtu/hr (55.59 kW) maximum
Shipping size: Main cabinet Height Width Depth	 79.00 in. (201 cm) 139.00 in. (353 cm) 50.00 in. (127 cm)
Shipping weight: Main cabinet Optional extension cabinet	 13,249 lbs (6,009 kg) 75 lbs (34 kg)

Motor-generator Unit (MGU)

The MGS-6A houses an MGU equipped with a 500-HP, 1500-RPM (50 Hz) or 1800-RPM (60 Hz), 398-Vac, 50-Hz or 460-Vac, 60-Hz drive motor. The generator output is rated at 300 kW at 0.9 to 1.0 PF, 225-Vac, 3-phase, 420-Hz power with 50-Hz input and 506-Hz power with 60-Hz input.

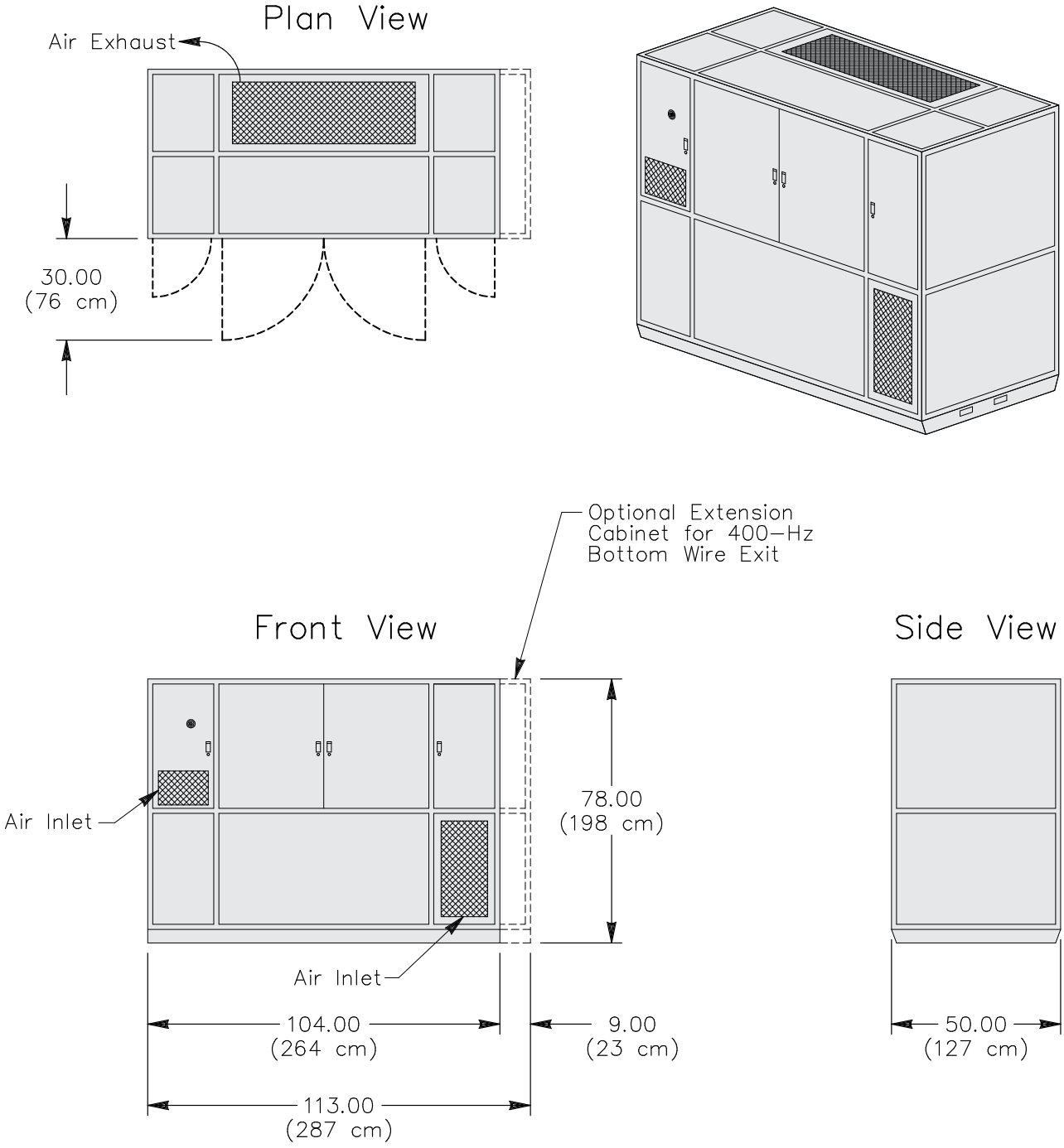


Figure 7-22. Kato Quietized Motor-generator Set (MGS-6A)

Motor-generator Controls

The MGS-6A contains control circuitry that provides the Cray Research mainframe with remote control of the motor and excitation fields. The controls and regulating devices are contained within the MGS-6A cabinet and are located immediately above the MGU.

Shipping

The main MGS-6A cabinet is shipped as illustrated in Figure 7-23. The lifts on each end are not part of the MGS-6A and are used only for transportation.

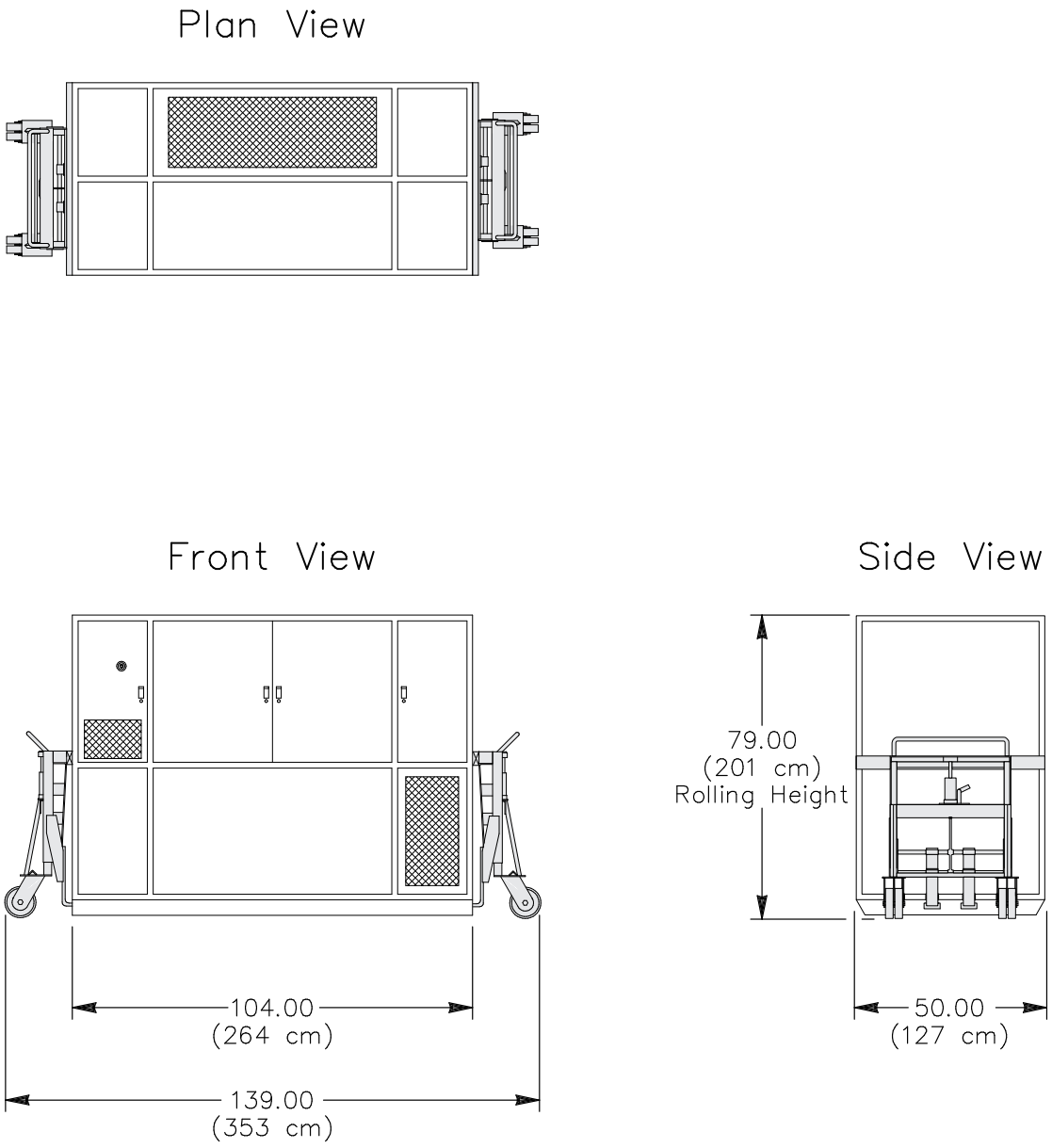


Figure 7-23. MGS-6A Main Cabinet Shipping Configuration

Floor Preparation

If the MGS-6A is located in the computer room, you must prepare floor cutouts to enable electrical connections. Figure 7-24 illustrates the area in the base of the MGS-6A that corresponds to the floor cutouts.

Cray Research recommends that you provide a mounting frame as illustrated in Figure 7-25 if the MGS-6A is placed in the computer room. Bolt the frame to the subfloor.

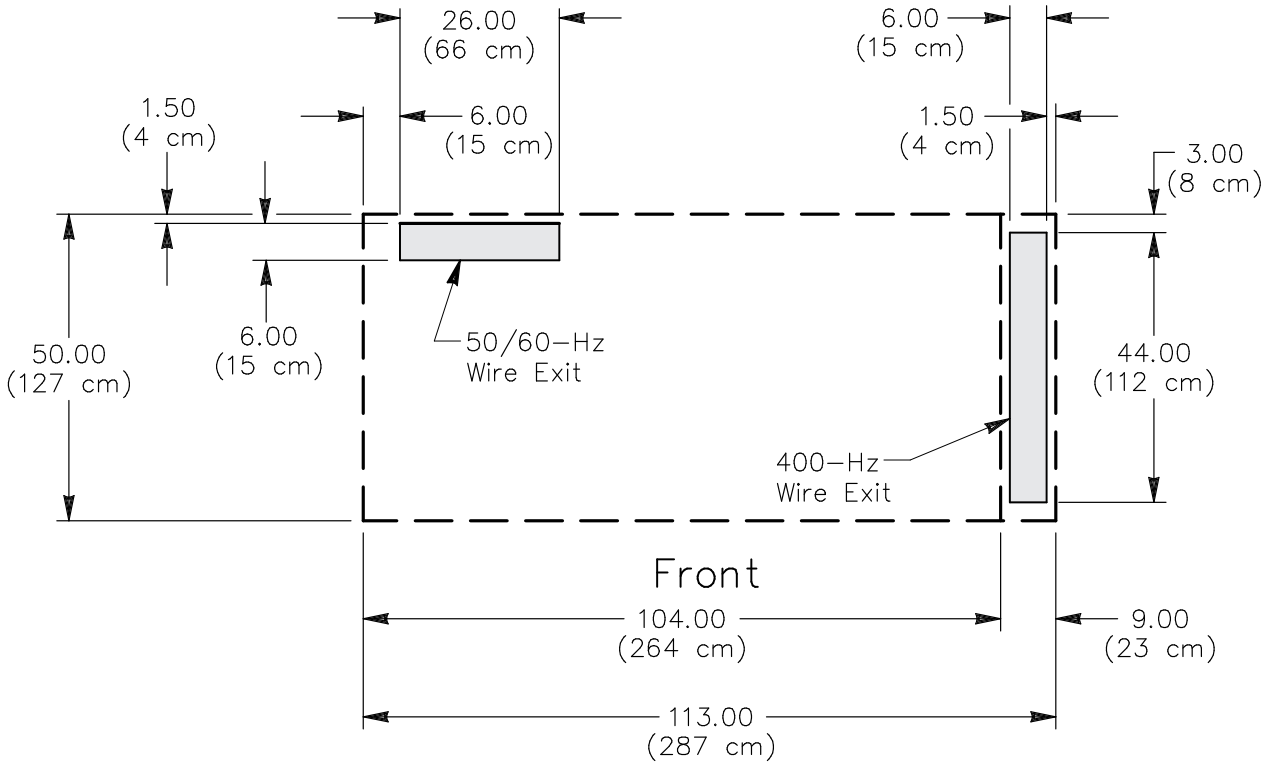
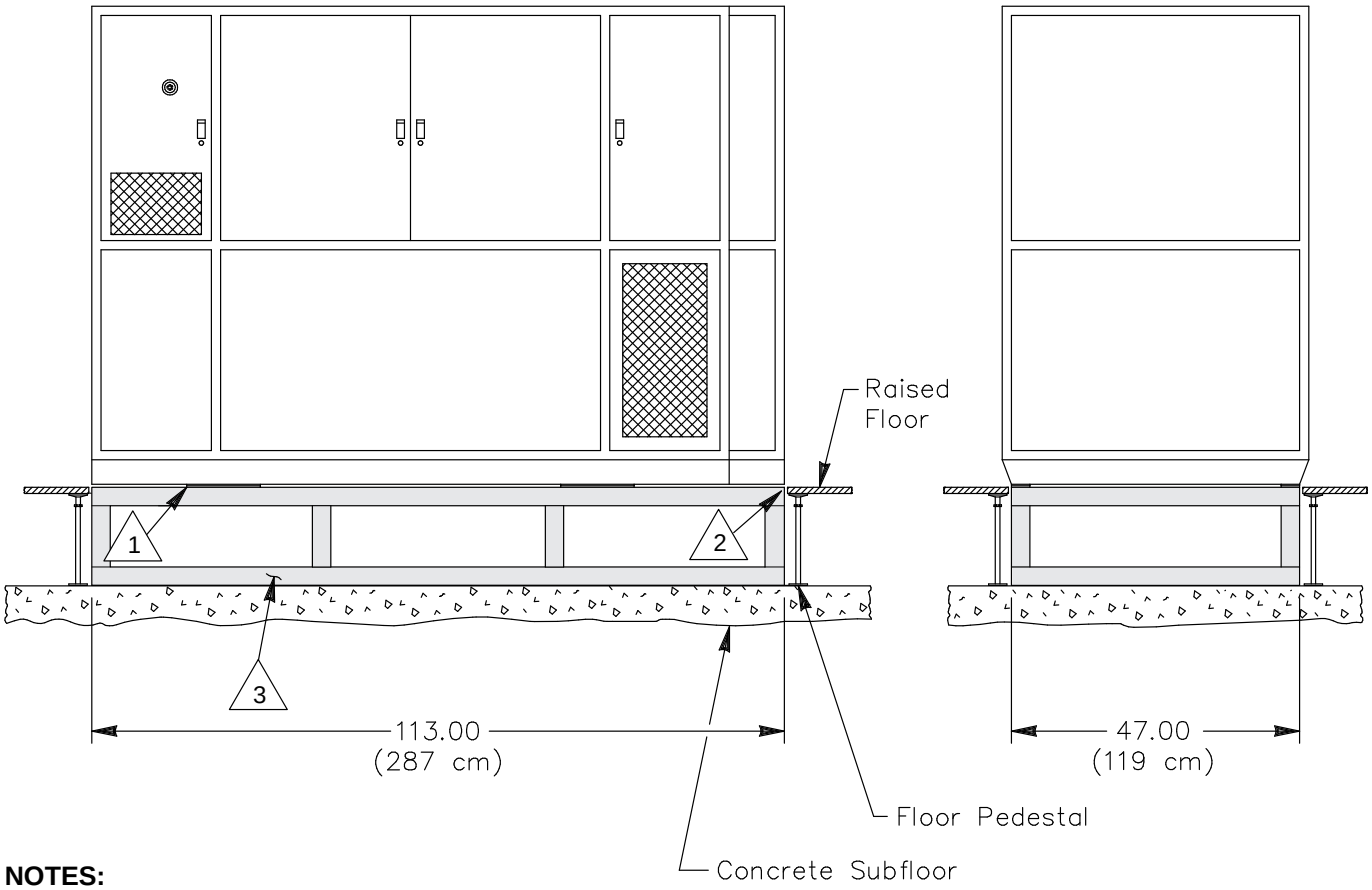


Figure 7-24. MGS-6A Floor Cutout



NOTES:

1. Cray Research supplied vibration pads.
2. Mounting frame should be flush with computer room raised flooring ±0.25 in. (0.6 cm).
3. Mounting frame is constructed from angle iron, which measures 3 in. (7.6 cm) x 3 in. (7.6 cm) x 0.25 in. (0.6 cm) minimum.

Figure 7-25. MGS-6A Mounting Frame

Power Wiring Requirements

You must provide and install all primary wiring (50/60 Hz), all secondary wiring (400 Hz), and all associated control wiring for the MGS-6A. Cray Research will provide a detailed wiring diagram early in the site planning process.

All primary, secondary, and control wiring is connected within the MGS-6A cabinet. The MGS-6A cabinet construction provides a wiring entrance through the top or the base of the unit.

For general planning purposes, you must provide and install the following items:

- One 800-A, 4-wire (three phases and ground) input-power circuit for each MGS-6A power cabinet. The MGS-6A has an equipment disconnect rated at 800 A.

- One 5-wire (three phases, neutral, and ground) secondary circuit (400 Hz) between the MGS-6A and the computer room circuit breaker panel or PDC.

NOTE: To prevent excessive voltage drops, this circuit requires multiple conductors per phase.

- One 5-wire (plus ground) control circuit between the MGS-6A and the Cray Research mainframe located in the computer room for start, stop, excitation field control, and temperature detection.

- One 2-wire shielded cable between the MGS-6A and the Cray Research mainframe for voltage regulation.

- One twisted 3-wire (plus ground) control circuit for remote voltage sensing between the MGS-6A and the computer room circuit breaker panel or PDC.

In addition to the items listed above, various 400-Hz and control-wiring circuits are required between associated MGS-6A online units and optional standby units. The specific number of circuits required depends on the proposed Cray Research system configuration.

The 400-Hz circuits must each consist of three phase lines, a neutral line, and a ground line. The voltage drop from the MGS-6A unit to the computer equipment should not exceed 2%. The conductor size and quantity must be approved by Cray Research. The conduit and raceways used for 400-Hz wiring must be constructed of aluminum or nonferrous materials.

Power Distribution Cabinet (PDC)

The power distribution cabinet (PDC) is a cabinet that distributes the 400-Hz output of a 300-kW motor generator set (MGS) to the CRAY C916 mainframe and IOS/SSD. Refer to Figure 7-26 for an illustration of the PDC. Table 7-7 provides specifications for the PDC.

The PDC consists of two 400-Hz output circuit breakers that distribute power to the mainframe and IOS/SSD, line and load compression lugs for power wiring, and compression screw terminals needed to attach remote voltage sensing wiring between the 300-kW MGS and the PDC.

Table 7-7. PDC Specifications

Characteristic	Specification
Height	46.50 in. (118 cm)
Width	30.00 in. (76 cm)
Depth	40.00 in. (102 cm)
Weight	550 lbs (249 kg)
Heat dissipation to air	Negligible
Access requirements	36.00 in. (91 cm) front and sides

Floor Preparation

The PDC can be located in either the computer room or equipment plant room. If the PDC is located in the computer room, you must prepare a single floor cutout for the PDC. Refer to Figure 7-27 for an illustration of this floor cutout.

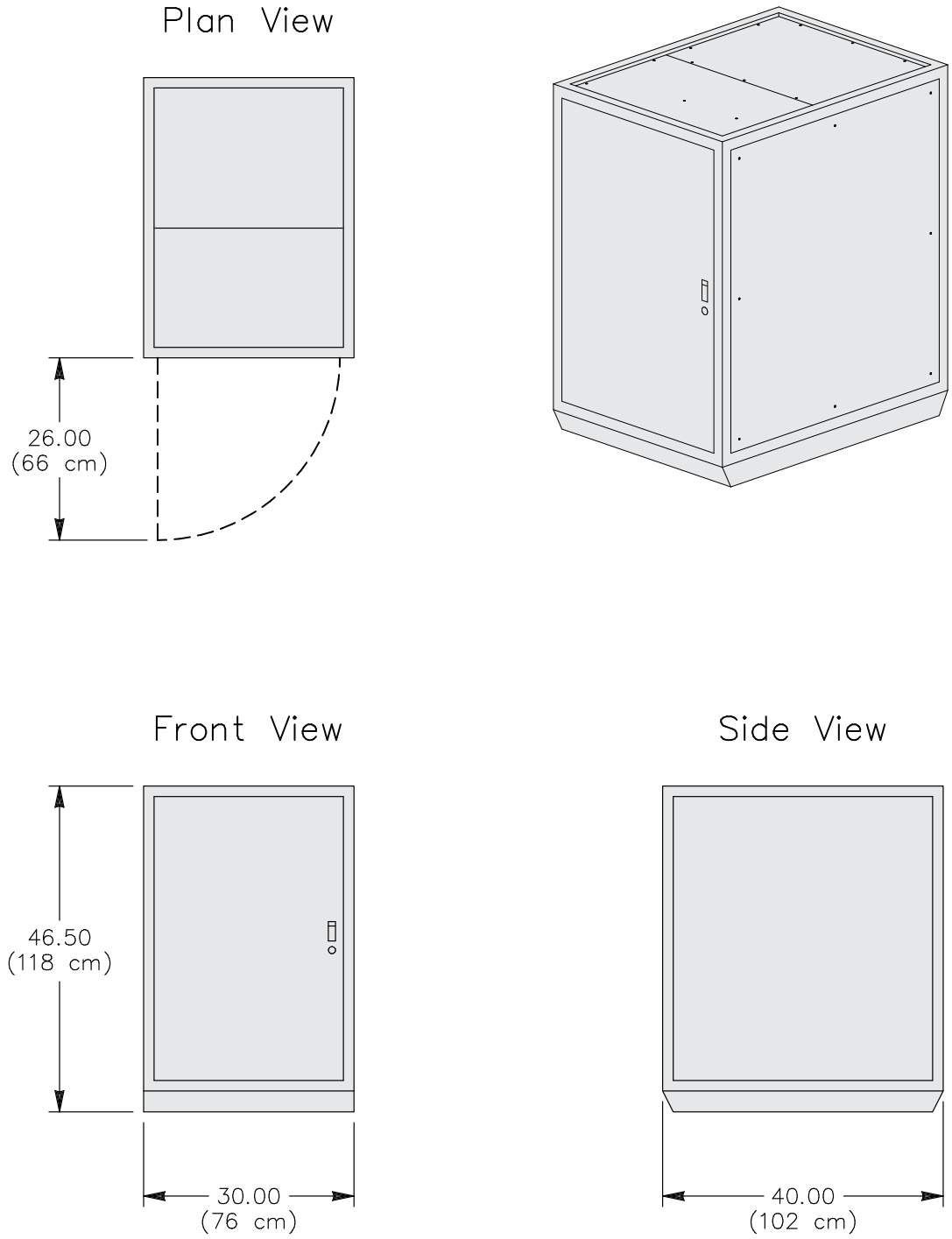


Figure 7-26. Power Distribution Cabinet (PDC)

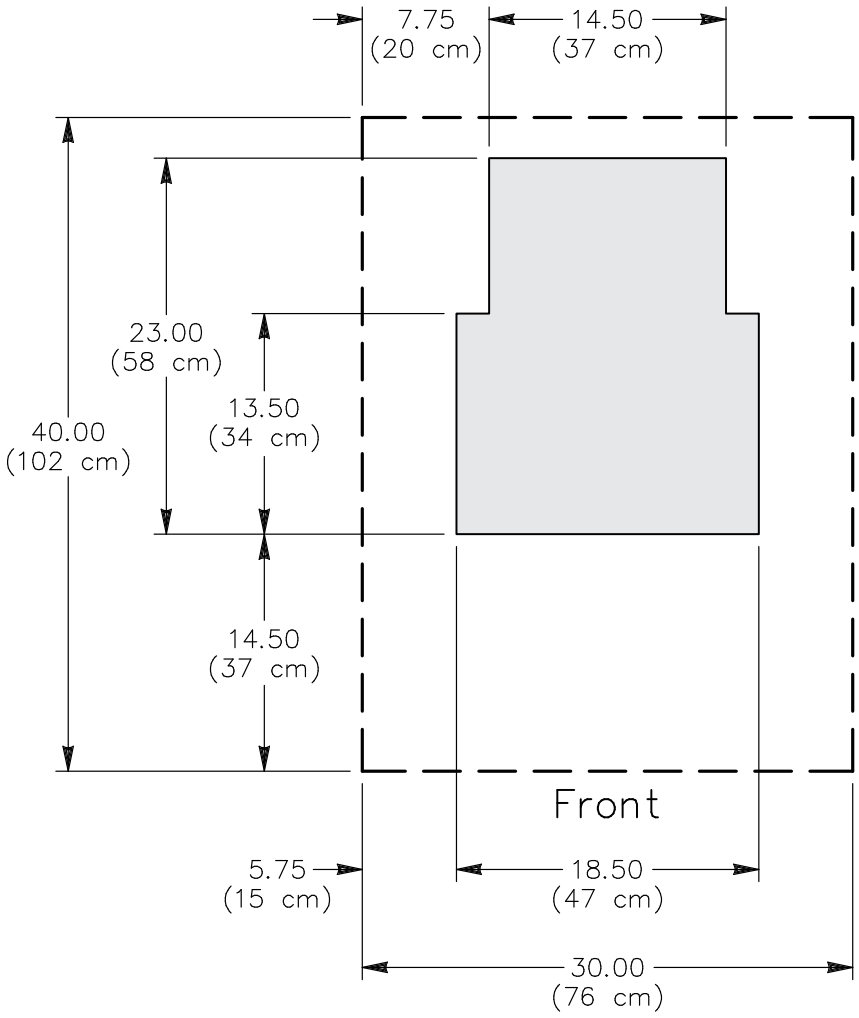


Figure 7-27. PDC Floor Cutout

Power Wiring Requirements

You must provide and install all 400-Hz input and output wiring and the remote voltage sensing control circuit for the PDC. Cray Research will provide a detailed wiring diagram early in the site planning process.

For general planning purposes, you must provide and install the following items:

- One 5-wire (three phases, neutral, and ground) 400-Hz power circuit between the 300-kW MGS and the PDC
- One 5-wire (three phases, neutral, and ground) 400-Hz power circuit between the mainframe and the PDC
- One 5-wire (three phases, neutral, and ground) 400-Hz power circuit between the IOS/SSD and the PDC

NOTE: To prevent excessive voltage drops, these circuits require multiple conductors per phase.

- One twisted 3-wire (plus ground) control circuit for remote voltage sensing between the MGS and the PDC

8 CHECKLISTS

Refer to Table 8-1 and Table 8-2 for site planning and site readiness checklists. These checklists are intended to be used as guidelines; there might be additional preparation issues at your site that are not included in these checklists.

Table 8-1. Site Planning Checklist

Yes	No	Site Planning Checklist	Comments
		Is the equipment layout established? Does the layout satisfy the equipment separation-limit requirements?	
		Has Cray Research approved the layout?	
		Have the floor cutout templates been ordered from Cray Research?	
		Has an installation date been determined? Installation date:_____	
		What is the height of the raised floor? (subfloor to top of panel) _____	
		Has an access route to the system location been identified?	

Table 8-2. Site Readiness Checklist

Yes	No	Site Planning Checklist	Comments
		Has the method of unloading the computer system been determined (equipment and/or personnel)?	
		Have arrangements been made for badges for the installation personnel? Will escorts be necessary?	
		Is the path from the unloading area to the system location clear?	
		Does the path satisfy the access requirements outlined in Section 1?	
		Is the access to the loading dock clear?	
		Is the access to the computer room clear?	
		Are the elevator measurements adequate? (if applicable)	
		Are the elevator door measurements adequate? (if applicable)	
		Is the elevator weight capacity adequate? (if applicable)	
		Are the ramp measurements adequate? (if applicable)	
		Are all the floor cutouts including those for the OWS/MWS and disk drives complete?	
		Are all floor cutouts free of burrs?	
		Have the mainframe and IOS/SSD 400-Hz input circuits been installed? Wire Size _____ Conduit Size _____ Quantity per Phase _____ Calculated Voltage Drop at Full Load _____	
		Are all 400-Hz circuits in aluminum or nonferrous conduit?	
		Have the control wires from the mainframe and IOS/SSD to the MGS been installed?	
		Have the refrigeration piping manifolds been installed according to the refrigeration piping diagram?	
		Are circuit breaker panels bonded to the signal reference grid?	
		Have the monitoring circuits to the HEUs been installed?	
		Are the receptacles for the OWS/MWS and disk drives installed and positioned to satisfy the equipment power cord length?	
		Are the circuit breaker panels and receptacles properly labeled?	

Table 8-2. Site Readiness Checklist (continued)

Yes	No	Site Planning Checklist	Comments
		Is the refrigeration piping bonded to the signal reference grid?	
		Will the raised-floor stringer system act as the signal reference grid? If so, are the stringers bolted to the pedestal heads?	
		How will the signal reference grid be constructed if the raised-floor system is not used?	
		Is the signal reference grid connected to the ground? How and where?	
		Are the raised-floor tiles conductive? (10^5 to 10^9 ohms of surface resistivity)	
		Has the computer room been tested to verify compliance with class 100,000 standards?	
		Have air handlers been tested?	
		Are the air handlers and air filters clean?	
		Does the computer room have positive air pressure?	
		Is the replacement air to the computer room filtered?	
		Is the rate of replacement air to the computer room satisfactory?	
		Does the computer room have proper humidity control?	
		Is the computer room vapor sealed?	
		Does the cooling water meet the specifications outlined in *Water Quality Requirements*, Site Engineering document 10658280? (if applicable)	
		Has the 50-Hz or 60-Hz power conditioner been load tested? (if applicable)	
		Have dedicated telephone lines for remote maintenance been installed?	
		Is the underfloor area clean?	
		Do the subfloor structures show any sign of corrosion?	
		Is the concrete subfloor sealed?	
		Do any unsealed penetrations exist in the underfloor that will allow plenum pressure to escape?	
		Are the ceiling tiles a nonshedding, vapor barrier type?	
		Does the service personnel office space meet the standards outlined in Section 1?	

Table 8-2. Site Readiness Checklist (continued)

Yes	No	Site Planning Checklist	Comments
		Is one of the following types of fire suppression systems used?	
		Halon	
		Underfloor	
		Above floor	
		Sprinklers	
		Preaction or wet type	

BIBLIOGRAPHY

Cray Research, Inc. Customer Publications

Submit orders for Cray Research, Inc. publications to the following address or telephone 800-284-2729, extension 35907.

Cray Research, Inc.
Distribution
2360 Pilot Knob Road
Mendota Heights, MN 55120

Cray Research Peripheral Equipment Site Planning Reference Manual, Cray Research publication number HR-00080.

The *Cray Research Peripheral Equipment Site Planning Reference Manual* provides site planning information about operator and maintenance workstation equipment, disk storage units, and front-end interface cabinets.

Cray Research Support Equipment Site Planning Reference Manual, Cray Research publication number HR-00082.

The *Cray Research Support Equipment Site Planning Reference Manual* provides site planning information about refrigeration condensing units (RCUs) and motor-generator sets (MGSs).

Principles of Computer Room Design, Cray Research publication number HR-04013.

The *Principles of Computer Room Design* manual describes computer room design principles to help computer room facility managers prepare, inspect, and maintain a stable, problem-free environment. Information on computer room and raised-floor construction, system cooling, environmental control, fire and lightning protection, power, and grounding is also discussed.

Safe Use and Handling of Fluorinert Liquids, Cray Research publication number HR-00306.

The *Safe Use and Handling of Fluorinert Liquids* manual is written for Cray Research, Inc. customers and field engineers whose Cray Research computer systems use Fluorinert Liquid. This manual also describes the Material Safety Data Sheets (MSDS) and explains the significance of using Fluorinert Liquid or any other chemical.

Cray Research, Inc. Site Engineering Documents

Submit orders for Cray Research, Inc. Site Engineering documents to the following address, or telephone 800-284-2729, extension 62820.

Cray Research, Inc.
Site Engineering
1620 Olson Drive
Chippewa Falls, WI 54729

Equipment Grounding for Cray Research, Inc. Computer Systems, Site Engineering document number 10658002.

The *Equipment Grounding for Cray Research, Inc. Computer Systems* document describes the equipment grounding requirements for Cray Research computer equipment.

Forklift Size Requirements for the Handling of Cray Research Equipment, Site Engineering document number 10658374.

The *Forklift Size Requirements for the Handling of Cray Research Equipment* document provides forklift requirements and recommendations for the safe handling of Cray Research computer equipment.

Refrigeration Piping and Component Installation Requirements, Site Engineering document number 10650228.

The *Refrigeration Piping and Component Installation Requirements* document describes the installation and component requirements for Cray Research refrigerant-cooled computer systems.

Vibration and Shock Limits for Installed Computer Systems, Site Engineering document number 10658300.

The *Vibration and Shock Limits for Installed Computer Systems* document identifies the limits of vibration and shock levels an installed Cray Research computer system can tolerate.

Water Quality Requirements, Site Engineering document number 10658280.

The *Water Quality Requirements* document identifies the cooling water quality requirements for a Cray Research computer system.

INDEX

E

F

G

H

I

K

L

M

N

O

P

Q

R

S

T

U

V

W